Contributions to Economics

Cesare Imbriani
Pasquale Scaramozzino *Editors*

Economic Policy Frameworks Revisited

A Restatement of the Evergreen Instruments

Springer

Contributions to Economics

The series *Contributions to Economics* provides an outlet for innovative research in all areas of economics. Books published in the series are primarily monographs and multiple author works that present new research results on a clearly defined topic, but contributed volumes and conference proceedings are also considered. All books are published in print and ebook and disseminated and promoted globally. The series and the volumes published in it are indexed by Scopus and ISI (selected volumes).

Cesare Imbriani • Pasquale Scaramozzino
Editors

Economic Policy Frameworks Revisited

A Restatement of the Evergreen Instruments

Springer

Editors
Cesare Imbriani
Department of Law and Economics
UnitelmaSapienza University of Rome
Rome, Italy

Pasquale Scaramozzino
School of Finance and Management
SOAS University of London
London, UK

Dipartimento di Economia e Finanza
Università degli Studi di Roma Tor Vergata
Rome, Italy

ISSN 1431-1933 ISSN 2197-7178 (electronic)
Contributions to Economics
ISBN 978-3-031-36517-1 ISBN 978-3-031-36518-8 (eBook)
https://doi.org/10.1007/978-3-031-36518-8

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Paper in this product is recyclable.

This volume is dedicated to the memory of Giancarlo Marini as a testimony to his originality, to his eclecticism, and to his talent for being ahead of his time.

Contents

Contributors

Leonardo Becchetti Dipartimento di Economia e Finanza, Università degli Studi di Roma Tor Vergata, Rome, Italy

Paolo Canofari Dipartimento di Scienze Economiche e Sociali, Università Politecnica delle Marche, Ancona, Italy

Angelo Castaldo Dipartimento di Studi Giuridici, Filosofici ed Economici, Università degli Studi di Roma La Sapienza, Rome, Italy

Audrey De Dominicis Dipartimento di Scienze Politiche, Università di Teramo, Teramo, Italy

Ana Gabriela Encino-Muñoz UnitelmaSapienza, Università degli Studi di Roma La Sapienza, Rome, Italy

Fabio Giudice UnitelmaSapienza, Università degli Studi di Roma La Sapienza, Rome, Italy

Cesare Imbriani Department of Law and Economics, UnitelmaSapienza University of Rome, Rome, Italy

Rama Dasi Mariani Dipartimento di Giurisprudenza, Università degli Studi Roma Tre, Rome, Italy

Piergiuseppe Morone UnitelmaSapienza, Università degli Studi di Roma La Sapienza, Rome, Italy

Alessandro Piergallini Dipartimento di Economia e Finanza, Università degli Studi di Roma Tor Vergata, Rome, Italy

Giovanni Piersanti Dipartimento di Scienze Politiche, Università di Teramo, Teramo, Italy

Rosanna Pittiglio Dipartimento di Scienze Politiche, Università degli Studi della Campania Luigi Vanvitelli, Caserta, Italy

Filippo Reganati Dipartimento di Studi Giuridici ed Economici, Università degli Studi di Roma La Sapienza, Rome, Italy

Furio Camillo Rosati Dipartimento di Economia e Finanza, Università degli Studi di Roma Tor Vergata, Rome, Italy

Domenico Sarno Dipartimento di Scienze Politiche, Università degli Studi della Campania Luigi Vanvitelli, Caserta, Italy

Pasquale Scaramozzino School of Finance and Management, SOAS University of London, London, UK
Dipartimento di Economia e Finanza, Università degli Studi di Roma Tor Vergata, Rome, Italy

Partha Sen Centre for Development Economics, Delhi, Delhi, India

Giovanni Trovato Dipartimento di Economia e Finanza, Università degli Studi di Roma Tor Vergata, Rome, Italy

Introduction: Time and Economic Policy

Cesare Imbriani and Pasquale Scaramozzino

What Is the Role of Economic Policy?

What is the role today of monetary and fiscal policy? The past few years have seen an intensification of the debate on the scope and rationale of economic policy, stimulated by the responses to the massive economic shocks which affected the global economy since the beginning of the current century (notably the financial crisis of 2007–08, the COVID-19 pandemic, and the Russian war in Ukraine). The proven effectiveness of the policy measures which have been put in place poses, however, a challenge to the many theoretical models which tend to question the desirability of discretionary fiscal and monetary policy, when not doubting their very effectiveness.

The analysis of monetary and fiscal policy in an intertemporal setting is usually cast in terms of its credibility, and is often directly related to whether it is time consistent. Kydland and Prescott (1977) asserted the superiority of simple rules over discretion. Their main argument rests on the view that rules effectively restrain the actions of the policymakers and prevent them from pursuing short-term gains, at the expense of a long-run efficient allocation of resources. Their analysis can ultimately be traced back to the debate on the desirability of active demand management policies which took place between the "Monetarists" and the "Keynesians" during the 1960s and 1970s (Friedman 1968 and Tobin 1972, were influential articles

C. Imbriani
Department of Law and Economics, UnitelmaSapienza University of Rome, Rome, Italy
e-mail: cesare.imbriani@unitelmasapienza.it

P. Scaramozzino (✉)
School of Finance and Management, SOAS University of London, London, UK

Dipartimento di Economia e Finanza, Università di Roma Tor Vergata, Rome, Italy
e-mail: ps6@soas.ac.uk

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_1

by leading authors of the two schools: see Imbriani 1979, 1981, 1984 for critical assessments of the debate).

Later contributions to the rules-*versus*-discretion debate have, however, substantially qualified the Kydland–Prescott prescription. In a stochastic context, it may be important to preserve the authorities' ability to respond to large, unforeseen shocks (Modigliani 1977). Credibility itself can be undermined when the rules become unsustainable because of shifts in the fundamentals (Lohmann 1992; Cowena et al. 2000), or when strict adherence to policy has long-lasting effects which jeopardise the authorities' ability to fulfil their commitment in the future (Drazen and Masson 1994). Barthélemy and Mengusc (2018) show that, under some circumstances, it may even be desirable for a Central Bank temporarily to deviate from its target level of inflation in order to ensure the long-run credibility of its anti-inflationary stance.

Policy design is often formulated as a game between the monetary and fiscal authorities, each one of which vies for dominance over the other party (see Nordhaus 1994 for a seminal contribution; Camous and Matveev 2023 is a recent study which shows that fiscal conditionality provisions can enhance the credibility of the Central Bank). The potential tension between fiscal and monetary authorities was apparent in the design of the European Central Bank and of the common European currency, with the euro allegedly having been "built on the principle of monetary dominance" (Schnabel 2020).

A fundamental asymmetry, however, exists between monetary and fiscal authorities: the monetary authority has an advantage over the fiscal authority because of its monopoly over the issue of *fiat* money. Furthermore, monetary policy also benefits from a greater institutional longevity because of the high political costs of tampering with the mandate of the Central Bank or with its formal structure (Lohmann 2003). These costs can effectively restrain the government from attempting to interfere with its operational independence. Efficient design of the Central Bank would involve some built-in flexibility to deal with unanticipated large shocks, which in the long run would enhance its ability to fulfil its mandate. Paradigmatic examples of the importance of the discretionary power of the monetary authorities are Paul Volker's use of interest rates to surprise markets and rein in inflation during his chairmanship of the Federal Reserve, and Mario Draghi's "whatever it takes" intervention in July 2012 which put an end to the speculative attacks against euro member states. An independent monetary authority will tend to have a longer planning horizon than the government and would therefore be less vulnerable to time inconsistency issues.

The role of the longer time horizon of the policy authorities, and in particular of the monetary institutions, has been explored in a number of path-breaking contributions by Giancarlo Marini (1985, 1986, 1987, 1988). Marini was fully aware that the monetary authorities have an advantage over the private sector thanks to their longevity, and that it is this advantage which can render monetary policy effective. In the presence of incomplete private markets, policy institutions can implement contingent forward contracts because of their time horizon and their permanence. The key for the effectiveness of policy lies therefore not in any informational advantage by the authorities but exclusively in their richer opportunity set. The Central Bank enjoys hegemonic control over the creation of liquidity. This powerful demand management tool can be applied to control not just current liquidity but future monetary aggregates too. A stark implication of this monopoly power by the Central Bank over the issue of monetary instruments is that, contrary to a commonly held view, monetary policy can be effective even under an *informational disadvantage* of the authorities. The policies of the Central Bank can also play a vital role in guiding inflation expectations, which are crucial for the stability of aggregate demand (Marini and Scaramozzino 1992, 1993).

Models of monetary policy based on asymmetric information failed to fully draw a crucial implication of the analysis: by affecting expectations of future variables, monetary policy can have an effect on current decisions by private agents. The neutrality of money cannot therefore hold, because anticipated changes in money supply can affect current real variables. Monetary policy is therefore fully vindicated.

This lack of attention to the fundamental asymmetry in the opportunity set and time horizon of private individuals and policy authorities, and especially of monetary institutions, is still a pervasive feature of some academic policy debate. This volume endeavours to address this issue by presenting a number of contributions, both theoretical and empirical, on the design and implementation of economic policies. The *fil rouge* connecting the chapters is the attention to the context in which the policy authorities operate, the analytical rigour of the analysis, and the empirical relevance of the issues addressed. This volume wishes to be a tribute to the late Giancarlo Marini, whose own contributions to a wide range of topics in economic theory and policy are a lasting legacy of his work both as a researcher and as an educator.

Summary of the Volume

A rigorous framework for economic policy requires both a sound and rigorous analytical structure, and empirical evidence on their consequences and effects. This volume is accordingly divided into two parts. The first part examines topics in the theory of monetary and fiscal policy, and the second part considers a number of applications to economic policy issues. Chapter "Intertemporal Choices, Information, and Opportunity Sets: The Effectiveness of Monetary Policy" by Imbriani and Scaramozzino addresses the key problem of how monetary policy can influence real variables. Following Marini (1985), it is argued that the key for its effectiveness lies not in an informational advantage of the monetary authorities but rather in the longevity of the monetary institutions and in their monopoly in the issue of *fiat* money. Because it can apply contingent forward contracts, the central bank can commit over a longer time horizon than the private sector. This institutional feature of monetary institutions has often been overlooked by much of the literature, but lies at the very heart of monetary policy effectiveness. Thanks to their richer opportunity set, the monetary authorities can stabilise the economy even when they are at an informational disadvantage *vis-à-vis* the private agents.

Chapter "Thinking Outside the Box: Giancarlo Marini, a Rigorous Eclectic Economist" by Imbriani and Scaramozzino offers a review of the contributions of Giancarlo Marini to a broad range of areas of economics from dynamic monetary and fiscal policy to environmental economics, and also encompassing environmental sustainability, intergenerational equity, international finance, and the empirical measurement of inflation. A distinguishing feature of Marini's research was his dissatisfaction with commonly accepted views and his quest for originality and rigour. This is particularly evident in some of his more unconventional investigations into the inflationary effects of the adoption of the euro by looking at well-known tourist guides, and into the nexus between leisure activities and social attitudes.

Many of Marini's works informed and stimulated later research. Chapter "Fiscal Policy and Sovereign Debt Dynamics: (Re-)assessing the Intertemporal Viability of the Government Budget Using a Model-Based and Consistently Measured Sustainability Indicator" by Piersanti et al. sets out a theoretically coherent indicator of public finance sustainability. Existing indicators of debt sustainability based on the debt-to-GDP ratio are inconsistent because they are constructed by relating a stock to a flow and because they ignore the country's long-run ability to meet its debt obligations. The authors build on seminal work by Giancarlo Marini (Imbriani et al. 1996; Marini 1990; Marini and Piergallini 2007) to develop a rigorous forward-looking optimising approach which directly leads to a wealth-based index of government policy sustainability. Commonly used output-based indicators can be strongly biased and misleading because they only look at the liabilities side of a country's balance sheet, but completely miss its asset side. Piersanti et al. calibrate their models to a set of European countries and obtain results which are often at variance with the mainstream consensus.

Chapter "Public Debt, Taylor Rules and Inflation Dynamics in an Overlapping Generations Model" by Alessandro Piergallini studies the interactions between fiscal and monetary policy in terms of the continuous-time overlapping generations framework developed by Marini and van der Ploeg (1988). When the government targets real government liabilities *via* gradual adjustment rules and the monetary authorities target inflation *via* a Taylor rule, a relaxation of the target stock for the government liabilities increases inflation both in the short and in the long run, even in the presence of an aggressive monetary policy stance. In order to be fully effective in achieving its targets, monetary policy thus requires that fiscal policy also fulfils its responsibilities (Draghi 2015).

The previous chapters all deal with macroeconomic policy issues for developed countries. Partha Sen in Chapter "Macroeconomic Policy and Development in India: Some Analytical Issues" explores the specific issues faced by policy authorities in developing or emerging economies. These countries faced the double task of compressing in the space of a few decades a process of economic growth which took centuries to be achieved in developed countries and of converting their production structure by reallocating labour and other resources from less productive sectors, notably agriculture, to the more developed ones (the so-called structural transformation). These countries also have to deal with a tighter external constraint than developed countries. Sen explores in detail the macroeconomic challenges encountered by policy authorities in developing countries, with a special attention to India. He argues for the need to keep the real exchange rate depreciated in order to stimulate an export-led growth, thus following the successful experience of East Asian countries.

The second part of the volume presents applications of policy to relevant economic issues. Chapter “Covid-19 Threats and Opportunities: Towards a Circular and Resilient Bioeconomy” by Giudice et al. discusses the intrinsic vulnerability to large external shocks of current economic systems, which was painfully exposed during the recent COVID-19 pandemic. It shows how a circular, bio-based economy can achieve greater resilience by reducing its dependence on fragile supply chains and by constructing more robust systems of network interconnectedness, and by enhancing the flexibility of small businesses. Giudice et al. outline a number of feasible steps which would enable a move towards a circular bioeconomy, consistent with the Ecodesign Directive of the European Union (European Commission 2022). The objectives set out by the Directive can be achieved through appropriate funding of the innovation network (from basic research to applied research and education and to piloting of new products and services), the conversion of environmentally harmful into environmentally friendly subsidies, and carefully designed product eco-labelling (Becchetti et al. 2019).

Chapter “A (Perfect) Case of Unnecessary, and Harmful Fiscal Consolidation: Italy’s Growth and Debt Since the 90s” by Piersanti extends the dynamic analysis of fiscal policy of Chapter “Fiscal Policy and Sovereign Debt Dynamics: (Re-)assessing the Intertemporal Viability of the Government Budget Using a Model-Based and Consistently Measured Sustainability Indicator” to estimate the intertemporal viability of Italy’s government budget by means of an endogenous growth model. It shows that it was the tight constraints placed on Italy’s fiscal policy according to the EMU rules which were primarily responsible for the very modest economic growth that the country has experienced since the mid-1980s. Contrary to the predictions of the *expansionary fiscal contraction* or *expansionary austerity* hypothesis, fiscal retrenchment has always had a negative effect both on the country’s growth rate and on its debt-to-GDP ratio.

Modern growth theory attributes a critical role to investment in education and human capital formation. Cross-country estimations of growth regressions, however, tend to find only a weakly significant effect of human capital on growth. The simultaneous modelling of both human capital and the labour-augmenting component of growth equations raises unobserved heterogeneity issues which are not easy to address. In Chapter “A (Perfect) Case of Unnecessary, and Harmful Fiscal Consolidation: Italy’s Growth and Debt Since the 90s”, Becchetti and Trovato build on the intuition by Bernanke and Gürkaynak (2001) that levels and growth rates of *per capita* income are determined by the same data generation process, and should therefore be studied simultaneously. They develop and implement an original empirical approach based on a semi-parametric finite mixture model, which makes it possible to relax the homogeneity assumption of traditional models. They can thus incorporate heterogeneity directly into the data generation process. Their results show that countries exhibit different growth dynamics, consistent with theoretical growth models with multiple equilibria. The findings in the chapter identify different clusters of countries and provide evidence supporting the importance of the initial conditions of schooling levels, as well as of the quality of education, legal structure, and property rights regulation.

In Chapter "Migrant Supply of Household Services and Women Time Allocation", Dasi Mariani and Rosati study another issue which can also be critical for economic growth: the allocation of time within the family and in particular the domestic production of goods and services, whose responsibility disproportionately still falls on women. As a consequence of the increased integration of labour markets in the European Union, the past few decades have seen a rise in the supply of marketable domestic services provided by low-skilled immigrants in some of the more advanced EU countries. Dasi Mariani and Rosati develop a theoretical framework to model the impact on time allocation of an increased supply of domestic marketable services. They then use the "natural experiment" of Bulgaria and Romania joining the EU and the Schengen Area of free movement of people in 2007 to study the impact on the Italian labour market of the sudden inflows of workers from those countries. Their difference-in-differences regressions show a positive effect of these inflows on native fertility, as well as a positive effect on human capital of young children in the Northern regions of the country: far from there being a trade-off between immigration and native fertility, there may actually be a *trade-in* between the two.

Chapter "Bank Financing and Start-up Survival in the Italian Economy" by Castaldo et al. looks at the role of financial markets in facilitating access to credit for small and medium enterprises and start-ups. They investigate whether access to bank credit in the early stages of a start-up's lifecycle can help predict the probability of future default of the company. This is relevant from a policy perspective because it can provide a justification for measures which facilitate access to credit, for instance through public credit guarantee programmes, interest rate subsidies, or direct lending. Castaldo et al. show that access to bank credit did have a positive and significant effect on the survival of Italian start-up firms, over a period which includes both the global financial crisis of 2007–09 and the sovereign debt crisis of 2011–12. Furthermore, short-term bank loans are found to have a stronger effect on the survival of firms than long-term loans. These results confirm the importance of providing effective support for the more financially fragile small businesses, as also argued by Giudice et al. in Chapter "Covid-19 Threats and Opportunities: Towards a Circular and Resilient Bioeconomy" of this volume.

We hope that the contributions collected in this volume are adequate testimony to the originality of Giancarlo Marini, to his eclecticism, and to his talent for being ahead of his time.

References

Barthélemy, Jean, and Eric Mengusc (2018), “The Signaling Effect of Raising Inflation”, *Journal of Economic Theory*, Vol. 178, pp. 488–516.

Becchetti, Leonardo, Francesco Salustri and Pasquale Scaramozzino (2019), “Making Information on CSR Scores Salient: A Randomized Field Experiment, *Oxford Bulletin of Economics and Statistics*, Vol. 81, Issue 6, December, pp. 1193–1213.

Bernanke, B. S., and R. S. Gürkaynak (2001), “Is Growth Endogenous? Taking Mankiw, Romer and Weil Seriously”, NBER Working Paper No. 8365.

Camous, Antoine, and Dmitry Matveev (2023), “The Central Bank Strikes Back! Credibility of Monetary Policy under Fiscal Influence”, *Economic Journal*, Vol. 133, January.

Cowena, Tyler, Amihai Glazerb and Katarina Zajc (2000), “Credibility May Require Discretion, Not Rules”, *Journal of Public Economics*, Vol. 76, pp. 295–306.

Draghi, Mario (2015), “Structural Reforms, Inflation and Monetary Policy”, Introductory speech at the ECB Forum on Central Banking, Sintra, Portugal, 22 May.

Drazen, Allan, and Paul Masson (1994), “Credibility of Policies Versus Credibility of Policy Makers”, *Quarterly Journal of Economics*, Vol. 109, Issue 3, August, pp. 735–754.

European Commission (2022) Sustainable product policy & ecodesign. https://single-market-economy.ec.europa.eu/industry/sustainability/sustainable-product-policy-ecodesign_en. Accessed 10.09.2022.

Friedman, Milton (1968), “The Role of Monetary Policy”, *American Economic Review*, Vol. 58, No.1, March, pp. 1–17.

Imbriani, Cesare (1979), *Il monetarismo, una riconsiderazione*, Napoli, Liguori.

Imbriani, Cesare (1981), “Il modello della sintesi e l’analisi monetaria”, in Augusto Graziani, Cesare Imbriani and Bruno Jossa (eds.), *Studi di economia keynesiana*, Napoli, Liguori.

Imbriani, Cesare (1984), “Introduzione. L’analisi empirica del monetarismo”, in Adalgiso Amendola, Domenico Piccolo e Argia M. Sbordone (eds.), *Monetarismo e causalità nel modello di St. Louis*, Milano, Franco Angeli.

Imbriani, Cesare, Raul de Luzenberger and Giancarlo Marini (1996), “Sustainability Issues in the Process of European Integration”, in Mario Baldassarri, Cesare Imbriani and Dominick Salvatore (eds.), *The International System between New Integration and Neo-Protectionism*, McGraw-Hill, 1996.

Lohmann, Susanne (1992), “Optimal Commitment in Monetary Policy: Credibility versus Flexibility”, *The American Economic Review*, Vol. 82, No. 1, March, pp. 273-286.

Lohmann, Susanne (2003), “Why Do Institutions Matter? An Audience-Cost Theory of Institutional Commitment”, *Governance: An International Journal of Policy, Administration, and Institutions*, Vol. 16, No. 1, January.

Kydland, Finn E., and Edward C. Prescott (1977), “Rules Rather than Discretion: The Inconsistency of Optimal Plans”, *Journal of Political Economy*, Vol. 85, No. 3, June, pp. 473–492.

Marini, Giancarlo (1985), “Intertemporal Substitution and the Role of Monetary Policy”, *The Economic Journal*, Vol. 95, No. 377, March, pp. 87–100.

Marini, Giancarlo (1986), “Employment Fluctuations and Demand Management”, *Economica*, Vol. 53, No. 210, May, pp. 209-218.

Marini, Giancarlo (1987), “Price Variability, Supply-Side Policies and Monetary Rules”, *Economica*, Vol. 54, No. 213, February, pp. 109–111.

Marini, Giancarlo (1988), “Policy Effectiveness and Design in New Classical Models”, *Oxford Economic Papers*, Vol. 40, No. 4, December, pp. 646–654.

Marini, Giancarlo (1990), “Teoria economica e debito pubblico”, *Giornale degli Economisti e Annali di Economia*, Nuova Serie, Anno 49, No. 5/6 (Maggio-Giugno 1990), pp. 153–174.

Marini, Giancarlo, and Alessandro Piergallini (2007), “Indicators and Tests of Fiscal Sustainability: An Integrated Approach”, Centre for Financial and Management Studies, SOAS University of London, Discussion Paper No. 75, May.

Marini, Giancarlo, and Frederick van der Ploeg (1988), “Monetary and Fiscal Policy in an Optimising Model with Capital Accumulation and Finite Lives”, *The Economic Journal*, vol. 98, September, pp. 772–786.

Marini, Giancarlo, and Pasquale Scaramozzino (1992), “Expected Inflation and Output Variability in Flexible Price and Contracting Models”, *Oxford Economic Papers*, Vol. 44, No. 2, April, pp. 232–241.

Marini, Giancarlo, and Pasquale Scaramozzino (1993), “Inflation Expectations, Price Flexibility and Output Variability in Macromodels”, *Structural Change and Economic Dynamics*, Vol. 4, No. 2, December, pp. 367–383.

Modigliani, Franco (1977), “The Monetarist Controversy or, Should We Forsake Stabilization Policies?”, *American Economic Review*, Vol. 67, No. 2, March, pp. 1–19.

Nordhaus, William D. (1994), “Policy Games: Coordination and Independence in Monetary and Fiscal Policies”, *Brookings Papers on Economic Activity*, Issue 2, pp. 139–216.

Schnabel, Isabel (2020), “The Shadow of Fiscal Dominance: Misconceptions, Perceptions and Perspectives”, Speech given at the Centre for European Reform and the Eurofi Financial Forum, *Is the Current ECB Monetary Policy Doing More Harm than Good and What Are the Alternatives?*, Berlin, September 11.

Tobin, James (1972), “Inflation and Unemployment”, *American Economic Review*, Vol. 62, No. 1/2, March, pp. 1–18.

Part I
Monetary and Fiscal Policy: Theoretical Issues

Intertemporal Choices, Information, and Opportunity Sets: The Effectiveness of Monetary Policy

Cesare Imbriani and Pasquale Scaramozzino

Introduction

The financial crisis of 2008 and the current COVID-19 pandemic have brought into sharp focus the need for an effective macroeconomic policy which can respond to aggregate shocks and avoid a deep and prolonged recession. In the aftermath of the financial crisis, the success of the robust counter-cyclical policies deployed in the USA stood in stark contrast to the more modest outcomes achieved by the cautious policies implemented in the European Union during the early stages of the crisis. By contrast, the responses by EU institutions to the COVID-19 pandemic, including the NextGenerationEU recovery plan, have been timelier and more aggressive, and proved effective in limiting the severe contraction in economic activity that would have resulted from the spread of the virus.

The debate on the effectiveness and desirability of counter-cyclical policies has a long and distinguished cultural history, which acquired particular salience during the debate on monetarist *versus* Keynesian policies since the 1960s. Arguing against the fiscal policies implemented by most Western countries since the end of the Second World War, Friedman (1968) maintained that systematic attempts to control the economy through fiscal policies would be counter-productive and would in fact exacerbate output fluctuations. The criticism of Keynesian stabilisation policies

C. Imbriani
Department of Law and Economics, UnitelmaSapienza University of Rome, Rome, Italy
e-mail: cesare.imbriani@unitelmasapienza.it

P. Scaramozzino (✉)
School of Finance and Management, SOAS University of London, London, UK

Dipartimento di Economia e Finanza, Università di Roma Tor Vergata, Rome, Italy
e-mail: ps6@soas.ac.uk

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_2

advanced by Milton Friedman and the monetarists[1] relied on two key arguments. First, the low values of the estimated parameters relating fiscal policy variables to output, and the instability of the consumption function schedule, undermined the effectiveness of fiscal policy as a reliable stabilisation tool. The interest inelasticity of the estimated demand for money schedule and its alleged greater statistical stability than the consumption function would justify a shift away from fiscal policy and towards monetary policy as the preferred tool for controlling the economy.

The second argument against Keynesian policies is possibly more radical and rests on the intrinsic dynamic features of a capitalist economy. According to Friedman, a decentralised market economy is inherently stable. Attempts to interfere with the endogenous adjustment process of markets operating through the price system would inevitably exacerbate rather than dampen output fluctuations. In particular, a constant and predictable rate of growth of money supply can anchor the expectations of the private sector and allow for a speedy return of prices and output to their market clearing equilibrium values.[2] Simple rules would be preferable to discretion because the latter would risk destabilising the economy by interfering with the stabilising mechanism of the price system. Kydland and Prescott (1977) purported to support Friedman's prescriptions by showing that, in a dynamic setting with endogenous expectations, a time consistent policy would not coincide with a first-best optimal policy. Their conclusion that rules are always superior and that discretionary policy should not be attempted appears, however, to be unwarranted in a second-best world, especially in the presence of unforeseeable real demand or supply shocks, or indeed of systemic financial shocks which were not considered by Kydland and Prescott in their original analysis.

In a criticism of the type of monetarist policies advocated by Friedman, Tobin (1970) showed that the lead-lag dynamics between monetary and output growth can actually be consistent with money aggregates adjusting to the business cycles rather than the other way around. In his presidential address to the American Economic Association, Tobin (1972) further discusses the difficulties of relying on nominal wage adjustments to stabilise the labour market and argues that the asymmetric consequences of inflation *versus* deflation offer a justification for active policies.

A rebuttal of the monetarist view championed by Friedman was put forward by Modigliani (1977). He argued that it is difficult to attribute the fluctuations of output in market economies since World War II to erratic growth of money supply, or to unintended consequences of stabilisation policies. The fundamental objection raised by Modigliani, however, is that monetary policy alone would be insufficient to correct the imbalances which result from exogenous shocks and

[1] Friedman (1956, 1968, 1969, 1970), Johnson (1971, 1972).

[2] Johnson (1971) emphasized the suitability of the monetarist approach to explain the rapid rise in inflation during the 1960s. Imbriani (1979) provides a detailed critical account of the views of Friedman; see also Imbriani (1981) for a discussion of monetarism in relation to the neoclassical-Keynesian synthesis, and Imbriani (1984) for an analysis of empirical evidence in the context of the St. Louis econometric model.

which have an unequal impact on the different sectors of the economy. Contrary to the recommendations by Kydland and Prescott (1977), the sectoral dimension of the shocks requires that, in addition to their stabilisation role, economic policies must also play an allocative function to sustain the process of accumulation in the face of an inadequate effort by the private sector and the failure of the price system to rapidly stabilise the economy.

Ultimately, the key difference between Modigliani and the Keynesians on the one hand and Friedman and the monetarists on the other is, however, due to a different *Weltanschauung*, with Modigliani maintaining that a capitalist market economy is dynamically unstable and may be unable rapidly to absorb the effects of exogenous shocks. The price system and the operation of automatic stabilisers may not be enough to restore equilibrium, and discretionary counter-cyclical policy may be necessary.

The intellectual *témoin* of Milton Friedman's monetarism was taken up in the 1970s and 1980s by Lucas, Sargent, Barro, and other proponents of the new classical macroeconomics. They introduced the rational expectations hypothesis (REH) in macroeconomic models and obtained strong money neutrality propositions. Their result that only unanticipated monetary shocks matter appeared to put to rest the notion that systematic counter-cyclical monetary policy may be effective in stabilising output in the face of shocks (Lucas 1972, 1973; Sargent and Wallace 1975; Barro 1976).[3] Their views relied on the seminal contribution by Phelps et al. (1970) on the microfoundations of macroeconomics and maintained that conventional Keynesian policies had no rigorous underpinnings in terms of rational behaviour by economic agents. Optimising individuals would anticipate systematic policies, thereby undoing the effects of counter-cyclical measures. Any systematic attempts to stabilise the economy would therefore prove futile because rational forward-looking agents would anticipate them and neutralise their effects.

Systematic budgetary policies could still play an important allocative role, as cogently explained by Buiter (1984). The ability of monetary policy to affect real economic variables would, however, be severely impaired if it could only rely on "surprise" monetary shocks generating misperceptions and thereby inducing a real response. This argument was central to the new classical macroeconomics and to their contention that simple monetary rules are superior to discretion in the conduct of monetary policy. Possible exceptions could be the presence of nominal rigidities, which prevent a full and timely adjustment of prices to the monetary aggregates, or asymmetric information between the policy authorities and the public, with the former enjoying an informational advantage which they could exploit for stabilisation purposes. The neutrality outcome relies on continuous market clearing and on perfectly flexible wages and prices: it is possible to show that under nominal rigidities systematic policy still has real effects, albeit only in the short run (Fischer 1977).

[3] See Attfield et al. (1985) for a clear and thoughtful discussion of the REH and of its implications for macroeconomics.

Tobin (1980) set out a detailed and thoughtful critique of the "rational expectations" variety of monetarism. In a second-best world without a full set of contingent markets, the assumption of rational expectations can be used as an attempt to approximate the Arrow–Debreu conclusions (Arrow 1953, and Debreu 1959; see also Hahn 1982). The main appeal of the assumption is that it recognises that agents learn from past experience and make full use of all the information available to them: in particular, their expectations are consistent with the model of the economy. Outside of steady-state equilibrium, however, it is not clear how to define consistency of expectations. The economy could be subject to shocks which are difficult to identify; furthermore, agents may disagree about the nature of the shocks and about their future consequences. Indeed, it is precisely because agents differ in their assessments of the probability distributions of future variables that trades in financial markets take place. Moreover, in a stochastic environment and under risk aversion, the certainty-equivalent value of a payoff does not usually coincide with its mathematical expectation (Tobin 1958). The rational expectations approach, therefore, does not appear to be entirely consistent with rational behaviour under uncertainty. In a dynamic setting, furthermore, even fully anticipated changes in the rate of inflation affect the relative returns on monetary and real assets, and monetary policy is not super-neutral (Tobin 1965; see also the illuminating discussion in Harris 1981).

It has been argued that monetary policy can still affect real variables if the authorities enjoy an informational advantage *vis-à-vis* the private sector. The monetary authorities could exploit their superior information and "deceive" the public (Barro 1976). Romer and Romer (2000) show that the Federal Reserve does possess information about the future state of the economy which is not available to the market. This privileged information pertains both to inflation and to real output. The actions of the monetary authorities are regularly scrutinised by agents with a view to inferring this hidden information. Woodford (2003) extends the notion of asymmetric information and refines it in terms of cognitive frictions, following Sims's (2003) rational inattention hypothesis. Market participants are unable fully to process all the information available to them, and this can be observationally equivalent to private agents being at an informational disadvantage relative to the policy authorities (see also Angeletos and Lian 2016).

From the perspective of the current policy debate, the macroeconomic controversies that took place since the 1970s and which were encapsulated in the then dominant new classical macroeconomics might seem outdated. Their arguments on the neutrality of policy, both fiscal (Ricardian debt neutrality) and monetary (only unanticipated money shocks matter), may be seen as largely irrelevant in the face of what appears to be overwhelming evidence of the effectiveness of expansionary policies in managing the large shocks and in limiting the depth of the recessions.

The general questions about the appropriateness and the counter-cyclical effects of macroeconomic policies are, however, still very much alive. With regard to fiscal policy, the debate centres on the magnitude of the fiscal multipliers and on the sustainability of the large public debts which have been dramatically increased in an attempt to counter the declining levels of economic activity (Blanchard and Leigh

2013). Objections to the scale and magnitude of the current interventions have been raised on the grounds that future generations may have to bear the full brunt of redressing the current fiscal imbalances.

Concerning monetary policy, the implementation of quantitative easing and of unconventional programmes by the monetary authorities is bound to have allocative consequences, in addition to their more usual stabilisation effects. The purchase by central banks of securities issued by private corporations affects relative asset prices and introduces asymmetries across different sectors of the economy. Further, there are concerns that the size of the monetary stimulus in advanced economies might trigger a resurgence of inflationary pressures (Summers 2021).

Opportunity Sets and the Effectiveness of Monetary Policy

A critical question which is still open concerns the fundamental mechanisms for the effectiveness of monetary policy. It has long been argued that a crucial issue is the asymmetry of information between the policy authorities and the private sector, with the former enjoying an informational advantage over the latter.

An important and often overlooked aspect in the analysis of monetary policy, however, is that monetary policy has an advantage over the private sector because of the longevity of its institutions and its exclusive power to issue *fiat* money. Even in the presence of rational expectations, perfectly flexible prices, continuous market clearing, and symmetric information between the authorities and the private sector, systematic demand management policies can still be effective stabilisation tools. The key for this result is that the policy authorities have a broader opportunity set than the private sector insofar as they are able to commit themselves over a longer time horizon than private individuals. In particular, policy authorities can commit to rules over a longer time horizon than private individuals. This asymmetry in the effective planning horizon can be crucial to make monetary and fiscal policy potentially successful in their counter-cyclical efforts.[4]

Indeed, it is the very fact that central banks are not constrained to a limited time horizon, together with their ability to issue fiduciary means of payments, which defines their role. This institutional feature of monetary institutions has, however, been overlooked by much of the recent literature on the effectiveness of monetary policy, which thus draws its implications from a misleading model of a monetary economy. This point has been forcefully made by Marini in a number of original and powerful contributions (Marini 1985, 1986, 1987, 1988). He demonstrated that, even under perfectly flexible prices and with rational expectations, the effectiveness

[4] Mario Draghi's celebrated "Whatever it takes" speech on 26 July 2012 at UKTI's Global Investment Conference is a vindication of the effectiveness of the monetary authorities in coordinating expectations and addressing market failures, thanks to their institutional position and to their ability to operate over a longer time horizon.

of aggregate demand management policy can be restored when agents engage in intertemporal substitution and face a signal extraction problem. The crucial distinction here is between the *information sets* and the *opportunity sets* of the public and the private sectors of the economy. Thanks to its wider opportunity set, the monetary authorities can succeed in stabilising the economy even if they are at an informational disadvantage relative to the private sector.

The potential for monetary policy to affect real variables by influencing the forecast of future prices had already been examined by Turnovsky (1980), in a context, however, where agents can observe all the current realisations of the stochastic disturbances. Weiss (1980, 1982) assumes asymmetric information within the private sectors, with workers knowing less than capitalists and with the monetary authorities sharing the same information set as the least informed private agents. In such a framework, monetary policy can be effective through a mechanism of revision of expectations. Nakamura and Steinsson (2018) have more recently shown that monetary policy could play a signalling role by affecting the private sector's expectations about the future path of the natural rate of interest, thanks to the superior information set with which the central bank is endowed. Jarociński and Karadi (2018) look at central bank announcements and show that they simultaneously convey information about both monetary policy and its assessment of the economic outlook. With reference to the USA, Hoesch et al. (2020) argue that the Federal Reserve does possess insider information on the future path of interest rates, but that the ability of the private sector to interpret the monetary policy signals may be impaired during periods of instability.

The analysis of Marini (1985) is, however, able to establish the effectiveness of monetary policy much more generally and without any asymmetry of information with the private sector being required, because it shows that the expected future rate of inflation simply depends upon the current expectations of future (conditional) policy responses. The expected rate of inflation directly influences the economy-wide nominal interest rate, unperceived monetary growth, and the local real rate of interest, and therefore also affects real variables. Because of its ability to apply contingent forward contracts, the central bank can commit over a longer horizon than the private sector. The longevity of the monetary policy institutions is the key for the effectiveness of their stabilisation policy, even in the absence of any privileged information by the central bank.

Monetary policy can also be effective in influencing the rate of capital accumulation and the level of consumption in the long run, thanks to its longer time horizon than the private sector. This has been established by Marini and van der Ploeg (1988a, b) in the context of overlapping generations models with a positive birth and death rate. The government can commit itself to policies which involve transfers to future and as yet unborn generations. Monetary policy can thus counteract the private sector's tendency to underinvest when agents have a finite time horizon, and stimulate capital investment and steady-state output levels.

The key for these results is always that, in the presence of incomplete private markets, the government has a richer opportunity set than the private sector because it can replicate contingent forward contracts.

The structure of this chapter is as follows. The next section summarises Barro's (1976) rational expectations model with imperfect information and market clearing. Section "Intertemporal Choices and Stabilisation Policy" shows that stabilisation policy can be effective even in this model. Section "Monetary Policy in the Long Run" discusses the effects of money growth in the long run. Section "Conclusions" concludes.

Imperfect Information and Market Clearing

The importance of the greater opportunity set afforded to the monetary authorities relative to the private sector can be seen by using Barro's (1976) model of production and expenditure. Barro's set-up is an elegant and useful framework to study the stabilisation effects of monetary policy in a new classical macroeconomic set-up. Agents specialise in acquiring information in their local environment, but their knowledge of economy-wide variables is less accurate. This asymmetric information is captured in the model by assuming that the realisations of local variables are observed at the exact time they occur, whereas macroeconomic variables are only observed after a time lag. Individuals inhabit isolated islands: they directly observe the local price and make optimal inferences about the current economy-wide variables by solving a signal extraction problem conditional on their information set. This differential information between local and aggregate variables is responsible for a potential misperception of nominal changes in prices for real ones and could lead agents to alter their real demand or supply in response to purely nominal shocks.

Each island/market produces a non-durable commodity indexed by z. The supply of commodity z at time t depends on the current price of output in market z relative to the price which is expected to prevail in the next period, on expected wealth, and on systematic factors. Omitting for simplicity the systematic factors, the supply of output in market z can be written in log-linearised form as:

$$y_t^s(z) = \alpha_s \left[P_t(z) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)\right] + \\ - \beta_s \left[M_t(z) + \mathbb{E}\left(\Delta M_{t+1}|\Omega_t(z)\right) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)\right] + \varepsilon_t^s(z) \qquad (1)$$

where $P_t(z)$ is the price of commodity z at time t, $\Omega_t(z)$ is the information set, P_{t+1} is the aggregate price at time $t+1$, $M_t(z)$ is money held by participants in market z, $\Delta M_{t+1} \equiv M_{t+1} - M_t$ are governmental money transfers at the start of period $t+1$, $\varepsilon_t^s(z)$ is an idiosyncratic supply shock which averages to zero across all markets, and α_s and β_s are positive constants. The first term $[P_t(z) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)]$ in Eq. (1) captures intertemporal substitution in leisure and labour supply, whilst the second term $[M_t(z) + \mathbb{E}\left(\Delta M_{t+1}|\Omega_t(z)\right) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)]$ is a negative real wealth effect through increased demand for leisure. The substitution effect is assumed to dominate the wealth effect: $\alpha_s > \beta_s > 0$.

The information set in market z, $\Omega_t(z)$, includes all the past history of the economy, the current price prevailing in the market z, $P_t(z)$, and the model itself. If the full information set at time t is denoted by Ω_t we thus have $\Omega_t(z) \equiv \Omega_{t-1} \cup \{P_t(z)\}$.The demand for output in market z is given by:

$$y_t^d(z) = -\alpha_d \left[P_t(z) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)\right] +$$

$$+ \beta_d \left[M_t(z) + \mathbb{E}\left(\Delta M_{t+1}|\Omega_t(z)\right) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)\right] + \varepsilon_t^d(z) \tag{2}$$

where α_d and β_d are again positive constants which capture intertemporal substitution and the real wealth effect, respectively, and $\varepsilon_t^d(z)$ is an idiosyncratic demand shock which averages to zero across all markets. The substitution effect is negative due to price speculation by demanders, and as is the case for supply it is assumed to dominate the wealth effect in absolute value: $\alpha_d > \beta_d > 0$.

The market clearing condition for market z requires that supply equals demand:

$$y_t^s(z) = y_t^d(z) = y_t(z) \tag{3}$$

It is helpful to define the following coefficients for the sums of the substitution and the wealth effects:

$$\alpha \equiv \alpha_d + \alpha_s \tag{4}$$

$$\beta \equiv \beta_d + \beta_s \tag{5}$$

The excess demand shock for market z is defined as:

$$\varepsilon_t(z) \equiv \varepsilon_t^d(z) - \varepsilon_t^s(z) \tag{6}$$

and is assumed to have a normal distribution: $\varepsilon_t(z) \sim N\left(0, \sigma_\varepsilon^2\right)$. The stochastic structure of the economy is completed by an aggregate random shock, u_t, which is required to determine output. The random variable u_t can in turn be thought of as the difference between a demand and a supply disturbance:

$$u_t \equiv u_t^d - u_t^s \tag{7}$$

The aggregate price index P_t and output y_t are (geometric, unweighted) averages across all markets z of the local prices $P_t(z)$ and outputs $y_t(z)$, respectively:

$$P_t \equiv \sum\nolimits_z P_t(z) \tag{8}$$

$$y_t \equiv \sum\nolimits_z y_t(z) \tag{9}$$

The idiosyncratic demand and supply shocks average out to zero across all markets z. The excess demand shocks must therefore also average to zero:

$$\sum_z \varepsilon_t(z) = 0 \tag{10}$$

The economy-wide shock u_t is assumed to follow a random walk:

$$u_t = u_{t-1} + v_t \tag{11}$$

where $v_t \sim N\left(0, \sigma_v^2\right)$ is a white noise which is orthogonal to the idiosyncratic shocks $\varepsilon_t(z)$.

Money growth can be described in terms of a stochastic control rule which includes both a systematic and a random component:

$$\Delta M_t \equiv M_t - M_{t-1} = g + m_t + \boldsymbol{f}_t' \cdot \boldsymbol{\xi}_t(l) \tag{12}$$

where g is a constant, $m_t \sim N\left(0, \sigma_m^2\right)$ is the unanticipated component of monetary policy, $\boldsymbol{f}_t$ is a $(k \times 1)$ vector of policy parameters, and $\boldsymbol{\xi}_t(l)$ is a $(k \times 1)$ vector of lagged economy-wide variables. Without loss of generality one can set $g = 0$.

All the stochastic components of the model can be expressed in compact form by defining the vector $\boldsymbol{\eta}_t$ as follows:

$$\boldsymbol{\eta}_t \equiv (\varepsilon_t, v_t, m_t)' \tag{13}$$

with $\boldsymbol{\sigma}_\eta^2 = \left(\sigma_\varepsilon^2, \sigma_v^2, \sigma_m^2\right)'$, and

$$\mathbb{E}\left(\boldsymbol{\eta}_t \cdot \boldsymbol{\eta}_s'\right) = \begin{cases} 0 \text{ if } t \neq s \\ diag\left(\sigma_\varepsilon^2, \sigma_v^2, \sigma_m^2\right) \text{ if } t = s \end{cases} \tag{14}$$

where $diag(\cdot)$ denotes a diagonal matrix. The solution of the model will yield a set of values for prices and output: $(P_t(z), P_t, y_t)$. This will in general be different from the full information solution, *i.e.* the solution which would be obtained under a full information set.

Barro completes the model by setting the following monetary feedback rule:

$$\Delta M_t = m_t + \gamma_1 v_{t-1} \tag{15}$$

This policy is meant to capture a counter-cyclical reaction to the last period's price level, with $\gamma_1 < 0$ representing the policy feedback parameter. Barro shows that this rule is ineffective, in the sense that it is not able to move output away from its full information equilibrium. As will be shown in the next section with a more general monetary feedback rule, this assertion by Barro is indeed correct. The monetary rule postulated by Barro is, however, the *only* one for which policy ineffectiveness holds.

The reason for this is a rather peculiar feature of Barro's model, where money is characterised as a store of value for period $t+1$ and only monetary growth estimates for periods from $t+2$ onwards matter. For a more general monetary feedback rule, policy effectiveness is restored. Moreover, it is possible to identify a broad class of feedback rules which in principle can perfectly stabilise output around its full information value.

Intertemporal Choices and Stabilisation Policy

An elegant and powerful demonstration of the effectiveness of monetary policy under perfectly flexible prices, market clearing, and rational expectations is due to Marini (1985). Policy effectiveness does not depend in any way on an informational advantage of the policy authorities. Indeed, monetary policy can be effective even when the authorities are at an informational disadvantage *vis-à-vis* the private sector.

In order to establish this result, consider the following general class of purely conditional money growth rules:

$$\Delta M_t \equiv M_t - M_{t-1} = m_t + \sum_{j=1}^{\infty} \gamma_j v_{t-j} + \sum_{j=1}^{\infty} \delta_j m_{t-j} \tag{16}$$

The set of monetary growth rules described by (16) is more general than Barro's (15) in that it allows for a richer set of responses to lagged variables. Private agents cannot observe the current aggregate variables, but they can solve a signal extraction problem. The information set on which private agents condition their inferences includes all past aggregate information plus the local price $P_t(z)$, and also comprises the monetary rule (16):

$$\Omega_t(z) = \{(P_{t-1}, P_{t-2}, \ldots; M_{t-1}, M_{t-2}, \ldots; v_{t-1}, v_{t-2}, \ldots; m_{t-1}, m_{t-1}, \ldots) \cup P_t(z)\} \tag{17}$$

The benchmark "full information" solution would be the equilibrium values of the real variables under full contemporaneous information, *i.e.* when the information set also includes all current contemporaneous variables:

$$\Omega_t = \{\Omega_t(z) \cup (m_t, M_t, \varepsilon_t(z), P_t)\} \tag{18}$$

It should be noted that, strictly speaking, knowledge of any one of the contemporaneous variables in Ω_t would be sufficient for private agents to infer exactly all the remaining ones.

A crucial feature of the model is the presence of the substitution effect, which is critical both for introducing an intertemporal aspect in the labour supply and in consumption choices and for inducing agents to form expectations and address the associated signal extraction problem. As we shall see, it is this intertemporal feature which is responsible for the potential effectiveness of policy.

Under imperfect information, the intertemporal substitution term takes the form:

$$P_t(z) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right)$$

We can also define a "full information" intertemporal substitution term, where agents can form expectation conditional on the full information set Ω_t:

$$P_t^*(z) - \mathbb{E}\left(P_{t+1}^*|\Omega_t\right)$$

Solving the model by undetermined coefficients (see Marini 1985) the difference between the actual and the full information substitution terms, D_t, is given by:

$$\begin{aligned} D_t &\equiv P_t(z) - \mathbb{E}\left(P_{t+1}|\Omega_t(z)\right) - \left[P_t^*(z) - \mathbb{E}\left(P_{t+1}^*|\Omega_t\right)\right] \\ &= \frac{\beta}{\alpha}\left[m_t - \mathbb{E}\left(m_t|\Omega_t(z)\right)\right] + \frac{1}{\alpha}\left[v_t - \mathbb{E}\left(v_t|\Omega_t(z)\right)\right] \\ &- \frac{\beta}{\alpha}\sum_{i=1}^{\infty}\left(\frac{\alpha-\beta}{\alpha}\right)^{i-1}\left[\mathbb{E}\left(\Delta M_{t+1+i}|\Omega_t(z)\right) - \mathbb{E}\left(\Delta M_{t+1+i}|\Omega_t\right)\right] \end{aligned} \tag{19}$$

This difference can be expressed in terms of the current monetary shock, $[m_t - \mathbb{E}\left(m_t|\Omega_t(z)\right)]$, and of the current aggregate shock, $[v_t - \mathbb{E}\left(v_t|\Omega_t(z)\right)]$:

$$\begin{aligned} D_t &= \frac{\beta}{\alpha}\left[1 + \sum_{i=1}^{\infty}\left(\frac{\alpha-\beta}{\alpha}\right)^{i-1}\delta_{i+1}\right]\left[m_t - \mathbb{E}\left(m_t|\Omega_t(z)\right)\right] \\ &+ \frac{1}{\alpha}\left[1 + \beta\sum_{i=1}^{\infty}\left(\frac{\alpha-\beta}{\alpha}\right)^{i-1}\gamma_{i+1}\right]\left[v_t - \mathbb{E}\left(v_t|\Omega_t(z)\right)\right] \end{aligned} \tag{20}$$

In the framework of this model, policy can be fully effective in stabilising output if it is able to eliminate the difference between the actual and the full information substitution terms. It is, however, immediate from (20) that perfect stabilisation of output around its full information value can always be achieved by simply setting the coefficients on the current monetary and aggregate shocks equal to zero:

$$1 + \sum_{i=1}^{\infty}\left(\frac{\alpha-\beta}{\alpha}\right)^{i-1}\delta_{i+1} = 0 \tag{21a}$$

$$1 + \beta\sum_{i=1}^{\infty}\left(\frac{\alpha-\beta}{\alpha}\right)^{i-1}\gamma_{i+1} = 0 \tag{21b}$$

There is an infinite number of policy parameters γ_i and δ_i in the conditional money growth rule (16) which satisfy the above conditions (21a) and (21b). As an illustration, a trivial solution is the following:

$$\delta_2 = \delta_3 = \cdots = \delta_N = \delta_{N+2} = \cdots = 0, \quad \delta_{N+1} = -\left(\frac{\alpha}{\alpha - \beta}\right)^{N-1} \tag{22a}$$

$$\gamma_2 = \gamma_3 = \cdots = \gamma_N = \gamma_{N+2} = \cdots = 0, \gamma_{N+1} = -\frac{1}{\beta}\left(\frac{\alpha}{\alpha - \beta}\right)^{N-1} \tag{22b}$$

Replacing (22a) and (22b) into (19) yields $D_t = 0$: the monetary authorities can always perfectly stabilise output around its "full information" level. This result is obtained despite the fact that the monetary authorities only use one piece of information lagged N periods, no matter how far in the past. What matters for policy effectiveness is not superior information, but rather the ability to commit over a longer time horizon. Barro's monetary policy rule (15) constitutes a singular case in its inability to stabilise output, because his parameter γ_1 does not affect the difference between actual and full information substitution terms in Eq. (19).

The key for the effectiveness result is that the lagged feedback rule implemented by the policy authority acts as a contingent forward contract, which can complete the set of contracts available in the model. Under rational expectations, this changes the informational content of the current local price and makes it fully revealing (Buiter 1988a).

It is also important to note that in this framework the stabilisation and allocative effects of monetary policies cannot be separated. This is easily seen from the value of equilibrium real output under incomplete information:

$$\begin{aligned} y_t(z) = \alpha_s\Big\{&\delta\gamma v_{t-2} + (1-\delta)\,\delta\gamma v_{t-1} + \Big[\alpha^{-1}(1-\theta) + (1-\delta)^2\theta\delta\gamma\Big][v_t + \varepsilon_t(z)]\Big\} \\ &- \beta_s\Big\{\gamma v_{t-2} + (1-\delta)\,\gamma v_{t-1} + \Big[(1-\delta)^2\theta\gamma - (\alpha\delta)^{-1}\theta\Big][v_t + \varepsilon_t(z)] \\ &- (\alpha\delta)^{-1}u_{t-1}\Big\} + u_t^s + \varepsilon_t^s(z) \end{aligned} \tag{23}$$

and the corresponding value under full information:

$$\begin{aligned} y_t^*(z) = \alpha_s\Big\{&\delta\gamma v_{t-2} + (1-\delta)\,\delta\gamma v_{t-1} + \alpha^{-1}\varepsilon_t(z) + (1-\delta)^2\delta\gamma v_t \\ &- \beta_s\Big\{\gamma v_{t-2} + (1-\delta)\,\gamma v_{t-1} + \Big[(1-\delta)^2\gamma - (\alpha\delta)^{-1}\Big] v_t + (\alpha\delta)^{-1}u_{t-1}\Big\} \\ &+ u_t^s + \varepsilon_t^s(z) \end{aligned} \tag{24}$$

where $\delta \equiv \beta/\alpha < 1$ and $\theta \equiv \sigma_v^2 / \left(\sigma_v^2 + \sigma_\varepsilon^2\right)$ from the signal extraction problem. Both the conditional first and second moments of $y_t(z)$ and of $y_t^*(z)$ depend on the policy feedback parameter γ. It is therefore not possible to implement a policy aimed at stabilising the economy without also considering its allocative implications: the two are inextricably intertwined (Marini 1985).

Monetary Policy in the Long Run

The allocative role of monetary policy is also apparent in an intertemporal setting. It is known at least since Tobin (1965) that the rate of growth of money supply can affect capital accumulation and consumption in long-run models. Sidrauski (1967) had proved that money is super-neutral in growth models with infinitely lived agents and inelastic labour supply. Levhari and Patinkin (1968) assign a role to money as either a consumer or a producer good. The rate of growth of money supply can affect the overall level of saving and the composition of saving between accumulation of physical capital and of real money balances in an exogenous growth model. These effects though fail to hold if the consumers maximise their utility over an infinite horizon: in this case, the capital–labour ratio unaffected would remain unaffected.

In an overlapping generations model with optimising agents and finite lives, however, money can still affect real variables in the long run. This result has been established by van der Ploeg and Marini (1988a, b) in the continuous-time framework originally developed by Yaari (1965), Blanchard (1985), and Weil (1989). In this context, the difference in the opportunity sets of the private sectors and of the government lies in the fact that the planning horizon of private agents is finite, whereas the horizon of the policy authorities is potentially infinite. The government can therefore commit itself to policies with involve transfers to future and as yet unborn generations.

The economy is formed of overlapping generations, with agents only differing in their dates of birth. At each time t, the representative consumer born at time $s \leq t$ faces the following maximisation programme:

$$\max_{\{c(s,v),m(s,v)\}} \int_t^\infty \left[\gamma \ln\Big(c(s,v) + (1-\gamma)\ln(m(s,v))\Big)\right] e^{-(\rho+\lambda)(v-t)} dv \qquad (25)$$

with $0 < \gamma < 1$, where $c(s, v)$ is consumption of the physical good, $m(s, v)$ are real money balances, $\rho > 0$ is the rate of time preference, and $\lambda > 0$ is the instantaneous death rate which also coincides for simplicity with the birth rate.[5] The objective function (25) is subject to the flow budget constraint:

$$\frac{da(s,t)}{dt} = [r(t)+\lambda]\,a(s,t) + w(t) + z(t) - c(s,t) - [r(t)+p(t)]\,m(s,t) \tag{26}$$

and to the transversality condition precluding private agents' Ponzi games:

$$\lim_{v\to\infty} a(s,v)\, e^{-\int_t^v [r(\mu)+\lambda]d\mu} = 0 \tag{27}$$

where $a(s,v)$ is real non-human wealth, $r(t)$ is the rate of interest, $w(t)$ is the wage rate, $z(t)$ are lump-sum transfers of the government to the private sector, and $p(t)$ is the inflation rate. There is no operating bequest motive: each individual signs an annuity contract with an insurance company according to which she receives an actuarially fair premium $\lambda a(s,t)$ on her non-human wealth whilst alive. Upon her death, the remaining wealth goes to the insurance company.

Maximisation of (25) subject to (26) and (27) yields the following optimal consumption and money holding plans:

$$c(s,t) = \gamma(\rho+\lambda)\,[a(s,t)+h(s,t)] \tag{28}$$

and

$$m(s,t) = \gamma(\rho+\lambda)\,\frac{[a(s,t)+h(s,t)]}{r(t)+p(t)} \tag{29}$$

where $h(s,t)$ is human wealth, defined as the present discounted value of future labour income. From (29), real money balances $m(s,t)$ fall when their opportunity cost $[r(t)+p(t)]$ increases.

Let θ denote the rate of growth of nominal money supply. Aggregate real money balances therefore evolve according to the following differential equation:

$$\dot{M} = [\theta - p(t)]\,M \tag{30}$$

Consistent with balanced budget, lump-sum transfers from the government are financed by the revenues from seigniorage: $z = \theta M$. The model is closed by the production side, described by a constant returns to scale production function $Y = F(K,L)$ which satisfies the usual Inada properties.

[5] Buiter (1988b) has shown that the critical condition for the non-neutrality of public debt is a positive birth rate, rather than a positive death rate.

In steady state, the real effects of monetary growth on aggregate consumption C and capital stock K are given by:

$$\frac{dC}{d\theta} = r\frac{dK}{d\theta} = -\frac{\lambda(\rho+\lambda)\gamma r M}{\Delta} \geq 0 \tag{31}$$

where Δ is the Jacobian of the system of differential equations in $(\dot{K}, \dot{M}, \dot{C})$, with $\Delta < 0$ for saddlepath stability.[6]

When the birth and death rate λ is equal to zero, consumption and capital are unaffected by the rate of monetary growth, and the super-neutrality result is confirmed. When λ is positive, however, an increase in monetary growth has a positive effect on steady-state consumption and on capital accumulation and output. The main reason for this result is that an increase in the rate of growth of money supply enhances seigniorage revenue, since[7]

$$\frac{dM}{d\theta} > 0 \tag{32}$$

which implies that it becomes possible to increase the lump-sum transfers to the private sector. Human capital is boosted by the fall in the real interest rate and the increase in the real wage, both of which are associated with a higher level of steady-state capital. With finite lives, a higher discount rate would lead agents to accumulate less capital. Monetary policy can counteract this effect and stimulate capital accumulation, thus enhancing total wealth, consumption, and output in the long run.

Conclusions

> "A mechanical rule blind to actual economic events and outcomes could not work, and for that reason alone would not be tolerated by central bankers, governments, and electorates" (Tobin 1998).

Monetary authorities have the advantage over the private sector because of the longevity of their institutions and their exclusive power to issue *fiat* money. With incomplete private markets, the government has a richer opportunity set than the private sector. In the presence of asymmetric information, monetary policy can serve a signalling role by implementing contingent contracts. Monetary policy can thus be effective even under rational expectations, perfectly flexible prices, and continuous market clearing. In an intertemporal setting, the government can enact transfers

---

[6] See Marini and van der Ploeg (1988b) for a proof.

[7] Marini and van der Ploeg (1988b).

across generations, thereby influencing the allocation of resources and enhancing capital accumulation.

Western countries have turned to activist monetary policy to mitigate and counter the consequences of the financial crisis which started in 2008 and of the current COVID-19 pandemic. The analysis in this chapter fully vindicates these efforts. In a second-best world, monetary policy can be effective both for stabilising the economy in the face of shocks and for sustaining capital accumulation. The current accommodating policies deployed by the Federal Reserve and by the European Central Bank are mostly aimed at stabilising the economy in response to the negative COVID-19 supply shocks. The new monetary policy strategy review announced by the ECB on 8 July 2021 states that the objective of price stability must be achieved by aiming for a *symmetric* 2% inflation target over the medium term (European Central Bank 2021). This stands in contrast to the previous policy strategy last agreed in 2003, which required the inflation rate to be close to but under 2%. The asymmetric framing built into the ECB's previous target resulted in an anti-growth bias in monetary policy, whereas the new symmetric target, if implemented, would ensure that the ECB can be more effective in its pursuance of anti-deflationary policies.

In addition to the stabilisation objective of the monetary authorities, even under conventional monetary policies changes in the rate of interest can have allocative implications though their effects on portfolio investment and on capital accumulation. The need to overcome the constraints due to the lower bound on nominal interest rates has led the monetary authorities to enrich its set of policy instruments and to deploy novel and unconventional monetary tools. These additional policy instruments include forward guidance, negative interest rates, long-term refinancing operations, and the direct purchase of stocks and debt securities other than government bonds in the open market (European Central Bank, 2021). Despite mainly having a stabilisation objective, these policies also have a clear allocative impact insofar as they alter the relative rates of returns on financial assets.

Effective monetary policy should be accompanied by appropriate counter-cyclical discretionary fiscal policy to limit the economic consequences of large negative shocks to the economy. At the same time, it is important that buffers are rebuilt once the recovery is in place, in order to maintain monetary and fiscal policy space.

In its recent monetary policy strategy review, the ECB has also explicitly introduced climate change considerations in monetary policy operations, both in the areas of risk assessment, collateral framework, and corporate sector asset purchases and of environmental sustainability disclosure and reporting. In both these dimensions, the monetary authorities will clearly also pursue allocative objectives which are regarded as socially desirable in the presence of market failures. This is made possible thanks to the Central Bank's longevity and to its capacity to internalise the welfare of future generations.

Acknowledgements We are grateful to Furio Camillo Rosati and Partha Sen for very helpful comments. We remain responsible for any errors.

References

Angeletos, George-Marios, and Chen Lian (2016), "Incomplete Information in Macroeconomics: Accommodating Frictions in Coordination", chapter 15 in John B. Taylor and Harald Uhlig (eds.), *Handbook of Macroeconomics*, Vol. 2A–2B, North Holland.

Arrow, Kenneth (1953), "Le Rôle de Valeurs Boursières pour la Répartition la Meilleure des Risques", *Econometrie. Fondements et Applications de la Théorie du Risque en Économétrie*, Paris, Centre National de la Recherche Scientifique.

Attfield, C. L. F., D. Demery and N. W. Duck (1985), *Rational Expectations in Macroeconomics. An Introduction to Theory and Evidence*, Oxford, Basil Blackwell.

Barro, Robert J. (1976), "Rational Expectations and the Role of Monetary Policy", *Journal of Monetary Economics*, 2, 1–32.

Blanchard, Olivier J. (1985), "Debt, Deficits and Finite Horizons", *Journal of Political Economy*, Vol. 93, No. 2, April, pp. 223–247.

Blanchard, Olivier J. and Daniel Leigh (2013), "Growth Forecast Errors and Fiscal Multipliers", *American Economic Review*, Vol. 103, No. 3, May, pp. 117–120.

Buiter, Willem H. (1984), "Allocative and Stabilisation Aspects of Budgetary and Financial Policy", CEPR Discussion Papers No. 2.

Buiter, Willem H. (1988a), "The Right Combination of Demand and Supply Policies: The Case for a Two-Handed Approach", in H. Giersch (ed.), *Macro and Micro Policies for More Growth and Employment*, Kiel Institute of World Economics, 305–345.

Buiter, Willem H. (1988b), "Death, Birth, Productivity Growth and Debt Neutrality", *Economic Journal*, Vol. 98, No. 391, June, pp. 279–293.

Debreu, Gérard (1959), *Theory of Value*, New York, Wiley.

European Central Bank (2021), *Economic Bulletin*, Issue 5/2021.

Fischer, Stanley (1977), "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule", *Journal of Political Economy*, Vol. 85, No.1, February, pp. 191–206.

Friedman, Milton (ed.) (1956), *Studies in the Quantity Theory of Money*, Chicago, University of Chicago Press.

Friedman, Milton (1968), "The Role of Monetary Policy", *American Economic Review*, Vol. 58, No.1, March, pp. 1–17.

Friedman, Milton (1969), *The Optimum Quantity of Money and Other Essays*, Macmillan.

Friedman, Milton (1970), "A Theoretical Framework for Monetary Analysis", *Journal of Political Economy*, Vol. 78, No. 2, March–April, pp. 193–238.

Hahn, Frank (1982), *Money and Inflation*, Oxford, Basil Blackwell.

Harris, Laurence (1981), *Monetary Theory*, New York, McGraw-Hill.

Hoesch, Lukas, Barbara Rossi and Tatevik Sekhposyan (2020), "Has the Information Channel of Monetary Policy Disappeared? Revisiting the Empirical Evidence", Federal Reserve Bank of San Francisco, Working Paper No. 2020-08.

Imbriani, Cesare (1979), *Il monetarismo, una riconsiderazione*, Napoli, Liguori.

Imbriani, Cesare (1981), "Il modello della sintesi e l'analisi monetaria", in Augusto Graziani, Cesare Imbriani and Bruno Jossa (eds.), *Studi di economia keynesiana*, Napoli, Liguori.

Imbriani, Cesare (1984), "Introduzione. L'analisi empirica del monetarismo", in Adalgiso Amendola, Domenico Piccolo e Argia M. Sbordone (eds.), *Monetarismo e causalità nel modello di St. Louis*, Milano, Franco Angeli.

Jarociński, Marek, and Peter Karadi (2018), "Deconstructing Monetary Policy Surprises: The Role of Information Shocks", *American Economic Journal: Macroeconomics*, Vol. 12, No, 1, pp. 1–43.

Johnson, Harry G. (1971), "The Keynesian Revolution and the Monetarist Counter-Revolution", *American Economic Review*, Papers and Proceedings, Vol. 61, No. 2, May, pp. 1–14.

Johnson, Harry G. (1972), *Macroeconomics and Monetary Theory*, London and New York, Routledge.

Kydland, Finn E., and Edward C. Prescott (1977), "Rules Rather than Discretion: The Inconsistency of Optimal Plans", *Journal of Political Economy*, Vol. 85, No. 3, June, pp. 473–492.

Levhari, David, and Don Patinkin (1968), "The Role of Money in a Simple Growth Model", *American Economic Review*, Vol. 58, No. 4, September, pp. 713–753.

Lucas, Robert E., Jr. (1972), "Expectations and the Neutrality of Money", *Journal of Economic Theory*, Vol. 4, Issue 2, April, pp. 103–24.

Lucas, Robert E., Jr. (1973), "Some International Evidence on Output-Inflation Tradeoffs", *American Economic Review*, Vol. 63, No.3, June, pp. 326–334.

Marini, Giancarlo (1985), "Intertemporal Substitution and the Role of Monetary Policy", *The Economic Journal*, Vol. 95, No. 377, March, pp. 87–100.

Marini, Giancarlo (1986), "Employment Fluctuations and Demand Management", *Economica*, Vol. 53, No. 210, May, pp. 209–218.

Marini, Giancarlo (1987), "Price Variability, Supply-Side Policies and Monetary Rules", *Economica*, Vol. 54, No. 213, February, pp. 109–111.

Marini, Giancarlo (1988), "Policy Effectiveness and Design in New Classical Models", *Oxford Economic Papers*, Vol. 40, No. 4, December, pp. 646–654.

Marini, Giancarlo, and Frederick van der Ploeg (1988a), "Monetary and Fiscal Policy in an Optimising Model with Capital Accumulation and Finite Lives", *The Economic Journal*, Vol. 98, No. 392, September, pp. 772–786.

Marini, Giancarlo, and Frederick van der Ploeg (1988b), "Finite Horizons and the Non-Neutrality of Money", *Economics Letters*, Vol. 26, Issue 1, pp. 57–61.

Modigliani, Franco (1977), "The Monetarist Controversy or, Should We Forsake Stabilization Policies?", *American Economic Review*, Vol. 67, No. 2, March, pp. 1–19.

Nakamura, Emi, and Jón Steinsson (2018), "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect", *Quarterly Journal of Economics*, Vol. 133, pp. 1283–1330.

Phelps, Edmund S., *et al.* (1970), *Microeconomic Foundations of Employment and Inflation Theory*, New York, W. W. Norton.

Romer, Christina D., and David H. Romer (2000), "Federal Reserve Information and the Behavior of Interest Rates", *The American Economic Review*, Vol. 90, No. 3, June, pp. 429–457.

Sargent, Thomas, and N. Wallace (1975), "'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule", *Journal of Political Economy*, Vol. 83, No. 2, April, pp. 241–254.

Sidrauski, Miguel (1967), "Rational Choice and Patterns of Growth in a Monetary Economy", *American Economic Review*, Papers and Proceedings, Vol. 57, No. 2, May, pp. 271–291.

Sims, Christopher A. (2003), "Implications of Rational Inattention", *Journal of Monetary Economics*, Vol. 50, Issue 3, April, pp. 665–690.

Summers, Lawrence H. (2021), "The Inflation Risk is Real", Larry Summers Columns, 24 May (http://larrysummers.com/2021/05/24/the-inflation-risk-is-real/).

Tobin, James (1958), "Liquidity Preference as Behavior towards Risk", *Review of Economic Studies*, Vol. XXV, No. 2, February, pp. 65–86.

Tobin, James (1965), "Money and Economic Growth", *Econometrica*, Vol. 33, No. 4, October, pp. 671–684.

Tobin, James (1970), "Money and Income: Post Hoc Ergo Propter Hoc?", *Quarterly Journal of Economics*, Vol. 84, No. 2, May, pp. 301–317.

Tobin, James (1972), "Inflation and Unemployment", *American Economic Review*, Vol. 62, No. 1/2, March, pp. 1–18.

Tobin, James (1980), *Asset Accumulation and Economic Activity. Reflections on Contemporary Macroeconomic Theory*, Chicago, The University of Chicago Press.

Tobin, James (1998), "Monetary Policy: Recent Theory and Practice", in Helmut Wagner (ed.), *Current Issues in Monetary Economics*, Heidelberg, Springer Verlag.

Turnovsky, Stephen J. (1980), "The Choice of Monetary Instrument under Alternative Forms of Price Expectations", *The Manchester School of Economic and Social Studies*, vol. 48, No. 1, March, pages 39–62.

Weil, Philippe (1989), "Overlapping Families of Infinitely-lived Agents", *Journal of Public Economics*, Vo. 38, Issue 2, March, pp. 183–198.

Weiss, Laurence (1980), "The Role for Active Monetary Policy in a Rational Expectations Model", *Journal of Political Economy*, Vol. 88, No. 2, April, pp. 221–233.

Weiss, Laurence (1982), "Information Aggregation and Policy", *Review of Economic Studies*, Vol. 49, No. 1, January, pp. 31–42.

Woodford, Michael (2003), "Imperfect Common Knowledge and the Effects of Monetary Policy," in Philippe Aghion, Roman Frydman, Joseph E. Stiglitz and Michael Woodford (eds.), *Knowledge, Information, and Expectations in Modern Macroeconomics: In Honor of Edmund S. Phelps*, Princeton, Princeton University Press.

Yaari, Mehahem (1965), "Uncertain Lifetime, Live Insurance and the Theory of the Consumer", *Review of Economic Studies*, Vol. 32, No. 2, April, pp. 137–150.

Thinking Outside the Box: Giancarlo Marini, a Rigorous Eclectic Economist

Cesare Imbriani and Pasquale Scaramozzino

Introduction

Macroeconomics research and policy have been in crisis since the rational expectations (RE) revolution of the 1970s and 1980s. The undermining of the Keynesian consensus on the grounds that it was not consistent with rational behaviour by economic agents was far-reaching and led to a complete reorientation of academic interests and policy prescriptions. Whilst some objections to naïve versions of the Keynesian models might have been appropriate—*e.g.* the scant attention paid to the effect on prices of expansionary monetary policy—the inescapable impression from most of the literature that followed is that the RE counter-revolution went too far in denying the possibility that demand management policies can be effective in stabilising output and affecting the allocation of resources in the long run.

The massive public interventions which followed the Great Recession triggered by the financial crisis in 2008, and more recently the global COVID-19 pandemic, have finally laid to rest the notion that government policies are not able to affect the real economy. Yet, the teaching and practice of macroeconomics, which had been dominated for a long time by the rational expectations–new classical macroeconomics paradigm and by its logical extensions which took the form of real business cycles, is still alive in the form of dynamic stochastic general equilibrium models. A common theme of many of these approaches is their emphasis on forward-looking

C. Imbriani
Department of Law and Economics, UnitelmaSapienza University of Rome, Rome, Italy
e-mail: cesare.imbriani@unitelmasapienza.it

P. Scaramozzino (✉)
School of Finance and Management, SOAS University of London, London, UK

Dipartimento di Economia e Finanza, Università di Roma Tor Vergata, Rome, Italy
e-mail: ps6@soas.ac.uk

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*,
Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_3

rational agents, flexible prices, and market clearing. A strong policy implication which emerges from these models is typically the ineffectiveness of systematic counter-cyclical demand management policies, which could be anticipated and neutralised by the private sector.

Some of the assumptions upon which the ineffectiveness results would hinge are quite restrictive. For instance, fiscal policy ineffectiveness would only hold with respect to the financing of a given spending plan and would not extend to the allocative implications of alternative public expenditure programmes. Still, the requirement that expectations are model-consistent places severe restrictions on the government's ability to affect real outcomes.

A major difficulty in countering the ineffectiveness outcomes is that possible objections must be cast in an analytical framework which is immediately comparable to that in which the objections were raised. The challenge was then to devise new interpretative frameworks which used the same analytical tools yet were rich enough to understand some realities of macroeconomics and policy prescription. The contributions by Giancarlo Marini clearly stand out. His early work in monetary economics revealed serious analytical inaccuracies in some ineffectiveness propositions (see Imbriani and Scaramozzino 2022, Chap. 1 of this volume). Marini went on to develop seminal contributions to a vast range of diverse areas in economic theory and policy.

After graduating from the University of Rome La Sapienza, Giancarlo Marini moved to London where he completed a PhD in Economics at the London School of Economics under the supervision initially of Janet Yellen and then—after she moved to Berkeley with her husband George Akerlof—of Willem Buiter. His dissertation was awarded the 1985 Sayer's Prize of the Royal Economic Society as the best PhD macroeconomic thesis in the UK. After a Leverhulme Fellowship at the University of Bristol, he returned to the London School of Economics as a full-time member of the Faculty, to teach on Advanced Macroeconomic Theory. Giancarlo Marini then decided to return to his native Italy, where he taught at the universities of Bari and Siena before finally settling at the University of Rome Tor Vergata. There he was in charge of the teaching of macroeconomics, set up and directed the PhD in International Economics, and served as the Head of the Department of Economics from 2007 until his sudden and premature death in 2013.

Giancarlo Marini had a profound influence on his colleagues and on generations of young researchers. He was acutely aware of the social aspects of economics and of the close links across different areas of the discipline, which are often overlooked in the current age of hyper-specialism. At the same time, his intellectual curiosity led him to be unsatisfied with the prevailing consensus in the profession and to investigate novel areas of research, and to propose highly original and unconventional solutions to well-known problems.

This chapter aims to offer a brief survey of some of the most important contributions by Giancarlo Marini to the economics literature. It summarises his main papers in monetary policy, fiscal policy, and international finance and discusses their relevance for the current economic debate. But it also tries to give a flavour of his more original and heterodox interests, including the use of original datasets for empirical analysis and his forays into areas not usually considered by economists such as the social relevance of his beloved game of bridge.

Monetary Policy

Policy Effectiveness in New Classical Macroeconomics Models

The early contributions of Giancarlo Marini to monetary economics are summarised in Chap. 1 of this volume (Imbriani and Scaramozzino 2022), and therefore will not be examined in detail in this chapter. In the presence of imperfect information and with private agents planning their choices over an intertemporal horizon, monetary policy can be effective even when the government finds itself at an informational disadvantage *vis-à-vis* the private sector. The key for this policy relevance result is the longevity of the monetary policy institutions, which can enact longer-term contracts and complete the set of markets in the economy (Marini 1985). They can effectively counteract the short-term horizon of the private sector through their commitment to long-term goals, even just with credible announcement as in the case of Mario Draghi's notable "Whatever it takes" speech in July 2012.

In a new classical macroeconomics framework, asymmetric information and intertemporal substitution make it possible to obtain a positive correlation between monetary and real variables because of misperceptions by private agents. Under full information, the classical dichotomy would still hold (Bagliano and Marini 1993). Under imperfect information, however, the contention that systematic countercyclical policies would be neutralised by the private sector is invalidated by the very mechanisms of intertemporal substitution that are introduced into the models. If the monetary authorities enact feedback policy rules which react to lagged realisations of economic variables, the private sector knows that the authorities will be able to *respond* in the future to the currently unobserved shocks. By contrast, private agents cannot perfectly *predict* the exact future policy response to the current shocks. The main difficulty with the neutrality propositions, as lucidly discussed in Marini (1988a), lies in their failure to distinguish between these two aspects of the response by the private sector.

The superiority of optimally designed monetary policy rules can also be established in the presence of endogenous labour supply and intertemporal substitution with a "surprise" component as in the influential model of Lucas and Rapping (1969), and with perfectly flexible wages and prices (Marini 1986). It can be obtained even under pre-determined labour contracts and nominal rigidities as in Fischer (1977), where it can be shown that an optimal monetary policy rule is unambiguously superior to wage or subsidy demand management policies in dampening price variability (Marini 1987).

In essence, all these results can be interpreted as "a new restatement of the old, sound principle that policy instruments must be allowed to fluctuate in order to dampen fluctuations of real variables. Preventing the policy instruments from responding over time to (lagged) shocks in economic activity would inevitably result in policy goals such as employment and output suffering from the stochastic nature of the world" (Marini 1986).

The effectiveness of monetary policy extends to fully dynamic real business cycle (RBC) models, where endogenous propagation mechanisms ensure that supply shocks generate a positive correlation between real and nominal variables. Bagliano and Marini (1991; see also Marini 1992) show that the evidence on cyclical variability which is offered to support RBC theories can actually be consistent with monetary factors when the authorities engage in successful stabilisation policies. The key for this result is again that forward-looking agents in the private sector anticipate future values of the aggregate price level by taking into account the feedback monetary rule. The monetary authorities can stabilise real output even when their policy rule only responds to aggregate past disturbances if agents cannot perfectly observe the current realisation of monetary or real shocks.

Price Flexibility and Employment Stabilisation

Marini also engaged with the classic issue discussed by Keynes (1936) in Chap. 19 of his *General Theory*, as to whether downward flexibility of wages and prices could help stabilise output about its equilibrium level, or whether it would rather exacerbate output fluctuations. This issue can be framed in terms of Fisher's (1933) debt-deflation theory, where the increase in the real burden of debt brought about by lower prices would dampen economic activity and trigger a downward spiral which would move the economy further away from equilibrium (see also Tobin 1980, Chap. 1, and Tobin 1990). The Pigou effect associated with falling prices may thus not be effective, as it would be outweighed by the contraction in investment generated by deflation expectations.

DeLong and Summers (1986) have explored the potential destabilising implications of increased wage and price flexibility in a Taylor-type staggered wage setting model with rational expectations, augmented with expected inflation and persistent aggregate demand shocks. Marini and Scaramozzino (1992) show that inflation expectations can be destabilising even with perfectly flexible prices and signal extraction, in the presence of correlated aggregate demand shocks. The reason for this result is that when demand disturbances are serially uncorrelated the shock is purely transitory, and therefore expectations of future prices are not affected: expected inflation moves countercyclically and acts as an automatic stabiliser. By contrast, in the polar opposite case when the shock is permanent, the expectation of the next period price level fully incorporates the current shock whereas the response of the present price level is dampened by the contemporaneous increase in output supply: as a result, expected inflation will move in a procyclical fashion, thus exacerbating demand shocks. With signal extraction, the destabilising effect of inflation expectations also requires that the price elasticity of aggregate supply is large *vis-à-vis* the real balance effect: this would imply that suppliers attach a small positive probability to the event that the shock is market specific, and therefore believe that its effects will persist into the future.

The effects on output of increased wage and price flexibility are confirmed with a version of Fischer's (1977) model with overlapping wage contracts and nominal rigidity. Increased flexibility is indeed destabilising when labour contracts are mainly short term. These analytical results fully confirm the numerical simulations by DeLong and Summers (1986) that increases in wage flexibility may exacerbate the variability of real output, when aggregate demand explicitly depends on inflation expectations. Marini and Scaramozzino (1993) show that similar results also hold in a version of Blanchard's (1983) model with staggered wage setting and overlapping contracts.

These findings corroborate that the source of instability studied by Fisher, Keynes, and Tobin can also be present when expectations are rational and when prices are not downward rigid.

Dynamic Instability in Monetary Economies

Taylor-style reaction functions, targeting the inflation rate and the output gap, are today increasingly adopted by Central Banks as a guide for the conduct of monetary policy. It is commonly believed that such rules can help stabilise the economy by eliminating the possibility of sunspot fluctuations and by forcing a unique rational expectations equilibrium trajectory. In a dynamic and forward-looking framework, a counter-cyclical Taylor reaction function with an active interest rate feedback rule could, however, fail to stabilise the economy in the face of negative shocks. The reason for this is that falling inflation must lead to real interest rate decreases when the Central Bank is committed to implementing a Taylor-style rule. Lower real interest rates have a negative impact on the aggregate accumulation of total real financial wealth. This reduces the level of consumption of future cohorts which in turn accelerates the deflationary spiral over time.

Annicchiarico and Marini (2006) clarify the distinction between multiple equilibria and nominal indeterminacy. They show that the wealth effect can solve the problem of nominal indeterminacy in dynamic optimising models with heterogeneous generations, but could also generate a multiplicity of equilibrium paths towards the steady state.

Annicchiarico et al. (2009) formally prove that liquidity traps are still possible even in the presence of wealth effects, in a dynamic optimising general equilibrium framework where the monetary authorities follow an active Taylor rule. The monetary authority will have to continuously lower nominal interest rates as a response to decreases in inflation, but this will also reduce expected future wealth and therefore consumption. Wealth effects prove incapable to avoid rational expectations equilibrium paths which lead the economy to a deflationary trap. The debt-deflation spiral studied by Fisher can therefore also be obtained in a fully dynamic and optimising setting.

Bagliano et al. (2000) explore a complementary and still under-researched source of instability associated with monetary policy. An active counter-cyclical monetary policy would require that interest rates must be increased when the economy runs the risk of overheating. Higher market rates, however, raise the cost of funding for banking institutions, which in turn reduces the gains that banks could obtain by adopting a more aggressive loan pricing strategy. As a result, there is greater incentive for banks to engage in some form of implicit collusion. An active monetary policy could thus alter the degree of competition in the banking system and elicit a procyclical response by banks. The analysis has important implications for the regulation of the banking sector, especially in the light of current proposals to reform the EU banking system under the aegis of the European Central Bank.

A message of caution on monetary policy's ability to burst rational bubbles in the housing market also emerges from Brito et al. (2016), who show that responding more strongly to house price inflation than to consumer price inflation could lead the economy to spiral down into a decelerating-inflation path and into a liquidity trap.

Fiscal Policy

Debt and Fiscal Sustainability

Fiscal policy was an important area of interest for Giancarlo Marini. An early contribution (Attanasio and Marini 1988) provides elegant empirical evidence of *bracket creep*, in contradiction to Barro's (1981) tax smoothing hypothesis. Marini (1990) gives a detailed and insightful critique of Ricardian equivalence and offers a discussion of the different effects of alternative forms of deficit financing. Ricardian equivalence maintains that a reduction in taxes funded by an increase of public debt would have no real effects on consumption and on capital accumulation, because it would simply lead to an equivalent increase in the present value of future taxes. The Ricardian equivalence, however, breaks down in the presence of new entrants in the economy who are not fully linked to the current generation by intergenerational altruism, because this makes it possible to transfer the future tax burden to those future entrants (Buiter 1988).

More broadly, the neutrality of public debt rests on the aggregation of identical consumers, so that the economy can be represented by many "Robinson Crusoes" without any "Fridays" (Marini 1990). In the presence of intra-generational heterogeneity, however, the issue of public debt is bound to have redistributive consequences. An increase in debt funded by distortionary taxation would clearly have such an effect. Marini and Scaramozzino (1996), however, show that pure lump-sum tax policies would have non-trivial redistribution consequences *via* their impact on the terms of trade in asset markets. Inequality would increase even under the simplest debt/tax experiment, under just the plausible condition that richer individuals are net lenders in asset markets. Alternative public debt policies would therefore not only affect the intergenerational allocation of resources but would also have a redistributive impact within each generation.

Imbriani et al. (1996) consider the sustainability of the financial positions of some of the main European economies in the aftermath of the Maastricht rules. They argue that the sustainability of external positions would provide a better guideline for the conduct of fiscal policy because of the constraints imposed by the current account. They make the important distinction between weak solvency, which requires that debt is first-difference stationary, and strong solvency, which in addition requires that the primary surplus/GNP ratio is stationary. They show that both France and Italy are strongly sustainable, although inflation played a role in the case of Italy (see also Imbriani et al. 1991). Germany is, however, "super-solvent" since it tends to accumulate foreign assets at a rate greater than the relevant rate of interest.

An important dynamic analysis of the long-run effects of fiscal policy on capital accumulation is Annicchiarico and Marini (2005a). In a monetary version of the continuous-time Yaari (1965)–Weil (1985)–Blanchard (1985) model of overlapping generations, a fiscal expansion funded by future lump-sum taxes increases the long-run price level and decreases the equilibrium level of capital accumulation, as government bonds crowd out physical capital. What is particularly noticeable in this analysis is that the role played by fiscal variables in determining the price level is entirely consistent with a monetary approach, and does not require any unpleasant monetarist arithmetic nor any of the channels suggested by the fiscal theory of the price level.

Indicators and Tests of Fiscal Policy

The long-run sustainability of fiscal policy is a key and contentious topic in the current academic and policy debate. A number of criteria have been developed to establish whether fiscal programmes satisfy some form of no-Ponzi game condition, which ensures that fiscal plans would not follow an explosive path. These criteria fall into two broad categories: tests and indicators. In the literature, these criteria have been used as alternative approaches, with a potential ambiguity of interpretation when they yield contradictory outcomes.

Marini (1990) has shown how these two criteria for sustainability could be integrated and used in a consistent fashion, and has explained how to resolve the issue of their interpretation when they deliver apparently conflicting results. By construction, formal statistical tests use historical data and therefore are necessarily backward-looking in their informational content. They can still be used for predictive purposes, but this requires that neither regime changes nor structural breaks occur in the data. Indicators, by contrast, are more flexible and can more easily incorporate current and expected future information. They are forward-looking in nature and are better able to capture any structural breaks, due for instance to systemic changes in the fiscal policy stance, which would affect the future sustainability of public finance and budgetary programmes.

Tests and indicators can thus be used jointly and in a complementary fashion. When their results are consistent, they simply reinforce each other. When their results are in contradiction, this can be taken as evidence of a regime change which is not captured by the tests but which is instead detected by the indicators.

Marini and Piergallini (2007) apply this approach to post-World War II US data to argue that US fiscal policy was on a sustainable path. Using later data, however, Canofari et al. (2020) show that the deficit increases from 2008 onwards may have shifted the course of US budgetary policy towards an unsustainable path, which would require a structural change in the stance of US fiscal policy to ensure long-run sustainability. In chapter Fiscal Policy and Sovereign Debt Dynamics: (Re-)Assessing the Intertemporal Viability of the Government Budget Using a Model-Based and Consistently Measured Sustainability Indicator, Piersanti et al. (2022) extend these results to 2018 using a more detailed version of the model.

Interactions Between Fiscal and Monetary Policy

The effects of fiscal policy can be very different depending on the mode of financing and on the stance of monetary policy. Marini and van der Ploeg (1988a, b) examine the interactions between fiscal and monetary policy in a continuous-time overlapping generations model *à la* Yaari–Weil–Blanchard with finite lifetimes and a positive birth rate. After Sidrauski (1967), it is well known that monetary policy is super-neutral in a traditional intertemporal set-up with infinite lifetimes. With finite lives, by contrast, an increase in money supply growth fully translates into higher inflation and lower interest rates. This leads to increased long-run capital accumulation, private consumption, and total wealth.

The financing mode of fiscal policy is crucial for its long-run outcomes. A fiscal expansion financed by tax increases would lead to a higher interest rate, a decline in capital stock, and a more than proportional crowding out of private consumption. By contrast, a fiscal expansion financed by the issuance of bonds or by an increase in money supply would lead to a lower interest rate and a higher capital stock and to an increase in output. The effects on the level of activity will be greater under a money-funded fiscal expansion. The reason for the failure of Ricardian equivalence is that, with finite lives, some of the taxes required to redeem the public debt will fall on individuals who are not yet born (Buiter 1988).

The effects of an expansionary monetary policy will again depend on its financing mode, but now also on the elasticity of substitution between goods and real money balances in individual preferences. When the increase in the rate of growth of money supply is financed by raising taxes, social welfare can increase when the fall in real money balances is more than offset by the increase in consumption. When the monetary expansion is financed by issuing bonds, there will be no effects on real variables when preferences over goods and real money balances are weakly separable, and super-neutrality of monetary growth will still hold. On the other hand, the higher nominal interest rate will be associated with lower real money balances and therefore with a decline in social welfare. By contrast, when preferences are non-separable a bond-financed money growth expansion will increase capital accumulation and consumption when the elasticity of substitution between goods and money balances is greater than unity, so that the substitution effect dominates the income effect.

Annicchiarico and Marini (2005b) and Annicchiarico et al. (2008) extend the Yaari–Weil–Blanchard OLG model to allow for stochastic shocks and for nominal rigidities following Calvo (1983). They apply their model to examine the interactions between fiscal policy and interest rules, and to explore alternative monetary–fiscal policy combinations. When calibrated to the Euro area economies, their model shows that the most effective regime for the purposes of stabilising inflation would consist of a generalised Taylor rule which incorporates an explicit targeting of the public debt–GDP ratio.

Other Issues

Environmental Economics and Intergenerational Equity

An important area of application of fiscal policy is the use of taxes and transfers to correct environmental externalities. The analysis of the environmental sustainability of the intertemporal allocation of resources had typically been carried out in terms of an infinitely lived representative individual, who is concerned with ensuring that natural resources are not depleted by overconsumption or overexploitation. A more appropriate framework to analyse intertemporal equity would instead require the explicit acceptance of limits to altruism towards future cohorts of individuals. Discrete-time overlapping generations have the property that consumers' asset holdings are age-dependent. Whilst this feature is appropriate for studying the conditions of equilibrium in asset markets, it is not essential for understanding pure environmental externalities across generations.

Marini and Scaramozzino (1995) use the continuous-time overlapping generations model of Yaari–Weil—Blanchard to study the implications of imperfect altruism in the intertemporal use of environmental resources. A crucial aspect of their analysis is the explicit requirement that an optimal fiscal policy must be time consistent; that is, the fiscal authority must have no incentive to renege *ex post* on an *ex ante* optimal fiscal programme. In order to achieve time consistency, it is necessary that all generations are treated in a symmetrical fashion. Formally this requires the utility of each generation to be discounted back to its date of birth, rather than to the current date (Calvo and Obstfeld 1988).

Marini and Scaramozzino's contribution helps clarify the conceptual differences between the individual subjective rate of time preference, the social rate of time preference, and the marginal rate of intertemporal transformation. An optimal time-consistent fiscal policy must satisfy the condition that the age-weighted marginal utilities are equalised across all agents. The appropriate rate for the evaluation of the marginal benefits from pollution abatement policies is the growth-corrected social rate of time preference, augmented by the rate at which the environment is able to absorb pollution.

The requirement of time consistency of optimal fiscal policy can also help determine an appropriate social discount rate to ensure that heterogeneous generations are treated in a symmetrical fashion. Marini and Scaramozzino (2000) show that a zero social discount rate, which is sometimes advocated as necessary to ensure that future generations are not disadvantaged relative to the current ones, would instead yield an intertemporal allocation of resources which is biased against the current generations. With positive productivity growth, the social discount rate must be set strictly above the individual subjective rate of time preference to achieve a fairer intertemporal allocation of resources.

The choice of an appropriate social discount rate can also help assess the feasibility of social security programmes. It is well known since Aaron (1966) that a balanced-budget unfunded social security system can be optimal when the economy is dynamically inefficient. Marini and Scaramozzino (1999) show that the social benefits from such a system can exceed the private returns from savings even under dynamic efficiency. In the case of a decline in fertility rates and ageing of the population a balanced-budget social security programme can still be preserved, provided it is redesigned to reduce the benefits to the older generations (see also Marini and Scaramozzino 2003). The case for social security schemes can therefore be quite strong even in the absence of myopic behaviour, externalities, or limited altruism by the current generations.

International Finance and Currency Crises

The debate on the international financial architecture since the end of World War II has been dominated by the relative merits of fixed *versus* flexible exchange rate regimes, and by the risk that currency crises may destabilise the global financial architecture. Giancarlo Marini devoted a relevant part of his academic research to the study of international finance and to the examination of the causes which could lead up to currency crises.

In an early contribution, Marini (1988b) engages with the fundamental issue of the conditions under which a small open economy should adopt a flexible or a fixed exchange rate regime. He demonstrates that, when foreign exchange markets are informationally efficient and the product market is affected by nominal rigidity, a flexible exchange rate may provide the “freedom of each country to pursue internal stability after its own lights” (Friedman 1953). Stabilisation of prices and output would, however, require an active counter-cyclical monetary policy, rather than a fixed monetary rule as advocated by Friedman.

A key difficulty faced by fixed exchange regimes is the risk that currency and financial crises would destabilise exchange rates. Marini and Piersanti (2003) set out an original model of currency crises based on economic fundamentals. They show that speculative attacks to a currency can be triggered by current account deficits brought about by current and prospective future fiscal deficits when the stocks of foreign reserves reach a critical threshold level. Annicchiarico et al. (2011) formally prove that a speculative currency attack can be the result of an increase in government budget deficits and the ensuing decumulation of assets.

Marini and Piersanti (2013) present an integrated model of the foreign exchange and of the financial sector, where asset price volatility and the instability of the domestic credit market can both be crucial in bringing about sudden reversals of capital flows and undermine the possibility to carry out independent macroeconomic policies. Dalmazzo and Marini (2000) argue that foreign debt can strategically be used by Less Developed Countries (LDCs) to reduce the extent of underinvestment, in the presence of international sanctions. Becchetti and Marini (2003) further look at the financial sector, and show that arbitrage opportunities by contrarian investors disappear when the stock market index is corrected for survivorship bias

The establishment of the euro as the common currency of a number of European Union countries in 1999 led to concerns that the currency area thus created would be plagued by internal tensions. The difficulty to respond to idiosyncratic shocks across the economies of the euro area could have exacerbated the imbalances in their fundamentals. Canofari et al. (2014) develop a rigorous methodology to derive a sustainability index for a currency in a monetary union, by considering the relationship between the shadow exchange rate and the output gap required to maintain the fixed peg amongst currencies. The shadow exchange rate is defined as the floating rate which would prevail if a country were to exit the currency area, and the output gap is estimated as the difference between the actual GDP and the level required to maintain the currency peg. Their sustainability index is estimated for a selected number of European countries, both over the 2000–2007 pre-crisis period and over the 2008–2012 post-crisis period. Whilst there are no apparent tensions in the euro area before the crisis, after the financial crisis there is evidence of an implicit gain in competitiveness for Germany and of a severe loss in competitiveness for Greece and Portugal. A moderate tendency for loss in competitiveness is experienced by the other countries in the sample, *e.g.* France, Ireland, Italy, and Spain.

Their model of voluntary exit and contagion in a monetary union is extended in Canofari et al. (2015), where the indicator of sustainability of the currency union is applied to explain the spread between the 10-year government bond yield in member countries and the German Bund benchmark. The sovereign risk premia were too large to be justified by economic fundamentals alone. Their high levels could only be explained by the perceived risk of countries leaving the monetary union. Yield premiums in non-core euro area countries are indeed shown to be related to the perceived risk of a break-up of the currency union and to fear of contagion originating from the countries which would have been forced to exit. The analysis offers a strong justification for intervention by the European Central Bank to correct mispricing by markets and defend the monetary union.

Inflation and the Euro

The main motivations for the adoption of the euro by a number of EU countries were the elimination of exchange rate risk, the reduction in transaction costs, and greater effectiveness in controlling inflation. The physical switch from national currency to the euro in January 2002 was, however, accompanied by a widespread perception of large one-off increases in prices for a number of goods and services. These higher perceived prices were not confirmed by official statistics, which on the contrary seemed to show no evidence of an abnormal increase in the measured inflation rate. This issue is of great practical importance because an under-reporting of inflation would result in a reduction in the purchasing power by households with potentially significant redistributive effects.

As a possible explanation of the discrepancy between perceived and measured inflation, it had been maintained that this gap could be traced to a limited set of commodities which are purchased at higher frequency and which bias the perception of inflation by consumers. An alternative explanation is that it is the official measures of inflation which were biased and underestimated the actual increase in prices. The difficulty of accurately measuring inflation has been widely documented, for instance by the Boskin Commission (1996). The main problems are associated with the standard chained Laspeyres methodology, with the sample of commodities which are included in the basket for the measurement of prices, and with the difficulty of adequately controlling for quality improvement. Furthermore, under imperfect competition firms enjoy some price setting power and could have exploited the changeover to coordinate to a higher-price equilibrium.

In the impossibility to directly verify the official inflation statistics, one has to rely on alternative methodologies to study the price changes which took place with the changeover to the euro. Marini et al. (2004) looked at three key sectors in Italy, where evidence of prices before and after the physical switch to the euro in 2002 can be inferred from official catalogues. Reputable guides on the catering, hospitality, and wine sectors report detailed prices for a large number of selected products and services. In all three sectors, prices have on average increased by substantially more than the official figures. This was despite the fact that the guides had excluded from their lists some products or establishments which had experienced a particularly steep increase in prices: the inflation figures from the guides are therefore likely to give a lower bound to the actual inflation in the sectors.

A more systematic attempt to measure the bias in the official inflation statistics is Marini et al. (2007). Their article implements a methodology first proposed by Nordhaus (1998), where an estimate of the inflation bias is based on whether changes in the deflated median incomes of households are consistent with survey data on their financial situation. The key assumption which informs this approach is that inflation is correctly measured if the median real income shows no change when an equal number of households report an improvement and a worsening of their financial condition. This methodology is applied to the UK and Italy, separately for the pre- and post-2002 periods. There is no evidence of bias in the official inflation figures for the UK, both before and after 2002. In Italy, by contrast, the bias of the official inflation rate is not significantly different from zero only for the pre-changeover period. Immediately after 2002 the rate of inflation appears to have been significantly underestimated, with the downward bias in measured inflation being of the order of at least 6 percentage points. These results are particularly relevant because the statements on the financial position of households are not affected by the relative frequency of purchases of commodities, and therefore the estimate of the bias is robust with respect to subjective perceptions of prices.

A detailed investigation of price changes following the adoption of the euro is Adriani et al. (2009). The introduction of the single currency provides a natural experiment to test the hypothesis that the switch from national to the common currency acted as a device which led imperfectly competitive firms to coordinate their price setting behaviour to a higher-price equilibrium. Customers have heterogeneous information sets, and firms can choose whether to specialise in dealing with only a subset of customers or to attract a wider set of customers. When applied to the catering sectors, low-quality restaurants or restaurants in tourist areas may decide to set a price which leaves their less well-informed customers with a negative surplus. By contrast, restaurants which wish to retain their regular customers will be more restrained in their price setting behaviour. The paper makes use of the prices of restaurants in the *Michelin Red Guide* in the pre- and post-changeover period both for a selected group of countries that adopted the euro in 2002 and for other countries outside the euro area. The empirical findings show that restaurants in the euro area did experience abnormal increases in prices which were not matched by restaurants outside the euro area. Furthermore, the increases in prices in the euro area were largely concentrated in restaurants which specialised in catering for tourists.

The physical adoption of the euro in 2002 appears therefore to have been associated with an increase in prices, both at the aggregate level and in some sectors, which was not fully accounted for by official statistics. This speculative change in relative prices was bound to have had significant redistributive consequences.

Thinking Outside the Box

A true scholar and intellectual distinguishes oneself by the ability to explore creative and unusual ideas in an imaginative fashion, to look at old issues with new eyes, or to think of completely new areas of research.

Giancarlo Marini was an accomplished bridge player who competed at the national and international level. In their book on *Animal Spirits*, Akerlof and Shiller (2009) discuss the importance of culture and leisure activities to inform social attitudes. They notice that economic recessions tend to be preceded by outbreaks of corruption or of bad faith, and by a breakdown in trust. They argue that an important indication of the level of trust in society can be obtained by examining the prevalent activities which people indulge in their leisure time. They observe that the social game of bridge used to be very popular in the USA. It is estimated that in the early 1940s about 44% of US households were playing bridge. An important feature is that bridge "is a game played by partners, who must cooperate—a social game that from the beginning was frequently recommended as a way to make friends or even find a beau" (Akerlof and Shiller, page 40). In the first decade of the twenty-first century, however, the practice of the game of bridge was in decline and there was a corresponding increase in popularity in the game of poker. The latter is an individualistic game which systematically relies on deception and bluffing, and which—unlike bridge—is usually played for money. Akerlof and Shiller ask themselves whether this shift from cooperation to deception that is observed in popular leisure activities may be relevant to detecting a parallel shift in the world of business and economics.

Giancarlo Marini took up the challenge of studying the nexus between leisure activities and social attitudes. Together with Leonardo Becchetti and Maurizio Fiaschetti (Becchetti et al. 2014), he devised and implemented an experiment in which a large number of regular bridge and poker players were asked to play a "trust game", where a solution exists which is preferred by both partners but which requires a form of we-thinking. This solution is superior to the outcomes which can be attained if players act in their own individualistic interest. A trust game is built as a setting which is played over several stages, and in which a player must decide how to divide a given amount with a counterparty about whose identity she possesses no information. If both players adopt a we-thinking approach, and if we-thinking is common knowledge, the amount received by both players will be multiplied. A rational individualistic approach to the game would instead yield inferior outcomes.

Each bridge and poker player was administered a questionnaire, and players were made to play online simulated experiments both without and with actual monetary payoffs. The results were carefully analysed controlling for individual demographic characteristics, risk aversion, and the number of years of experience playing bridge or poker. The results were striking. Regular bridge players were much more likely to choose a cooperative strategy than poker players. Furthermore, any additional year of experience playing bridge would make the adoption of a cooperative strategy more likely. These findings lend strong empirical support to the existence of a strong association between our chosen leisure activities and our broad social attitudes.

Giancarlo Marini put into practice his views on the pedagogical importance of the game of bridge by organising a postgraduate course on *Introduction to Game Theory and Probability with an Application to Bridge* in University of Rome Tor Vergata, a joint initiative of the Faculty of Economics and the Faculty of Engineering. Students were taught the mathematical foundations of games of strategy and then were taught how to play bridge by leading international players. This course was well received by the participants and attracted great attention in the world of bridge and in the national press.

It is telling that one of the last original research projects initiated by Giancarlo Marini was about the desire to be remembered, and the importance of keeping alive the memory of those who have preceded us (Canofari et al. 2017).

Conclusions

In the current age of extreme disciplinary specialism, it is rare to find an economist whose interests span more than a narrow field of research. Giancarlo Marini clearly stands out. He applied his talent to an impressive range of problems across the whole spectrum of macroeconomic theory and policy, and to topics which lie even beyond what are usually regarded as areas of competence of an economist. He was able to resolve the apparent oxymoron of being both rigorous and eclectic.

Giancarlo Marini was always fully aware that economics is not a purely intellectual experiment but a discipline with far-reaching policy implications. Alongside his research activity, he devoted a large part of his efforts to teaching and to the formation of young researchers and colleagues. Above all, he was mindful of the social dimension of his work and of the role that each one of us is called to play in society. An accomplished draughts player, he was fully aware that every action has consequences. It is therefore fitting to remember him with the words of the very Founder of our discipline:

> "The man of system [. . .] seems to imagine that he can arrange the different members of a great society with as much ease as the hand arranges the different pieces upon a chess-board. He does not consider [. . .] that in the great chess-board of human society, every single piece has a principle of motion of its own, altogether different from that which the legislature might choose to impress upon it."
>
> (Adam Smith, *The Theory of Moral Sentiments*, Part VI, Section II, Chapter II, pp. 233–234, 1759)

References

Aaron, Henry (1966), "The Social Insurance Paradox", *The Canadian Journal of Economics and Political Science/Revue canadienne d'Economique et de Science politique*, Vol. 32, No. 3, pp. 371–374.

Adriani, Fabrizio, Giancarlo Marini and Pasquale Scaramozzino (2009), "The Inflationary Consequences of a Currency Changeover: Evidence from the Michelin Red Guide, *Oxford Bulletin of Economics and Statistics*, Vol. 71.

Akerlof, George A., and Robert J. Shiller (2009), *Animal Spirits. How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism*, Princeton and Oxford, Princeton University Press.

Annicchiarico, Barbara, and Giancarlo Marini (2005a), "Government Deficits, Consumption and the Price Level", *Portuguese Economic Journal*, 4(3).

Annicchiarico, Barbara, and Giancarlo Marini (2005b), "Fiscal Policy and the Price Level", *Topics in Macroeconomics*.

Annicchiarico, Barbara, and Giancarlo Marini (2006), “Interest Rate Pegs, Wealth Effects, and Price Level Determinacy”, *Metroeconomica*.
Annicchiarico, Barbara, Giancarlo Marini and Alessandro Piergallini (2008), “Monetary Policy and Fiscal Rules”, *The B.E. Journal of Macroeconomics,* Contributions, 8(1), Article 4.
Annicchiarico, Barbara, Giancarlo Marini and Alessandro Piergallini (2009), “Wealth Effects, the Taylor Rule and the Liquidity Trap”, *International Journal of Economic Theory*.
Annicchiarico, Barbara, Giancarlo Marini and Giovanni Piersanti (2011), “Budget Deficits and Exchange-Rate Crises”, *International Economic Journal*, vol. 25.
Attanasio O., and Marini G. (1988), “Equivalenza ricardiana e tassazione ottimale. Una verifica empirica per il caso italiano (1960–1983)”, *Rivista internazionale di scienze economiche e sociali*, v. 96, n. 3, luglio-settembre, pp. 371–381.
Bagliano, Fabio Cesare, and Giancarlo Marini (1991), “On the Role of Monetary Factors in Business Cycle Models”, *Recherches Economiques de Louvain*.
Bagliano, Fabio Cesare, and Giancarlo Marini (1993), “Monetarismo”, *Enciclopedia Italiana*.
Bagliano, Fabio Cesare, Alberto Dalmazzo and Giancarlo Marini (2000), “Bank Competition and ECB’s Monetary Policy”, *Journal of Banking and Finance*.
Barro, Robert J. (1981), “On the Predictability of Tax-Rate Changes”, NBER Working Paper No. 636.
Becchetti, Leonardo, Maurizio Fiaschetti and Giancarlo Marini (2014), “Card Games and Economic Behavior”, *Games and Economic Behavior*, Vol. 88.
Becchetti, Leonardo, and Giancarlo Marini (2003), “Can We Beat the Dow? The Mirage of Growth Strategies”, *Research in Banking and Finance*.
Blanchard, Olivier Jean (1983), “Price Asynchronization and Price Level Inertia”, in R. Dornbusch and M. H. Simonsen (eds), *Inflation, Debt and Indexation*, MIT Press, Cambridge, MA.
Blanchard, Olivier Jean (1985), “Debt, Deficits and Finite Horizons”, Journal of Political Economy, Vol. 93, No, 2, April, pp. 223–247.
Boskin Commission (1996), “Toward a More Accurate Measure of the Cost of Living”, Final Report to the US Senate Finance Committee.
Brito, Paulo, Giancarlo Marini and Alessandro Piergallini (2016), “House Prices and Monetary Policy”, *Studies in Nonlinear Dynamics and Econometrics*, Vol. 20, pp. 251–277.
Buiter, Willem H. (1988), “Death, Birth, Productivity Growth and Debt Neutrality”, *Economic Journal*, Vol. 98, No. 391, June, pp. 279–293.
Calvo Guillermo A., (1983), “Staggered Prices in a Utility-Maximizing Framework”, *Journal of Monetary Economics*, Vol 12, No. 3, September, pp. 383–398.
Calvo, Guillermo A, and Maurice Obstfeld (1988), “Optimal Time-Consistent Fiscal Policy with Finite Lifetimes”, *Econometrica*, Vol. 56, No. 2, March, pp. 411–432.
Canofari, Paolo, Giancarlo Marini and Alessandro Piergallini (2020), “Financial Crisis and Sustainability of US Fiscal Deficit: Indicators or Tests?”, *Journal of Policy Modeling*.
Canofari, Paolo, Giancarlo Marini and Giovanni Piersanti (2014), “Measuring Currency Pressure and Contagion Risks in Countries under Monetary Unions: The Case of Euro”, *Atlantic Economic Journal*.
Canofari, Paolo, Giancarlo Marini and Giovanni Piersanti (2015), “Expectations and systemic risk in EMU government bond spreads”, *Quantitative Finance*, Vol. 15, No. 4, pp. 711–724.
Canofari, Paolo, Giancarlo Marini and Pasquale Scaramozzino (2017), “The Importance of Being Remembered: Prices for Cemetery Plots in the US”, *Economic Modelling*, Vol. 64, August, pp. 638–645.
Dalmazzo, Alberto, and Giancarlo Marini (2000), “Foreign Debt, Sanctions and Investment. A Model with Politically-Unstable LDC’s”, *International Journal of Finance and Economics*.
DeLong, J. B., and L. H. Summers (1986), “Is Increased Price Flexibility Stabilizing””, *American Economic Review*, Vol. 76, pp. 1031–44.
Fischer, Stanley (1977). “Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule”, *Journal of Political Economy*, 85, No. 1, 191–205.
Fisher, Irving (1933), “The Debt Deflation Theory of Great Depression”, *Econometrica*, October.

Friedman, Milton (1953), “The Case for Flexible Exchange Rates”, in *Essays in Positive Economics*, Chicago, University of Chicago Press.

Imbriani, Cesare, Raul de Luzenberger and Giancarlo Marini (1991), “La sostenibilità del debito pubblico:una valutazione dei fondamenti teorici e delle metodologie empiriche”, in AA.VV., *Ricerche applicate e modelli per la politica economica. Contributi all’analisi economica*, Servizio Studi, Banca d’Italia.

Imbriani, Cesare, Raul de Luzenberger and Giancarlo Marini (1996), “Sustainability Issues in the Process of European Integration”, in Mario Baldassarri, Cesare Imbriani and Dominic Salvatore (eds.), *The International System between New Integration and Neo-Protectionism*, Springer.

Imbriani, Cesare, and Pasquale Scaramozzino (2022), “Intertemporal Choices, Information, and Opportunity Sets: The Effectiveness of Monetary Policy”, chapter 1, *this volume*.

Keynes, John Maynard (1936), *The General Theory of Employment, Interest and Money*, London, Macmillan.

Lucas, Robert E., and Leonard A. Rapping (1969), “Real Wages, Employment and Inflation”, *Journal of Political Economy*, 77, pp. 721–54.

Marini, Giancarlo (1985), “Intertemporal Substitution and the Role of Monetary Policy”, *The Economic Journal*.

Marini, Giancarlo (1986), “Employment Fluctuations and Demand Management”, *Economica*.

Marini, Giancarlo (1987), “Price Variability, Supply-Side Policies and Monetary Rules”, *Economica*.

Marini, Giancarlo (1988a), “Policy Effectiveness and Design in New Classical Models”, *Oxford Economic Papers*.

Marini, Giancarlo (1988b), “Flexible Exchange Rates and Stabilizing Speculation”, *Journal of International Money and Finance*.

Marini, Giancarlo (1990), “Teoria economica e debito pubblico”, *Giornale degli Economisti e Annali di Economia*, Nuova Serie, Anno 49, No. 5/6 (Maggio-Giugno 1990), pp. 153–174.

Marini, Giancarlo (1992), “Monetary Shocks and the Nominal Interest Rate”, *Economica*.

Marini, Giancarlo, and Alessandro Piergallini (2007), “Indicators and Tests of Fiscal Sustainability: An Integrated Approach”, Centre for Financial and Management Studies, SOAS University of London, Discussion Paper No. 75, May.

Marini, Giancarlo, Alessandro Piergallini and Pasquale Scaramozzino (2004), “The Changeover to the Euro and the Behaviour of Inflation”, *Review of Economic Conditions in Italy*, No. 1, January–April, pp. 139–153.

Marini, Giancarlo, Alessandro Piergallini and Pasquale Scaramozzino (2007), “Inflation Bias after the Euro: Evidence from the UK and Italy”, *Applied Economics*, Vol. 39, pp. 461–470.

Marini, Giancarlo, and Giovanni Piersanti (2003), “Fiscal Deficits and Currency Crises”, CEIS Tor Vergata, Research Paper Series, Working Paper No. 15 May.

Marini, Giancarlo, and Giovanni Piersanti (2013), “Models of Speculative Attacks and Crashes in International Capital Markets”, chapter 10 in Piergiuseppe Morone (ed.), *Knowledge, Innovation and Internationalization: Essays in Honour of Cesare Imbriani*, Routledge.

Marini, Giancarlo, and Frederick van der Ploeg (1988a), “Monetary and Fiscal Policy in an Optimising Model with Capital Accumulation and Finite Lives”, *The Economic Journal*.

Marini, Giancarlo, and Frederick van der Ploeg (1988b), “Finite Horizons and the Non-neutrality of Money”, *Economics Letters*.

Marini, Giancarlo, and Pasquale Scaramozzino (1992), “Expected Inflation and Output Variability in Flexible Price and Contracting Models”, *Oxford Economic Papers*, Vol. 44, No. 2, April, pp. 232–241.

Marini, Giancarlo, and Pasquale Scaramozzino (1993), “Inflation Expectations, Price Flexibility and Output Variability in Macromodels”, *Structural Change and Economic Dynamics*, Vol. 4, No. 2, December, pp. 367–383.

Marini, Giancarlo, and Pasquale Scaramozzino (1995), “Overlapping Generations and Environmental Control”, *Journal of Environmental Economics and Management*, Vol. 29, No. 1, July, pp. 64–77.

Marini, Giancarlo, and Pasquale Scaramozzino (1996), "Public Debt and Redistribution", *The Manchester School of Economic and Social Studies*, Vol. LXIV, No. 3, September, pp. 269–280.

Marini, Giancarlo, and Pasquale Scaramozzino (1999), "Social Security and Intergenerational Equity", *Journal of Economics - Zeitschrift für Nationalökonomie*, Vol. 70, No. 1, pp. 17–35.

Marini, Giancarlo, and Pasquale Scaramozzino (2000), "Social Time Preference", *Journal of Population Economics*, Vol. 13, pp. 639–645.

Marini, Giancarlo, and Pasquale Scaramozzino (2003), "Intergenerational Transfers and Growth", chapter 3 in Luigi Paganetto and Edmund S. Phelps (eds.), *Finance, Research, Education and Growth*, London, Macmillan.

Nordhaus, W. D. (1998), "Quality Changes in Price Indexes", *Journal of Economic Perspectives*, Vol. 12, pp. 59–68.

Smith, Adam (1759), *The Theory of Moral Sentiments*, London Strand and Edinburgh, Millar, Kinkaid and Bell; reprinted, *The Theory of Moral Sentiments*, Oxford, Oxford University Press, 1976.

Sidrauski, Miguel (1967), "Inflation and Economic Growth", Journal of Political Economy, December, Vol. 75, No. 6, pp. 796–810.

Tobin, James (1980), *Asset Accumulation and Economic Activity. Reflections on Contemporary Macroeconomic Theory*, Chicago, The University of Chicago Press.

Tobin, James (1990), *Price Flexibility and Full Employment. The Debate Then and Now*, Istituto Italiano per gli Studi Filosofici, Seminari di Scienze, Napoli.

Weil, Philippe (1985), *Essays on the Valuation of Unbacked Assets*, Ph.D. dissertation, Harvard University, Cambridge (MA).

Yaari, Menahem (1965), "Uncertain Lifetimes, Life Insurance, and the Theory of the Consumer", *Review of Economic Studies*, Vol. 32, pp. 137–150.

Fiscal Policy and Sovereign Debt Dynamics: (Re-)Assessing the Intertemporal Viability of the Government Budget Using a Model-Based and Consistently Measured Sustainability Indicator

Giovanni Piersanti, Paolo Canofari, Alessandro Piergallini, and Audrey De Dominicis

A focus on the ratio of debt-to-GDP is simply economic nonsense. No one would judge a firm by looking at its debt alone. Anyone claiming economic expertise would want to look at the balance sheet—assets as well as liabilities.

Joseph E. Stiglitz, The Economists' Voice, 2012

Introduction

The observed sharp increase in fiscal deficits and sovereign debt level in major economies since the global financial crisis (GFC) and even worse with the Covid-19 pandemic shock and the Russia–Ukraine war have heightened fears and anxiety about the sustainability of public finances and future economic growth. These developments, while moving to center stage the issue of fiscal consolidation and a policy mix that supports growth, engineered considerable uncertainty about the size and timing of such policy adjustments, with some arguing for fiscal austerity, and others arguing for more fiscal stimulus. This surge in policy-induced uncertainty

We would like to express our own personal deepest thanks to Giancarlo Marini for invaluable discussions, suggestions, and critical thinking about this line of enquiry.

G. Piersanti (✉) · A. De. Dominicis
University of Teramo, Teramo, Italy
e-mail: gpiersanti@unite.it

P. Canofari
Marche Polytechnic University, Ancona, Italy

A. Piergallini
University of Rome Tor Vergata, Rome, Italy

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_4

was an important factor behind the weakness of the global recovery and, notably, the weakness of activity in the euro area after the GFC (e.g., Bloom 2009; Kose and Terrones 2012; Baker et al. 2016; Kostka and van Roye 2017).

Economic theory and empirical evidence suggest that uncertainty, economic activity, and policy decisions are negatively correlated, although the relationship between the variables is a complex one as they may interact and affect each other.[1] Nonetheless, one of the major implications to emerge from this literature is that by implementing sensible and timely measures, policymakers can reduce policy-induced uncertainty and minimize the impact on economic activity. This, in turn, calls for a set of reliable indicators—theoretically grounded and internally consistent—assessing the efficacy and soundness of alternative policy actions.

In this chapter, we focus on uncertainty about fiscal policy decisions related to the budget sustainability assessment that jumped to the top of the policymakers agenda after the GFC and the explosion of the sovereign debt crisis in the EU. Our main goal is to provide a model-consistent indicator of fiscal sustainability that overcomes the shortcomings of the most widely used marker based on the debt-to-GDP ratio (DGR) while helping the fiscal authorities to make sensible decisions about projected long-run budget imbalances, so contributing to lowering policy-induced uncertainty. As underlined in recent policy and academic debates, having a rigorous and reliable indicator of the government budget position is critical to run stabilization policies properly; otherwise, there is a risk of providing misleading policy recommendations, which would not only lead to miss policy targets but also introduce more uncertainty with negative economic and social consequences.[2] For example, if the indicator fails to detect an unsustainable policy, the government may default on debt rising financial instability. Conversely, if the indicator provides the wrong information that a policy is unsustainable when it is not, it may force the government to raise taxes or cut spending driving down economic activity.

In the economics literature, fiscal discipline and the sustainability of public finances are commonly evaluated by assessing the time path of the DGR, which displays a stock variable measured relative to a flow variable. In the present chapter, we argue that this measure is seriously flawed and may lead to wrong and possibly harmful policy measures.

We advocate a number of theoretical pitfalls that help explain why the DGR is a spurious indicator of debt sustainability. First, it is not logically consistent to compare a stock relative to a flow variable, although obvious relationships exist between the two. The time discrepancy between these two magnitudes raises non-trivial problem of interpretation. Second, there is little relationship between GDP and the amount of adequate resource that can be collected to finance the outstanding debt (Wyplosz, 2011). This flaw has been frequently recognized in

[1] See, e.g., Gilchrist et al. (2014), Straub and Ulbricht (2017), Fajgelbaum et al. (2017), Plante et al. (2018), and Arellano et al. (2019).

[2] See, e.g., Bi et al. (2013), Auerbach (2015), Alesina et al. (2015), Fernández-Villaverde et al. (2015), Stiglitz (2016), Stiglitz et al. (2018), and Davig and Foerster (2019).

the literature, prompting many to search for alternative scaling factor, such as revenues, exports, or GNI (see, e.g., Balassone et al. 2007; Giammarioli et al. 2007; Aizenman and Jinjarak 2010; Greenwood 2018; Blot 2018). Nevertheless, as does the GDP, these other debt-scaling measures also display a stock variable measured relative to a flow variable. Third, the DGR only looks at the liability side of the government, therefore missing the asset side that makes up the other basic component of a country's balance sheet. Based on this view, a more recent approach (Arrow et al., 2012; Piketty and Zucman, 2014; Piketty, 2015; Dasgupta, 2015; Stiglitz, 2016) emphasizes the central role of wealth and its structure (i.e., the proportions of productive capital and of financial wealth) in the assessment of economic sustainability. Countries with nearly the same national income may not have the same accumulated capital (national wealth) and, hence, the same ability to sustain a given debt burden. Finally, public debt sustainability cannot be filtered out of general, dynamic equilibrium conditions linking fiscal policy to the rest of economy (Bohn 1998, Bruce and Turnovsky 1999; Turnovsky 2004; Blot 2018; Canofari et al. 2020a,b).

To illustrate these points clearly, this chapter uses an endogenous growth setup with the public sector, along the lines developed by Bruce and Turnovsky (1999) and Canofari et al. (2020), and shows that forward-looking agents' optimizing behavior typically gives rise to a wealth-based and not to an output-based sustainability index of government policy. Then, computing the resulting wealth-based indicator from 2001 to 2018 for 15 European countries along with the U.S. and Japan as reference countries, the chapter provides results that appear to be fundamentally different from common wisdom. In particular, it finds the long-run fiscal balance of countries such as the Netherlands, Denmark, Belgium, Finland, Sweden, Germany, Italy, and Portugal to be sustainable, whereas that of countries such as Austria, Greece, France, Spain, the U.K. along with the U.S. and Japan, being unsustainable.

These findings are obscured and even overturned if one concentrates on the dynamics of the DGR, and signal that indicators and tests of government solvency, used in the current fiscal policy literature, are misleading and may lead to undue and perverse policy strategies. The unsustainability results here obtained, say, for Austria and France on the one hand, in conjunction with the sustainability results obtained, say, for Italy on the other hand are absolutely instructive and contribute to explaining the recent bouts of uncertainty and wrangling about fiscal policy in the Eurozone and the observed adverse effects on economic activity and growth perspective.

Overall, the analysis developed in this chapter shows that incorporating agents' wealth in the formulation of budgetary policy indicators turns out to be essential to guarantee logical consistency in monitoring fiscal sustainability and making sensible policy decisions that reduce uncertainty and boost growth in the euro area and the rest of the world. From this perspective, therefore, it adds to the burgeoning literature on better metrics for better policies opened up by the "Beyond GDP" roadmap adopted in 2009 in the international organizations such as the European Union, OECD, IMF, and World Bank (e.g., Stiglitz et al. 2009; Arrow et al. 2012;

Feigl et al. 2013; Dasgupta 2015; Stiglitz 2016; Coyle 2017; Stiglitz et al. 2018; Giovannini and Rondinella 2018).

The rest of the chapter proceeds as follows. Section "The Model" describes the optimizing model. Section "Empirical Evidence" calibrates the implied fiscal sustainability indicator for the European countries and the two reference economies, the United States and Japan, and lays out the policy implications. Section "Conclusion" summarizes the main conclusions.

The Model

The Basic Structure

The environment we consider is typical of the so-called endogenous growth models with the public sector. This has two main advantages: (i) it allows the fiscal policy to play a key role in the long-run economic growth; (ii) it provides a powerful framework to address substantial issues related to the intertemporal aspect of changes in the government's budget balance.[3]

The economy consists of three basic sectors: households, firms, and the government. All households and firms are assumed to be identical, enabling us to consolidate the private sector of the economy into a single representative composite household-firm unit and to focus on just one unit's behavior. Individuals are assumed to live forever and to have perfect foresight.

The preferences of the representative unit for consumption over time are described by the following intertemporal isoelastic utility function:

$$U(t) = \int_t^{\infty} \frac{1}{\sigma} \left[C(v)\, G(v)_C^{\varepsilon} \right]^{\sigma} e^{-\beta(v-t)} dv, \tag{1}$$

$$\varepsilon > 0, \ -\infty < \sigma < 1, \ \varepsilon\sigma < 1, \ 1 > \sigma(1+\varepsilon),$$

where C denotes private consumption, G_C is government spending on consumption goods, ε a parameter measuring the impact of government consumption on the welfare of private agents, β the constant time-preference rate, σ a parameter linked to the intertemporal elasticity of substitution ξ by $\sigma = (\xi - 1)/\xi$), and the constraints on the coefficients are imposed to ensure that the utility function is strictly concave in its arguments.

[3] See, e.g., Barro (1990), Jones and Manuelli (1990), Rebelo (1991), Jones et al. (1993), Pecorino (1993), Ireland (1994), Turnovsky (1996, 2000), Bruce and Turnovsky (1999), and Canofari et al. (2020a,b).

The production technology is externally affected by productive government spending according to a simple Cobb–Douglas function of the form

$$Y(t) = AG(t)_I^{\alpha} K(t)^{1-\alpha} = A\left[\frac{G(t)_I}{K(t)}\right]^{\alpha} K(t),\ 0 \leq \alpha \leq 1, \tag{2}$$

where Y denotes output, A is an index of productivity that summarizes the current state of technological know-how, K is the private capital stock, and G_I the flow of services derived from productive government activity such as public investment in roads, bridges, communication systems, education, health, and so on.[4] The overall technology ensures constant returns to scale with respect to both inputs, even though private capital accumulation faces diminishing returns. This allows the possibility of a steady state where both K and G_I grow at the same rate and the economy follows a path of ongoing endogenous growth. For simplicity, we let K be infinitely durable so that private capital accumulates residually in line with the economy-wide resource constraint

$$\dot{K}(t) = Y(t) - C(t) - G(t), \tag{3}$$

where $\dot{K}(t) \equiv [dK(t)/dt]$, and $G(t) \equiv G(t)_C + G(t)_I$ is the total public expenditure.

The government finances its expenditures by levying taxes or issuing debt. Its flow (or short-run) budget constraint is

$$\dot{B}(t) = r(t)B(t) + G(t) - \tau Y(t) - \varkappa C(t) - T, \tag{4}$$

where $B(t)$ denotes the value of government bonds held by households at time t, $\dot{B}(t) \equiv [dB(t)/dt]$, $r(t)$ the real interest rate on government bonds, τ the (constant) tax rate on income, $\varkappa$ the (constant) tax rate on consumption, and T a lump-sum tax (transfer if negative). Notice that, in order to take account of different tax rates on income and the interest on bonds, we set the tax rate on r equal to 0 for simplicity, so that r is also the after-tax real interest rate.

[4] Including productive government expenditure in the production function as a flow variable is standard in an endogenous growth model (see, e.g., Barro 1990; Barro and Sala-i-Martin 1992; Turnovsky 1996; Bruce and Turnovsky 1999). An alternative, more appealing formulation would be to include public capital in the production function. This, however, has a price in terms of analytical complexity, as it generates complex transitional dynamics and steady-state computations without changing most results that are obtained in the flow case (see, e.g., Futagami et al. 1993; Turnovsky 1997, 2004; Irmen and Kuehnel 2009). This is why we choose the flow case formulation.

Aggregating finally (3) and (4) leads to the following wealth accumulation equation of the representative agent:

$$\overset{\bullet}{W}(t) \equiv \overset{\bullet}{K}(t) + \overset{\bullet}{B}(t) = r(t)\,B(t) + (1-\tau)\,Y(t) - (1+\varkappa)\,C(t) - T, \tag{5}$$

where $\overset{\bullet}{W}(t) \equiv [dW(t)/dt]$, and $W(t) \equiv K(t) + B(t)$ is total real wealth.

The Household Firm's Problem

The objective of the composite household-firm unit is to choose its consumption flows and the accumulation of capital and government bonds over time, so as to maximize its intertemporal utility function (Eq. 1), subject to the production technology (Eq. 2) and the flow budget constraint (Eq. 5). The solution to this problem is obtained by defining the Lagrangian (or augmented Hamiltonian) equation

$$L(t) = \frac{1}{\sigma}\left[C(t)\,G(t)_C^{\varepsilon}\right]^{\sigma} e^{-\beta t} + \lambda(t)\,e^{-\beta t}\,[r(t)\,B(t) + (1-\tau)\,Y(t) - (1+\varkappa)\,C(t) + \\ -T - \overset{\bullet}{K}(t) - \overset{\bullet}{B}(t)\Big],$$

or, using (2),

$$L(t) = \frac{1}{\sigma}\left[C(t)\,G(t)_C^{\varepsilon}\right]^{\sigma} e^{-\beta t} + \lambda(t)\,e^{-\beta t}\Big[r(t)\,B(t) + (1-\tau)\,AG(t)_I^{\alpha}\,K(t)^{1-\alpha} + \\ -(1+\varkappa)\,C(t) - T - \overset{\bullet}{K}(t) - \overset{\bullet}{B}(t)\Big], \tag{6}$$

where $\lambda(t)$ is the costate variable associated with the budget constraint (Eq. 5) and represents the shadow price (or marginal utility) of wealth. Performing the maximization leads to the following first-order optimality conditions:

$$\frac{\partial L(t)}{\partial C(t)} = 0 \Longrightarrow \left[C(t)\,G(t)_C^{\varepsilon}\right]^{\sigma-1} G(t)_C^{\varepsilon} = \lambda(t)\,(1+\varkappa),$$

$$\frac{\partial L(t)}{\partial K(t)} = -\frac{d\lambda(t)\,e^{-\beta t}}{dt} \Longrightarrow A(1-\alpha)(1-\tau)\left[\frac{G(t)_I}{K(t)}\right]^{\alpha} = -\frac{\overset{\bullet}{\lambda}(t)}{\lambda(t)} + \beta,$$

$$\frac{\partial L(t)}{\partial B(t)} = -\frac{d\lambda(t)\,e^{-\beta t}}{dt} \Longrightarrow r(t) = -\frac{\overset{\bullet}{\lambda}(t)}{\lambda(t)} + \beta.$$

The first equation states that in equilibrium the marginal utility of consumption must equal the tax-adjusted marginal utility of wealth. The remaining two conditions are

Euler equations stating that the (after-tax) rate of return on savings, either in the form of bonds or physical capital, must equal the rate of return on consumption. Combing the last two allows to state the agent's optimality conditions as

$$\left[C\left(t\right)G\left(t\right)_C^{\varepsilon}\right]^{\sigma-1}G\left(t\right)_C^{\varepsilon}=\lambda\left(t\right)\left(1+\varkappa\right), \tag{7a}$$

$$r\left(t\right)=A\left(1-\alpha\right)\left(1-\tau\right)\left[\frac{G\left(t\right)_I}{K\left(t\right)}\right]^{\alpha}=\beta-\frac{\dot{\lambda}\left(t\right)}{\lambda\left(t\right)}. \tag{7b}$$

In addition, the transversality conditions

$$\lim_{v\longrightarrow\infty}\lambda\left(t\right)B\left(t\right)e^{-\beta(v-t)}=\lim_{v\longrightarrow\infty}\lambda\left(t\right)K\left(t\right)e^{-\beta(v-t)}=\lim_{v\longrightarrow\infty}\lambda\left(t\right)W\left(t\right)e^{-\beta(v-t)}=0 \tag{7c}$$

must be met, thereby ruling out explosive equilibria.

Balanced Growth Equilibrium

In this setting, given tax rates and public spending, the optimality conditions (7a–7b), together with the government and the agent budget constraints (4) and (5), and the production technology (2), can be used to compute the short-run solutions for the five variables C, K, B, r, λ, in terms of the dynamically evolving variables λ, K, and B, i.e., to describe the perfect foresight equilibrium of the economy and to determine its dynamic evolution. A feature of this type of model is that the equilibrium is always on a balanced growth path ($\mathfrak{g}$), where

$$\frac{\dot{Y}\left(t\right)}{Y\left(t\right)}=\frac{\dot{K}\left(t\right)}{K\left(t\right)}=\frac{\dot{B}\left(t\right)}{B\left(t\right)}=\frac{\dot{W}\left(t\right)}{W\left(t\right)}=\frac{\dot{C}\left(t\right)}{C\left(t\right)}=\frac{\dot{G}\left(t\right)_C}{G\left(t\right)_C}=\frac{\dot{G}\left(t\right)_I}{G\left(t\right)_I}\equiv\mathfrak{g}, \tag{8}$$

and the ratios of private and public spending to capital, wealth, and output remain constant over time (see, e.g., Barro 1990; Rebelo 1991; Turnovsky 1996).

To solve the model for $\mathfrak{g}$, take the time derivative of Eq. 7a and combine with Eq. 7b to find

$$\left(\sigma-1\right)\frac{\dot{C}\left(t\right)}{C\left(t\right)}+\left(\varepsilon\sigma\right)\frac{\dot{G}\left(t\right)_C}{G\left(t\right)_C}=\beta-r\left(t\right); \tag{9}$$

then, substituting (8) for $\left(\dot{C}/C\right)=\left(\dot{G}_C/G_C\right)=\mathfrak{g}$ yields

$$\mathbf{g}=\frac{r\left(t\right)-\beta}{1-\sigma\left(1+\varepsilon\right)}, \tag{10}$$

which describes the equilibrium growth rate of this economy.

To find the solution for the "great ratios" (C/K), (C/W), (K/W), (Y/K), let the government set its expenditures-to-output ratio constant over time, namely

$$G(t)_C = \gamma_C Y(t),\ 0 < \gamma_C < 1 \tag{11a}$$

$$G(t)_I = \gamma_I Y(t),\ 0 < \gamma_I < 1, \tag{11b}$$

where γ_C and γ_I are the (constant) shares of public spending for consumption and investment, respectively. Next, using the aggregate production function (2), write Eq. 11b as

$$G(t)_I = \gamma_I A \left[\frac{G(t)_I}{K(t)}\right]^{\alpha} K(t),$$

whence

$$\frac{G(t)_I}{K(t)} = (A\gamma_I)^{\frac{1}{1-\alpha}}, \tag{12a}$$

and Eq. 11a as

$$\frac{G(t)_C}{K(t)} = \gamma_C \gamma_I^{\frac{\alpha}{1-\alpha}} A^{\frac{1}{1-\alpha}}. \tag{12b}$$

Also, substituting Eq. 12a in Eq. 7b, we may express the interest rate as

$$r(t) = A(1-\alpha)(1-\tau)\left[\frac{G(t)_I}{K(t)}\right]^{\alpha} = A(1-\alpha)(1-\tau)(A\gamma_I)^{\frac{\alpha}{1-\alpha}}, \tag{13}$$

which, combined with the production function (Eq. 2), allows to express aggregate output as

$$Y(t) = \left[\frac{r(t)}{(1-\alpha)(1-\tau)}\right] K(t),$$

whence

$$\frac{Y(t)}{K(t)} = \frac{r(t)}{(1-\alpha)(1-\tau)} = \frac{A(1-\alpha)(1-\tau)(A\gamma_I)^{\frac{\alpha}{1-\alpha}}}{(1-\alpha)(1-\tau)}. \tag{14}$$

Finally, combining Eq. 14 with either the economy-wide resource constraint (Eq. 3) or the wealth accumulation equation (Eq. 5), the solution for the ratios (C/K), (C/W), and (K/W) can be obtained as follows:

From Eq. 3, after dividing by K, together with the use of Eq. 14, we find that the ratio of private consumption to capital is given by

$$\frac{C}{K} \equiv \varphi = \frac{r(1-\gamma_C-\gamma_I)}{(1-\alpha)(1-\tau)} - \mathbf{g}. \tag{15}$$

Similarly, after dividing by W, together with the use of Eq. 14, from Eq. 5, we find

$$\frac{C}{W} \equiv \eta = \frac{r\left(1 + \frac{\alpha\omega}{1-\alpha}\right) - \mathbf{g}}{(1+\varkappa)} \tag{16}$$

$$\frac{K}{W} \equiv \omega = \frac{r - \mathbf{g}}{(1+\varkappa)\varphi - \frac{r\alpha}{1-\alpha}}. \tag{17}$$

It is immediate to see from Eqs. 10–17 that on the balanced growth path equilibrium, the "great ratios" (C/K), (C/W), (K/W), (Y/K) are constant and that fiscal policy has a clear-cut impact on the macro-dynamic equilibrium of this economy as shown in the following (partial derivative) effects of changes in policy instruments:

$$\partial\mathbf{g}/\partial\tau < 0;\ \partial\,(C/K)\,/\partial\tau > 0,\ \partial r/\partial\tau < 0 \tag{18a}$$

$$\partial\mathbf{g}/\partial\varkappa = \partial r/\partial\varkappa = 0;\ \partial\,(C/W)\,/\partial\varkappa < 0,\ \partial\,(K/W)\,/\partial\varkappa < 0 \tag{18b}$$

$$\partial\mathbf{g}/\partial\gamma_C = \partial r/\partial\gamma_C = 0;\ \partial\,(C/K)\,/\partial\gamma_C < 0 \tag{18c}$$

$$\partial\mathbf{g}/\partial\gamma_I > 0;\ \partial r/\partial\gamma_I > 0. \tag{18d}$$

The explanation for these signs is as follows. A rise in the income tax rate, τ, reduces both the growth rate, **g**, and the interest rate, r, and increases the consumption–capital ratio, C/K, (Eq. 18a). An increase in the consumption tax rate, $\varkappa$, reduces both the consumption–wealth ratio, C/W, and the capital–wealth ratio, K/W, but do not affect the interest rate and the growth rate (Eq. 18b). A rise in the government consumption ratio, γ_C, crowds out the consumption–capital ratio, C/K, but has no effect on either the interest rate or the growth rate (Eq. 18c). Finally, a rise in the government investment ratio, γ_I, raises both the interest rate and the growth rate (Eq. 18d).

The Government Long-Run Fiscal Balance

In order to determine the conditions required to ensure the long-run balance (or sustainability) of the government budget, we now focus on fiscal policies that are consistent with a balanced growth equilibrium. For simplicity, we assume that government bonds consist only of perpetuities paying a (taxable) coupon rate of one unit. The value of this government bond is $1/r\,(t)$, and the value of the outstanding debt is $B\,(t) = [b\,(t)\,/r\,(t)]$, where b is the number of outstanding bonds. This, with r constant, implies further that $\dot{B}\,(t) = \dot{b}\,(t)\,/r$.

Making use of Eqs. (11a–11b), 14, and 15, let us now rewrite the government budget constraint (4) as

$$\frac{\overset{\bullet}{b}(t)}{r} = b(t) + \left[\frac{\gamma_C + \gamma_I - \tau}{(1-\alpha)(1-\tau)}\right] rK(t) - \varkappa\varphi K(t) - T. \tag{19}$$

Integrating this equation over the range $[t, \infty)$ and using (17) leads to

$$\int_t^\infty T(v)\,e^{-r(v-t)}dv = \frac{b(t)}{r} + \int_t^\infty \left[\frac{(\gamma_C + \gamma_I - \tau)\,r}{(1-\alpha)(1-\tau)} - \varkappa\varphi\right]\omega W(t)\,e^{-(r-\mathbf{g})(v-t)}dv. \tag{20}$$

Equation (20) is the intertemporal budget constraint of the government, requiring that the present value of government expenditures less tax receipts on economic activity, that is, the present value of the primary budget deficit, plus the current value of debt, must equal the value of present and future lump-sum tax payments. Solving (20) under the transversality conditions (7c) and dividing through by the size of the current wealth, we find

$$\mathfrak{F}(t) \equiv \int_t^\infty \frac{T(v)\,e^{-r(v-t)}}{W(t)}dv = \frac{B(t)}{W(t)} + \frac{r\left[\dfrac{\gamma_C + \gamma_I - \tau}{(1-\alpha)(1-\tau)}\right] - \varkappa\varphi}{r - \mathfrak{g}}\omega. \tag{21}$$

Observe that in the light of (7b) and (10) the condition (7c) reduces to

$$r > \mathbf{g}, \tag{22}$$

which ensures that the integral in (20) is well-defined and, hence, that the government is intertemporally solvent.[5]

This completes the description of the economy, from which the macroeconomic equilibrium and its (long-run) viability can be derived as follows. Equations (10), (13), (15), (16), and (17) determine the state of the economy and its fiscal policy as described by the parameter set $\{\tau, \varkappa, \gamma_C, \gamma_I\}$; Eq. (21) determines the present discounted value of T required for the government to be intertemporally solvent. These equilibrium relationships fully describe the balanced growth path of the economy.

Equation (21) is a key relationship of the model and provides a sensible index to assess the intertemporal (or long-run) sustainability of the government budget policy. It measures the present value of fiscal policy adjustments necessary to ensure

[5] Condition (22) is the opposite of that arising in early, backward-looking models centered on the debt-to-GDP ratio. The reason is that the dynamics is here forward-looking.

the long-run sustainability of government debt. Following Canofari et al. (2020), we take $\mathfrak{F}$ to be the *sustainability index of fiscal policy*.[6]

A number of advantages follow from (21). First, all values are derived relative to the current size of wealth, thus avoiding the shortcoming of the DGR, where a stock variable is measured relative to a flow variable. Second, the right-hand side includes two (correctly normalized) components. The first is the current stock of government debt. The second is the present value of the primary budget deficit. Hence, the left-hand side computes the value of fiscal policy adjustments (here assumed to take the form of lump-sum taxes) required to warrant the viability of the long-run fiscal balance as reflected by the two components in the right-hand side of (21). Finally, being based on endogenous growth model, the index provides a "dynamic scoring" of government debt that takes into account the intertemporal nature of fiscal policy and its impact on the growth rate and other macroeconomic variables, and by which we can assess a country's fiscal position as follows:

- When $\mathfrak{F}(t) \leq 0$, fiscal policy is said to be strongly sustainable, meaning that the long-run government's budget requires no corrective action for it generates sufficient primary surpluses to exactly finance the outstanding debt, $B(t)$.
- When $0 < \mathfrak{F}(t) \leq [B(t)/W(t)]$, fiscal policy is said to be weakly sustainable, implying that the government is running a primary surplus, but of insufficient magnitude to fully pay off its debt.
- When $\mathfrak{F}(t) > [B(t)/W(t)]$, fiscal policy is said to be unsustainable, as the government is running a primary deficit that adds to its outstanding debt, thus requiring a corrective action to ensure the intertemporal viability of the budget.

Additional worthy properties to follow from the above sustainability index are as detailed below:

(a) It does not imply any threshold level for the debt, which is puzzling and highly questioned in the academic literature.[7]
(b) It yields a "simple, transparent and standardized measure that can be easily implementable to all countries" (see section "Empirical Evidence").[8]
(c) It provides a dynamic scoring of the government fiscal balance that switches emphasis from levels to paths and computes how much adjustment is required to converge to the stability path.
(d) It implies that the adjustment process need not necessarily occur immediately, but better spanned over a longer planning horizon to avoid the deep recessions

[6] This sustainability index is similar to that proposed by Bruce and Turnovsky (1999). They express their measure relative to the size of private capital stock, whereas we express ours relative to the size of national wealth.

[7] See, e.g., Cordella et al. (2010), Wyplosz (2011), Panizza and Presbitero (2014), Pescatori et al. (2014), Egert (2015), Schadler (2016), Chudik et al. (2017), and Ash et al. (2020).

[8] As noted by Wyplosz (2011) and Debrun et al. (2019), this is the stated, but missed goal of the international organizations, such as the IMF and World Bank, when dealing with the debt-sustainability issue.

resulting from huge fiscal contractions and the risk of possible devilish dynamics driven by self-fulfilling expectations of debt non-sustainability.[9]

(e) It is consistent with and strictly reflects, via the present value of the primary budget deficits, the government budgetary policies, and the interest-growth gap $(r - \mathbf{g})$, differently from the DGR indicator.

(f) It takes into account the role of capital (and, therefore, the productive potential of the economy) in the assessment of sustainability multiplying the primary budget balance by the capital–wealth ratio (K/W).[10]

As a final remark, it is also worth mentioning that the above setup makes it plain to see where the "original sin" of the DGR indicator takes root: a fiscal sustainability analysis not addressed within an explicit intertemporal macro-model linking fiscal policy to the rest of the economy.

Empirical Evidence

This section computes the fiscal sustainability index for a large sample of European countries over the period 2001–2018 along with the U.S. and Japan as reference countries. The index estimate is derived from the country-specific calibration of all model parameters involved in Eq. 21.[11] A detailed list of the variables with the indication of their statistical source is in Appendix "Appendix A: Data Description and Sources."

Parameters Calibration

In order to simplify the empirical discussion and data representation, let us first rewrite the fiscal sustainability indicator (21) as

$$\mathfrak{F}(t) = \frac{B(t)}{W(t)} + \frac{VB(t)}{W(t)}, \tag{21'}$$

where all variables are in real terms, $W(t) \equiv K(t) + NFW(t)$, $K(t)$ is the stock of private capital, $NFW(t)$ the net financial wealth, $B(t)$ the value of the outstanding government debt, and $VB(t)$ the present value of primary

[9] See, e.g., Wyplosz (2011), DeLong and Summers (2012), De Grauwe and Ji (2013), Cafiso and Cellini (2014), Canofari et al. (2015), Debrun et al. (2019), and House et al. (2020).

[10] This is what Stiglitz (2016) calls the problem of "missing capital" in standard wealth accounts that may impair our ability to assess economic sustainability.

[11] The computations and results shown here, therefore, not only extend those featured in Canofari et al. (2020a,b) but strictly reflect all model parameters.

surpluses/deficits determined as

$$VB\left(t\right)=\frac{r\left[\dfrac{\gamma_{C}+\gamma_{I}-\tau}{(1-\alpha)(1-\tau)}\right]-\varphi\varkappa}{r-\mathbf{g}}K\left(t\right). \tag{22}$$

Consistent with the restriction imposed on (21), let us compute the fiscal sustainability index $\mathfrak{F}\left(t\right)$ only for those countries in which the after-growth real interest rate $(r-\mathbf{g})$ came out to be positive. This condition is crucial for determining a country's maximum sustainable debt level and implies that the debt ratio will explode in the future unless the government runs a large budget surplus to compensate. Hence, in order to stay in a non-explosive path, the total value of the debt outstanding must be paid off by future budget surpluses. Conversely, if $(r-\mathbf{g})<0$, a positive growth dividend will always ensure the long-run sustainability of the government's budget (see, e.g., Bohn 2008; Barret 2018; Blanchard 2019).

Based on (21') and (22), we calibrated the values for $B\left(t\right)$, $W\left(t\right)$, and the set of parameters $\{\gamma_C, \gamma_I, \tau, \varphi, \varkappa, g, r\}$ needed to determine $\mathfrak{F}\left(t\right)$ from available official data (see, Appendix "Appendix A: Data Description and Sources"). Also, we computed the size of α (i.e., the output elasticity to public investment) from Eq. 15 as

$$\alpha=\frac{(\mathbf{g}+\varphi)(1-\tau)-(1-\gamma_{C}-\gamma_{I})\,r}{(1-\tau)\,(\mathbf{g}+\varphi)}, \tag{23}$$

using the value of all parameters on the right-hand side of (23).

From (21')–(23), it follows that the $\mathfrak{F}\left(t\right)$ computation requires only realized value for the variables of interest, thus escaping the "impossible mission" of trying to predict future primary balances over an infinite or very long horizon met in many empirical approaches to debt-sustainability assessment.[12]

Results

The results we gained by applying (21') to our sample of 17 countries are in Appendix "Appendix B: Tables and Graphs", Tables 1, 2, 3, and 4.

Table 1 reports the interest-rate-growth gap $(r-\mathbf{g})$, disjoining Ireland and Norway, where the gap came up to be negative and, hence, not included in the sustainability rating, from the other countries with positive interest-growth differential.[13]

[12] See, e.g., Wyplosz (2011) and Debrun et al. (2019).

[13] What may be of special interest here is the fact that financial repression, teamed with a steady dose of inflation, played a key role to bring down the interest-growth gap in many advanced and emerging economies. See, e.g., Reinhart et al. (2011) and Reinhart (2012).

Table 2 reports the (average) values of all parameters needed to determine $\mathfrak{F}(t)$ in countries where $(r - \mathbf{g}) > 0$. Table 3 shows the average value of $\mathfrak{F}$, along with its two basic components (B/W), and (VB/W) and the average value of the debt-to-GDP ratio (B/Y). Finally, Table 4 gives the country's sustainability ranking flowing from our metrics ($\mathfrak{F}$) and the standard DGR indicator (B/Y).

Under the $\mathfrak{F}(t)$ computation, the tables reveal that the fiscal position of countries such as the Netherlands, Sweden, Denmark, Finland, and Belgium is strongly sustainable because the index takes on a value $\mathfrak{F}(t) < 0$. The positions of Italy, Germany, and Portugal are found to be weakly sustainable because $0 < \mathfrak{F}(t) \leq [B(t)/W(t)]$, whereas all the remaining countries are found to be unsustainable as $\mathfrak{F}(t) > [B(t)/W(t)]$. This contrasts sharply with the DGR-based assessment, where the ranking of countries such as Italy, Belgium, Austria, France, United Kingdom, United States, and Spain are fully overturned.

Additional information on the above governments' budget position is given in Figs. 1, 2, and 3, which display the dynamics of $\mathfrak{F}(t)$ over 2001–2018. The graphs confirm the findings reported in Tables 3 and 4 and make visible a dynamics of the index not too far from the computed country's average values despite a common upward trend observed in the crisis period just offset by downward movement in the post-crisis phase.

These results are openly at variance with consolidated beliefs about sovereign debt sustainability in EU countries and suggest that indicators and tests of government solvency, used in the current fiscal policy literature and based on the dynamics DGR, are strongly biased and misleading. This is directly visible from (21') and Tables 3 and 4, which show that the value $\mathfrak{F}$ depends and strictly reflects via VB the government budgetary policy and the interest-growth differential, a feature hardly found in the DGR metrics. In addition, Table 3 brings into view that if consistently measured relative to the current level of wealth, public debt levels sound much less threatening than the corresponding debt/GDP ratios, as they amount to 18% of the total wealth on average in contrast to the 86% of the total output. Obviously, this simply reflects the different scaling factors used to measure the level of indebtedness, but no doubt it spreads a less gloomy and compelling picture than commonly inferred from DGR metrics. Furthermore, the dynamics of $\mathfrak{F}(t)$ shown in Figs. 1, 2, and 3 reveal a clear tendency toward strong sustainability in most countries, thus signaling that debt fears, compulsively and regularly raised in international policy circles, academic debates, and mass media after the GFC are frankly overdone. We therefore expect that the new index could act as a powerful therapy against the "dangerous debt obsession" (Blot 2018, Krugman 2019) and a "single-minded focus on government liabilities" (Stiglitz, 2016; Stiglitz et al., 2018) found in the economics literature (e.g., Reinhart and Rogoff 2010; Cottarelli 2011; Ghosh et al. 2012; Reinhart et al. 2015; Kose et al. 2021) and international policy institutions such as the IMF, the World Bank, OECD, and European Commission. A less debt-obsessed, but more growth-oriented policy strategy, therefore, would be welcomed.

The new approach to the sustainability assessment of government debt is thereby not without policy implications as it points to fiscal policy reactions and commitments running in the opposite direction of those recommended so far for many European countries because of DGR metrics. The case of Italy—assessed to be on an unsustainable path—and that of countries such as Austria and France—rated as sustainable—is enlightening.[14] These findings are obscured and even misread if one focuses on the dynamics of DGR and may lead to heated wrangling over fiscal policy, including taxes and government spending, which has been found to be one of the major factors behind the recent rise in policy uncertainty.

Conclusion

This chapter argues that a key step toward reducing the surge of elevated uncertainty about fiscal policy observed in many OECD economies since the GFC is to have a reliable indicator measuring the budgetary adjustments needed to warrant the long-run sustainability of the government debt. Focusing on this issue, the chapter first shows that the standard indicator based on the evolution of DGR is inconsistent with the basic principles of both measurement theory and dynamic optimization, and a potential source of economic and political hardships about policy changes. Then, using an endogenous growth model, it finds that forward-looking agents' optimizing behavior typically gives rise to a wealth-based and not to an output-based sustainability index of government policy.

Computing the new index from 2001 to 2018 for 15 European countries along with the USA and Japan as reference countries, the chapter provides results remarkably different from consolidated beliefs. In particular, our analysis shows the long-run fiscal position of the Netherlands, Denmark, Belgium, Finland, Sweden, Germany, Italy, and Portugal to be sustainable, whereas that of Austria, Greece, France, Spain, the UK, together with the U.S. and Japan, being unsustainable.

Such results are arguably neglected if one focuses the attention on the dynamics of the debt-to-GDP ratio, and signal that indicators and tests of debt sustainability based on the debt-to-GDP ratio are strongly biased and misleading, and have been an important factor behind the boost in policy-induced uncertainty observed after the Great Recession. Specifically, the (un)sustainability results we obtained, say, for Austria, France, and Italy are instructive and constitute a plausible explanation about the recent course of visible disagreement on the fiscal austerity measures undertaken within the Eurozone and the observed negative impacts on economic activity and growth perspective.

[14] A comprehensive empirical investigation of the deleterious effects on the growth and public debt of Italy channeled through DGR-based policy responses is in the contribution by Piersanti (2023, Chap. 7 of this volume).

Appendix A: Data Description and Sources

Yearly Data (1992–2018)		
Variable's Name	Description	Source
Real GDP	Real GDP in national currency	AMECO
Real growth rate (g)	Percentage change of real GDP (average)	Computation on AMECO
GDP deflator	Price deflator gross domestic product	AMECO
Indirect taxes (T_i)	Taxes linked to imports and production (indirect taxes)	AMECO
Real Indirect taxes	(Ratio) Indirect taxes/real GDP deflator	Computation on AMECO
Real consumption	Private final consumption expenditure at 2010 prices	AMECO
Consumption tax rate ($\varkappa$)	(Ratio) Real indirect taxes/real consumption (average)	Computation on AMECO
TR	Total revenue: general government	AMECO
Income taxes (T_d)	$T_d = TR - T_i$	AMECO
Real income taxes	(Ratio) T_d /real GDP deflator	Computation on AMECO
Income tax rate (τ)	(Ratio) Real income taxes/real GDP (average)	AMECO
Government debt	General government consolidated gross debt	AMECO
Real public debt (B_t)	(Ratio) Government debt/GDP deflator	Computation on AMECO
Private capital stock (K_t)	Net capital stock at 2010 prices: total economy	AMECO
Consumption–capital ratio (φ)	(Ratio) Real consumption/real net private capital stock (average)	Computation on AMECO
Inflation rate	Percentage change of GDP deflator (average)	Computation on AMECO
Interest rate	Interest as percent of gross public debt of previous year	AMECO
real interest rate (r)	interest rate minus inflation rate (average)	Computation on AMECO
Real wealth (W_t)	Real net household's wealth	AMECO and OECD
Total primary expenditure (G)	Total expenditure excluding interest payments	AMECO
Real primary expenditure (G_r)	(ratio) G /GDP deflator	Computation on AMECO
($\gamma_I + \gamma_c$)	(ratio) G_r/real GDP (average)	Computation on AMECO

Appendix B: Tables and Graphs

Table 1 Average values for after-growth interest rate, 1992–2018

Country	$r - g$	Country	$r - g$
Ireland	−0,0296	Austria	0.012483
Norway	−0.0112	Belgium	0.014428
		Denmark	0.024155
		Finland	0.00785
		France	0.014142
		Germany	0.019654
		Greece	0.016538
		Italy	0.024927
		Japan	0.015959
		Netherlands	0.008624
		Portugal	0.014173
		Spain	0.002987
		Sweden	0.002347
		United Kingdom	0.012492
		United States	0.014089

The data in the table have been computed averaging 10 years $(r - g)$ MA starting from the time range $[1992,\ 2001]$

Table 2 Average values for parameters, 2001–2018

Country	$\gamma_C + \gamma_I$	τ	φ	α	$\varkappa$
Austria	0.49	0.35	0.15	0.89	0.27
Belgium	0.47	0.37	0.2	0.91	0.25
Denmark	0.52	0.38	0.2	0.88	0.36
Finland	0.51	0.39	0.18	0.92	0.26
France	0.52	0.36	0.18	0.91	0.28
Germany	0.44	0.33	0.19	0.91	0.19
Greece	0.43	0.29	0.18	0.91	0.2
Italy	0.43	0.31	0.2	0.89	0.24
Japan	0.37	0.26	0.19	0.96	0.13
Netherlands	0.42	0.31	0.17	0.92	0.25
Portugal	0.42	0.28	0.23	0.91	0.22
Spain	0.39	0.27	0.18	0.91	0.2
Sweden	0.51	0.29	0.13	0.93	0.49
United Kingdom	0.38	0.26	0.23	0.92	0.19
United States	0.34	0.25	0.29	0.92	0.1

For parameter definitions, refer to "Appendix A: Data Description and Sources"

Table 3 Average fiscal sustainability indicator, 2001–2018

Country	$\frac{B(t)}{Y(t)}$	$\frac{B(t)}{W(t)}$	$\frac{VB(t)}{W(t)}$	$\mathfrak{F}(t)$
Denmark	0.40	0.11	−0.41	−0.29
Sweden	0.43	0.09	−3.34	−3.26
Finland	0.48	0.13	−0.31	−0.17
Netherlands	0.56	0.13	−0.29	−0.16
United Kingdom	0.63	0.13	0.28	0.42
Spain	0.68	0.15	1.03	1.18
Germany	0.69	0.17	−0.05	0.12
Austria	0.75	0.16	0.07	0.24
France	0.80	0.18	0.45	0.63
United States	0.85	0.16	0.36	0.52
Portugal	0.97	0.24	−0.01	0.23
Belgium	1.01	0.20	−0.34	−0.14
Italy	1.19	0.24	−0.20	0.04
Greece	1.40	0.30	0.74	1.04
Japan	2.01	0.36	1.18	1.54
Aggregate	0.86	0.18	−0.06	0.13

B/Y = Government debt-to-GDP ratio; B/W = Government debt-to-wealth ratio; $\mathfrak{F}$ = sustainability index of fiscal policy; VB/W = present value of government primary balance-to-wealth ratio

Table 4 Countries' classification

Wealth-based Indicator			Debt-to-GDP Ratio		
S	W	U	S	W	U
$\mathfrak{F}(t) < 0$	$0 < \mathfrak{F}(t) < \frac{B(t)}{W(t)}$	$\mathfrak{F}(t) > \frac{B(t)}{W(t)}$	$\frac{B(t)}{Y(t)} < 60\%$	$60\% < \frac{B(t)}{Y(t)} < 100\%$	$\frac{B(t)}{Y(t)} > 100\%$
Sweden	Italy	Austria	Denmark	United Kingdom	Belgium
Denmark	Germany	United Kingdom	Sweden	Spain	Italy
Finland	Portugal	United States	Finland	Germany	Greece
Netherlands		France	Netherland	Austria	Japan
Belgium		Greece		France	
		Spain		United States	
		Japan		Portugal	

S = Strong sustainable; W = Weak sustainable; U = Unsustainable. The DGR-based tripartition follows from the standard debt thresholds settled in the IMF's, or European Commission's debt-sustainability framework

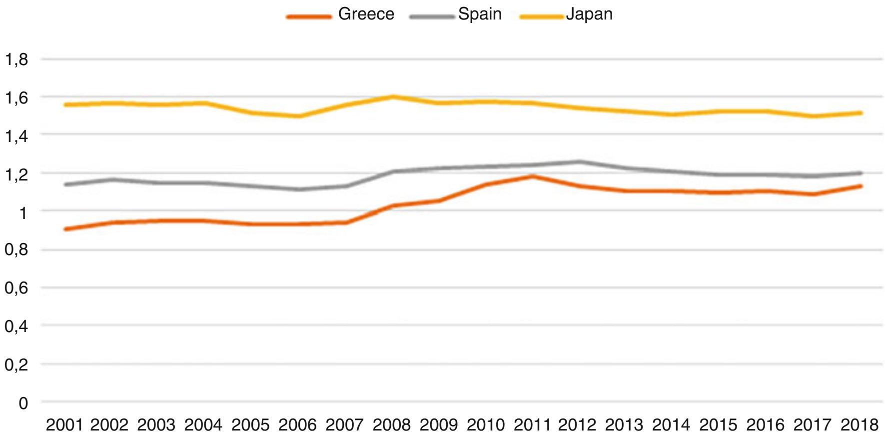

Fig. 1 Dynamics of fiscal sustainability index $\mathfrak{F}(t)$ over 2001–2018 in Greece (orange line), Spain (gray line), and Japan (yellow line)

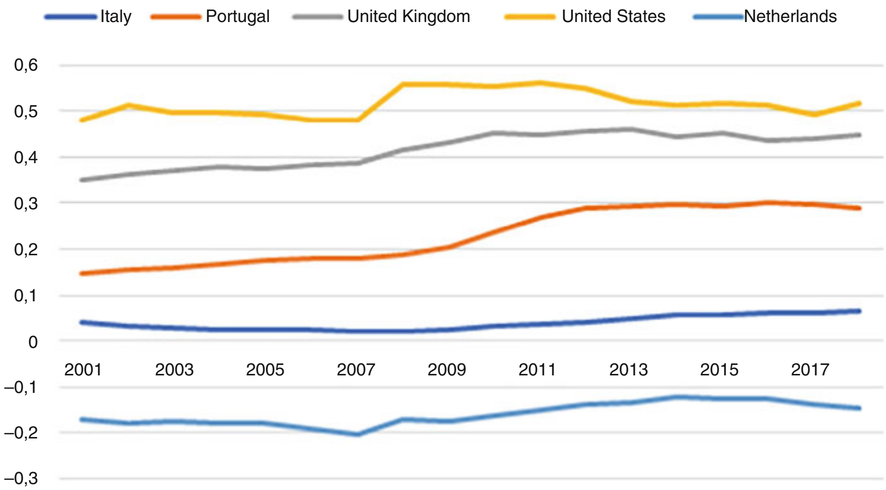

Fig. 2 Dynamics of fiscal sustainability index $\mathfrak{F}(t)$ over 2001–2018 in Italy (dark-blue line), Portugal (orange line), United Kingdom (gray line), United States (yellow line), and Netherlands (light-blue line)

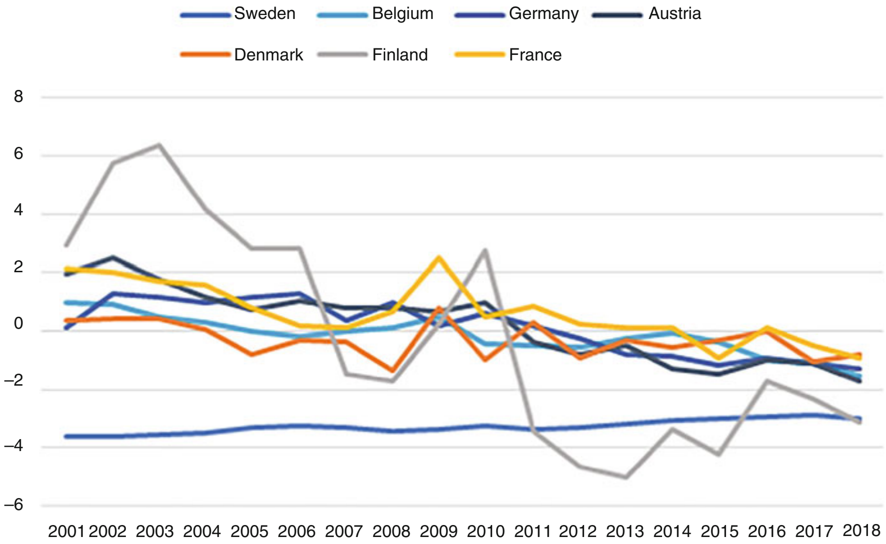

Fig. 3 Dynamics of fiscal sustainability index $\mathfrak{F}(t)$ over 2001–2018 in Sweden (dark-blue line), Belgium (light-blue line), Germany (indigo line), Austria (black line), Denmark (orange line), Finland (gray line), and France (yellow line)

References

Aizenman, J. and Y. Jinjarak (2010). De facto Fiscal Space and Fiscal Stimulus: Definition and Assessment. NBER working paper No. 16539.

Alesina, A., C. Favero, and F. Giavazzi (2015). The Output Effect of Fiscal Consolidation Plans. *Journal of International Economics* 96 (S1): 19–42.

Arellano, C., Y. Bai, and P. Kehoe (2019). Financial Frictions and Fluctuations in Volatility. *Journal of Political Economy* 127 (5): 2049–2103.

Arrow, K.J., P. Dasgupta, L.H. Goulder, K.J. Mumford, and K. Oleson (2012). Sustainability and the Measurement of Wealth. *Environment and Development Economics* 17 (3): 317–353.

Ash, M., D. Basu, and A. Dube (2020). Public Debt and Growth: An Assessment of Key Findings on Causality and Thresholds. Political Economy Research Institute, Working Paper series No. 433.

Auerbach, A. (2015). Fiscal Uncertainty and How to Deal with It. *Proceedings. Annual Conference on Taxation and Minutes of the Annual Meeting of the National Tax Association* 108: 1–29.

Baker, S.R., N. Bloom, and S.J. Davis (2016). Measuring Economic Policy Uncertainty. *The Quarterly Journal of Economics* 131 (4): 1593–1636.

Balassone, F., D. Franco, and S. Zotteri (2007). The Reliability of EMU Fiscal Indicators: Risks and Safeguards. In Larch, M., and J. Nogueira Martins, (eds.). *Fiscal Indicators*. European Economy-Economic Papers No. 297 (Proceedings from the Directorate-General for Economic and Financial Affairs of the European Commission, September 22, Brussels, 2006).

Barret, P. (2018). Interest-Growth Differentials and Debt Limits in Advanced Economies. IMF Working Paper No. 18/82.

Barro, R.J. (1990). Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy* 98 (5): S103-S125.

Barro, R.J. and X. Sala-i-Martin (1992). Public Finance in Models of Economic Growth. *Review of Economic Studies* 59 (4): 645–661.
Bi, H., E.M. Leeper, and C. Leith (2013). Uncertain Fiscal Consolidations. *Economic Journal* 123 (566): F31–F63.
Blanchard, O. (2019). Public Debt and Low Interest Rates. *American Economic Review* 109 (4): 1197–1229.
Bloom, N. (2009). The Impact of Uncertainty Shocks. *Econometrica* 77 (3): 623–685.
Blot, C. (2018). Sustainability of Public Debt: A Dangerous Obsession?. In D.V. Malito, G. Umbach, and N. Bhuta (eds.). *The Palgrave Handbook of Indicators in Global Governance*. Palgrave Macmillan, London.
Bohn, H. (1998). The Behavior of U.S. Public Debt and Deficits. *Quarterly Journal of Economics* 113 (3): 949–963.
Bohn, H. (2008). The Sustainability of Fiscal Policy in the United States. In R. Neck and J. Sturm. *Sustainability of Public Debt*. MIT Press, Cambridge: 15–49.
Bruce, N., and S.J. Turnovsky (1999). Budget Balance, Welfare, and the Growth Rate: Dynamic Scoring of the Long-Run Government Budget. *Journal of Money, Credit and Banking* 31 (2): 162–186.
Cafiso, G., and R. Cellini (2014). Fiscal Consolidations and Public Debt in Europe. *International Tax and Public Finance* 21 (4): 614–644.
Canofari, P., G. Marini, and G. Piersanti (2015). Expectations and Systemic Risk in EMU Government Bond Spreads. *Quantitative Finance* 15 (4): 711–724.
Canofari, P., A. Piergallini, and G. Piersanti (2020a). The Fallacy of Fiscal Discipline. *Macroeconomic Dynamics* 24 (1): 55–68.
Canofari, P., A. Piergallini, and G. Piersanti (2020b). Assessing Sovereign Debt Sustainability Using a Wealth-Based Fiscal Indicator. *Economics Bulletin* 40 (4): 2677–2688.
Chudik, A., K. Mohaddes, M.H. Pesaran, and M. Raissi (2017). Is there a Debt Threshold Effect on Output Growth?. *The Review of Economics and Statistics* 99 (1): 135–150.
Cordella, T., L.A. Ricci, and M. Ruiz-Arranz (2010). Debt Overhang or Debt Irrelevance?. *IMF Staff Papers* 57 (1): 1–24.
Cottarelli, C. (2011). The Risk Octagon: A Comprehensive Framework for Assessing Sovereign Risks. http://www.imf.org/external/np/fad/news/2011/docs/Cottarelli1.pdf
Coyle, D. (2017). Rethinking GDP. *Finance & Development* 54 (1): 17–19.
Dasgupta, P. (2015). Disregarded Capitals: What National Accounting Ignores. *Accounting and Business Research* 45 (4): 447–464.
Davig, T., and A. Foerster (2019). Uncertainty and Fiscal Cliffs. *Journal of Money Credit and Banking* 51 (7): 1857–1887.
Debrun, X., J.D. Ostry, T. Willems, and C. Wyplosz (2019). Debt Sustainability. In S.A. Abbas, A. Pienkowski, and K.S. Rogoff (eds). *Sovereign Debt: A Guide for Economists and Practitioners*. Oxford University Press, Oxford.
De Grauwe, P., and Y. Ji (2013). Self-fulfilling Crises in the Eurozone: An Empirical Test. *Journal of International Money and Finance* 34 (C): 15–36.
DeLong, J.B., and L.H. Summers (2012). Fiscal Policy in a Depressed Economy. *Brookings Papers on Economic Activity* 43 (1): 233–297.
Egert, B. (2015). Public Debt, Economic Growth and Nonlinear Effects: Myth or Reality?. *Journal of Macroeconomics* 43 (C): 226–238.
Fajgelbaum, P., E. Schaal, and M. Taschereau-Dumouchel (2017). Uncertainty Traps. *Quarterly Journal of Economics* 132 (4): 1641–1692.
Feigl, G., S. Hergovich, and M. Rehm (2013). Beyond GDP: Can We Re-Focus the Debate?. In D. Natali and B. Vanhercke (eds.). *Social Development in the European Union 2012*. OSE, ETUI, Brussels.
Fernández-Villaverde, J., P. Guerrón-Quintana, K. Kuester, and J. Rubio-Ramírez (2015). Fiscal Volatility Shocks and Economic Activity. *American Economic Review* 105 (11): 3352–3384.
Futagami, K., Y. Morita, and A. Shibata (1993). Dynamic Analysis of an Endogenous Growth Model with Public Capital. *Scandinavian Journal of Economics* 95 (4): 607–625.

Ghosh, A., J.I. Kim, E. Mendoza, J. Ostry, and M. Qureshi (2012). Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies. *The Economic Journal* 123 (566): F4–F30.

Giammarioli, N., C. Nickel, P. Rother, and J.P. Vidal (2007). Assessing Fiscal Soundness. Theory and Practice. ECB Occasional Paper Series No. 56.

Gilchrist, S., J.W. Sim, and E. Zakrajšek (2014). Uncertainty, Financial Frictions, and Investment Dynamics. NBER Working Paper No 20038.

Giovannini, E., and T. Rondinella (2018). Going Beyond GDP: Theoretical Approaches. In C. D'Ambrosio (ed.). *Handbook of Research on Economic and Social Well-Being*. Edward Elgar Publishing, London.

Greenwood, D.T. (2018). Moving Beyond Traditional Indicators of Fiscal Sustainability: Examples from Locally Chosen Indicators. In D.V. Malito, G. Umbach, and N. Bhuta (eds.). *The Palgrave Handbook of Indicators in Global Governance*. Palgrave Macmillan, London.

House, C.L., C. Proebsting, and L.L. Tesar (2020). Austerity in the Aftermath of the Great Recession. *Journal of Monetary Economics* 115 (C): 37–63 .

Ireland, P. (1994). Supply-Side Economics and Endogenous Growth. *Journal of Monetary Economics* 33 (3): 559–571.

Irmen, A., and J. Kuehnel (2009). Productive Government Expenditure and Economic Growth. *Journal of Economic Surveys* 23 (4): 692–733.

Jones, L.E. and R.E. Manuelli (1990). A Convex Model of Equilibrium Growth: Theory and Policy Implications. *Journal of Political Economy* 98 (5): 1008–1038.

Jones, L.E., R.E. Manuelli, and P.E. Rossi (1993). Optimal Taxation in Models of Endogenous Growth. *Journal of Political Economy* 101 (3): 485–517.

Kose, M.A., and M. Terrones (2012). How Does Uncertainty Affect Economic Performance?. *World Economic Outlook*, Box 1.3, October, International Monetary Fund: 49–53.

Kose, M.A., F.L. Ohnsorge, C.M. Reinhart, and K.S. Rogoff (2021). The Aftermath of Debt Surges. NBER Working Paper No. 29266.

Kostka T., and B. van Roye (2017). Assessing the Decoupling of Economic Policy Uncertainty and Financial Conditions. *ECB Financial Stability Review* May: 135–143.

Krugman. P. (2019). The World Has a Germany Problem. The Debt Obsession that Ate the Economy. *The New York Times*: August 20.

Panizza, U., and A.F. Presbitero (2014). Public Debt and Economic Growth: Is There a Causal Effect?. *Journal of Macroeconomics* 41 (C): 21–41.

Pecorino, P. (1993). Tax Structure and Growth in a Model with Human Capital. *Journal of Public Economics* 52 (2): 251–271.

Pescatori, A., D. Sandri, and J. Simon (2014). Debt and Growth: Is There a Magic Threshold?. IMF Working Paper No. 14/34.

Piersanti, G. (2023). A (Perfect) Case of Unnecessary, and Harmfull Fiscal Consolidation: Italy's Growth and Debt since the 90s. In C. Imbriani and P. Scaramozzino (eds.). *Economic Policy Framework Revisited*. Springer Nature Switzerland AG, Zurig.

Piketty, T., and G. Zucman (2014). Capital is Back: Wealth-Income Ratios in Rich Countries, 1700–2010. *Quarterly Journal of Economics* 129 (3): 1255–1310.

Piketty, T. (2015). About Capital in the Twenty-First Century. *American Economic Review: Papers & Proceedings* 105 (5): 1–6.

Plante, M., A.W. Richter, and N.A. Throckmorton (2018). The Zero Lower Bound and Endogenous Uncertainty. *Economic Journal* 128 (611): 1730–1757.

Rebelo, S. (1991). Long-Run Policy Analysis and Long-Run Growth. *Journal of Political Economy* 99 (3): 500–521.

Reinhart, C. M. (2012). The Return of Financial Repression. *Financial Stability Review, Banque de France* 16 (April): 37–48.

Reinhart, C.M., and K.S. Rogoff (2010). Growth in a Time of Debt. *American Economic Review: Papers & Proceedings* 100 (2): 573–578.

Reinhart, C.M., J.F. Kirkegaard, and M.B. Sbrancia (2011). Financial Repression Redux. *Finance & Development* 48 (1): 23–26.

Reinhart, C.M., V. Reinhart, and K.S. Rogoff (2015). Dealing with Debt. *Journal of International Economics* 96 (S1): S43–S55.

Schadler, S. (2016). Does the Level of Public Debt Matter?. Centre for International Governance Innovation, Policy Brief No. 76, April.

Stiglitz, J.E., A. Sen and J.P. Fitoussi (2009). Report by the Commission on the Measurement of Economic and Social Progress. CMEPSP, http://ec.europa.eu/eurostat/documents/118025/118123/Fitoussi+Commission+report.

Stiglitz, J.E. (2012). Stimulating the Economy in an Era of Debt and Deficit. *The Economists' Voice* 9 (2): 1–6.

Stiglitz, J.E. (2016). The Measurement of Wealth: Recessions, Sustainability and Inequality. In J.E. Stiglitz and M. Guzman (eds.). *Contemporary Issues in Macroeconomics. Lessons from the Crisis and Beyond*. IEA Conference Volume, No. 155-II, Palgrave Macmillan, Houndmills, UK and New York.

Stiglitz, J.E., J.P. Fitoussi, and M. Durand (2018). *Beyond GDP: Measuring What Counts for Economic and Social Performance*. OECD Publishing, Paris.

Straub, L., and R. Ulbricht (2017). Endogenous Uncertainty and Credit Crunches. ADEMU Working Paper Series, 2017/065.

Turnovsky, S.J. (1996). Optimal Tax, Debt, and Expenditure Policies in a Growing Economy. *Journal of Public Economics* 60 (1): 21–44.

Turnovsky, S.J. (1997). Fiscal Policy in a Growing Economy with Public Capital. *Macroeconomic Dynamics* 1 (3): 615–639.

Turnovsky, S.J. (2000). Fiscal Policy, Elastic Labor Supply, and Endogenous Growth. *Journal of Monetary Economics* 45 (1): 185–210.

Turnovsky, S.J. (2004). The Transitional Dynamics of Fiscal Policy: Long-Run Capital Accumulation and Growth. *Journal of Money, Credit and Banking* 36 (5): 883–910.

Wyplosz, C. (2011). Debt Sustainability Assessment: Mission Impossible. *Review of Economics and Institutions* 2 (3): 1–37.

Public Debt, Taylor Rules, and Inflation Dynamics in an Overlapping Generations Model

Alessandro Piergallini

> *[T]here is a chance that macroeconomic stimulus on a scale closer to World War II levels than normal recession levels will set off inflationary pressures of a kind we have not seen in a generation. [...] Stimulus measures of the magnitude contemplated are steps into the unknown.*
>
> Lawrence H. Summers (2021)

Introduction

One of the most critical issues in the current public policy debate is whether the unprecedented, massive surge in public debt-to-GDP ratios to counter the pandemic-induced recession acts as an independent source of the persistent revival of global inflationary pressures (e.g., Andolfatto 2021; Ball et al. 2021; Blanchard 2021; Cochrane 2021; Gopinath 2021; Summers 2021). The potential inflationary consequences of lax fiscal policies—and whether inflation is a fiscal phenomenon—are a central topic in macroeconomic theory, at the least since the seminal work by Sargent and Wallace (1981). The branch of literature known as the "fiscal theory of the price level" (FTPL) (e.g., Leeper 1991, 2015; Woodford 1994, 1995; Sims 1994; Cochrane 1999, 2005, 2011, 2022; Leeper and Yun 2006; Leeper and Leith 2016; Jacobson et al. 2019) contends, in particular, that fiscal variables critically affect price-level determination in the case of a "non-Ricardian" policy regime, whereby according to Woodford (1994, 1995)'s terminology the public solvency condition—precluding Ponzi's games and stipulating that the present discounted value of total

I am profoundly grateful to Giancarlo Marini, who was a major influence on my decision to pursue study and research in the field of fiscal and monetary policy. My deepest thanks to Giancarlo for the endless discussions and the invaluable encouragement.

A. Piergallini (✉)
Department of Economics and Finance, University of Rome Tor Vergata, Rome, Italy
e-mail: alessandro.piergallini@uniroma2.it

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_5

government liabilities converges to zero—is not satisfied by fiscal authorities for all possible time paths of endogenous variables, including the price level. With the intertemporal budget constraint of the government rationalized as an equilibrium condition, nominal variables endogenously adjust in order for fiscal solvency to hold in a policy environment in which primary surpluses are not expected to react to public debt accumulation. In other words, under a non-Ricardian regime, fiscal policy—not monetary policy—provides the "nominal anchor."

The theoretical validity of the foregoing approach to monetary–fiscal policy interactions—whereby in synthesis "the price level is determined by the needs of fiscal solvency" (Canzoneri et al. 2001, 2010)—has severely been questioned by a number of distinguished authors, including McCallum (2001), Buiter (2002, 2005), Niepelt (2004), Daniel (2007), and Buiter and Sibert (2018). The main argument, explicitly invoked by Buiter and Sibert (2018), is that "the original FTPL was based on an elementary but fatal error: it confused a budget constraint with an equilibrium condition. Specifically, it confused the intertemporal budget constraint of the State (...), with a misspecified equilibrium sovereign nominal bond pricing equation. It then applied this 'equilibrium condition' twice."

On this ground, Annicchiarico and Marini (2005a,b) depart from the FTPL by demonstrating within a forward-looking optimizing setup that fiscal expansions generate inflationary effects even when the government intertemporal budget constraint is respected for any prices trajectory (thereby excluding the fiscal revaluation mechanisms of the type predicted by the FTPL), with no recourse to the money financing of budget deficits (thereby excluding the "unpleasant monetarist arithmetic" via money creation of the type discussed by Sargent and Wallace 1981). Thus, fiscal policy does not require to be intertemporal unbalanced to explain the impact of expansionary budgetary policies on nominal variables. This conclusion is derived, specifically, using the discipline of an overlapping generations monetary framework of the style originally developed by Marini and van der Ploeg (1988), with the fiscal policy behavior described by a "Ricardian" tax adjustment rule and the monetary policy behavior described by a money supply rule not reacting to potential escalation of debt.[1]

This chapter provides additional analytical foundations to the findings obtained by Annicchiarico and Marini (2005a,b). In particular, the present investigation complements their analysis in two directions. First, we consider a budgetary policy regime in which fiscal authorities gradually adjust the stock of real government liabilities relative to the size of the economy in order to converge toward a target level in the long run—thus preserving public solvency, as assumed by Futagami et al. (2008), Minea and Villieu (2013), Maebayashi et al. (2017), and Cheron et al.

[1] Monetary models with overlapping generations of finite-horizon agents, along the line of research traced by Marini and van der Ploeg (1988), are increasingly adopted for both monetary and fiscal policy analysis, further in the context of discrete-time New Keynesian frameworks (Woodford 2003; Galí 2015, 2018). See, e.g., Petrucci 1999, 2003; Leith and Wren-Lewis 2000; Piergallini 2006; Annicchiarico et al. 2008, 2009; Leith and von Thadden 2008; Ascari and Rankin 2013; Brito et al. 2016; Nisticò 2012, 2016; Rigon and Zanetti 2018, and Galí (2021).

(2019) in non-monetary contexts with endogenous growth to analyze the case of fiscal constraints such as those prescribed by the Maastricht Treaty and the Fiscal Compact prevailing in the European Union.[2] Second, we consider an interest-rate policy regime in which monetary authorities target inflation and react to positive deviations from the target rate by increasing the nominal interest rate more than proportionally, according to a Taylor-type feedback rule (e.g., Taylor 1999, 2012, 2021; Woodford 2003; Galí 2015; Walsh 2017). By relaxing the Ricardian debt equivalence (Barro 1974), due to a finite planning horizon of private agents and to the absence of perfect intergenerational altruism as originally proposed in the Yaari (1965) and Blanchard (1985)'s uncertain lifetime approach, the model set forth in this chapter enables one to explore in an analytically tractable way the interactions between monetary and fiscal policies and the nexus between fiscal and nominal variables.

The main result of our analysis is that a rise in the target stock of government liabilities via bond financing causes inflation to increase both in the short run and in the long run, even under an aggressive interest-rate policy and an intertemporally balanced budgetary policy stance. On impact inflation jumps upward, undershooting in first difference the change in the new long-run equilibrium. A slow fiscal adjustment toward the target and a relatively inactive monetary policy are shown to interact negatively with the objective of maintaining price stability. The view that the rules-based approach to monetary policy (Taylor 2021) is not sufficient to pin down inflation at the target rate without an appropriate fiscal commitment—even under a Ricardian fiscal policy stance—has, therefore, solid theoretical bases. When the government intertemporal budget constraint is respected by fiscal authorities for any prices path, inflation is neither only a monetary nor only a fiscal phenomenon. Rather, it appears to be a monetary–fiscal phenomenon.

The underlying mechanism at work is as follows. A fiscal easing relaxing the target ratio of real government liabilities to output triggers a redistribution of human wealth from future to current generations, since the current burden of fiscal consolidation plans falls at expense of the future burden needed to finance the higher debt target level. Such an intergenerational redistribution of resources in favor of living cohorts provides a stimulus to aggregate demand and dampens aggregate saving. The increase in aggregate demand occurs without affecting the intertemporal budget constraint of the government, as Ricardian equivalence does not apply. The resulting excess demand in the goods market induces as a consequence an increase in the equilibrium real interest rate, both in the short run and in the steady state. When the monetary policy regime is based on a Taylor-style interest-rate feedback

[2] The Fiscal Compact—formally "Treaty on Stability, Coordination and Governance in the Economic and Monetary Union," reforming the Stability and Growth Pact—is in force since 2013, even though temporarily suspended from 2020 to 2023 because of the pandemic crisis, and features a firmly defined debt reduction benchmark rule. Specifically, the rule establishes that Member States whose debt-to-GDP ratio exceeds the 60% threshold are required to reduce their ratios to the reference value at an average rate of one-twentieth per year.

rule ensuring uniqueness and stability of perfect-foresight equilibrium, a rise in the real interest rate can occur only if inflation jumps upward.

The remainder of the chapter is organized in three sections. Section "The Model" develops the optimizing continuous-time overlapping generations model and specifies the monetary policy regime. Section "Fiscal Policy and Transitional Dynamics" analyzes the issue of equilibrium dynamics under a debt targeting fiscal policy regime and determines the effects of a fiscal expansion consisting in a rise in the target stock of real government liabilities relative to the size of the economy. Section "Conclusions" summarizes the main conclusions.

The Model

For the purposes of this chapter, we account for intergenerational heterogeneity within a monetary economy in continuous time by formulating a modified version of the Yaari (1965), Blanchard (1985), and Weil (1989) overlapping generations setup—in which forward-looking agents have finite horizons—extended in order to include money in the agents' asset menu and embed the general case of non-separable preferences over consumption and real cash balances, along the lines first proposed by Brock (1974, 1975).

The Individual's Consumption Behavior

Forward-looking agents face uncertainty about the duration of their lives, since they are assumed to be subject to a common and constant instantaneous probability of death, $\mu > 0$. Total population is assumed to grow at a constant rate n. Because at each instant of time t, a new generation is born, the birth rate is $\beta = n + \mu$. Denoting by $N(t)$ the total population at time t, with $N(0) = 1$ for simplicity, it follows that the size of the generation born at time t is $\beta N(t) = \beta e^{nt}$, while the size of the surviving cohort born at time $s \le t$ is $\beta N(s) e^{-\mu(t-s)} = \beta e^{-\mu t} e^{\beta s}$. As a consequence, population at time t is given by $N(t) = \beta e^{-\mu t} \int_{-\infty}^{t} e^{\beta s} ds$. Following Blanchard (1985), there is no intergenerational operative bequest motive, so that newly born agents have no assets.

Individuals have identical preferences and are assumed to supply one unit of labor inelastically, which is transformed one-for-one into output, for analytical convenience. Each agent belonging to the generation born at time $s \le 0$ chooses the time path of consumption, $\overline{c}(s,t)$, and real money balances, $\overline{m}(s,t)$, in order to maximize the expected discounted value of the utility function expressed by

$$E_0 \int_0^{\infty} \log \Upsilon\left(\overline{c}(s,t), \overline{m}(s,t)\right) e^{-\rho t} dt, \tag{1}$$

where E_0 indicates the expectation operator conditional on period 0 information, $\rho > 0$ denotes the pure rate of time preference, and the subutility function $\Upsilon(\cdot)$ is strictly increasing, concave, linearly homogenous and obeys $\Upsilon_{cm} > 0$. Consumption and real money balances are Edgeworth complements (Reis 2007), and, as a consequence, the elasticity of substitution between the two is lower than unity (Cushing 1999).

Since the probability at time 0 of surviving at time $t \geq 0$ is $e^{-\mu t}$, the expected lifetime utility function (1) becomes

$$\int_0^{\infty} \log \Upsilon\left(\overline{c}(s,t), \overline{m}(s,t)\right) e^{-(\mu+\rho)t} dt, \tag{2}$$

so that the effective subjective discount rate with lifetime uncertainty is $\mu + \rho$.

Agents accumulate their real assets, $\overline{a}(s,t)$, in the form of interest bearing public bonds, $\overline{b}(s,t)$, and real money balances, so that $\overline{a}(s,t) = \overline{b}(s,t) + \overline{m}(s,t)$. The instantaneous budget constraint in real terms is given by

$$\dot{\overline{a}}(s,t) = (R(t) - \pi(t) + \mu)\,\overline{a}(s,t) + \overline{y}(s,t) - \overline{\tau}(s,t) - \overline{c}(s,t) - R(t)\overline{m}(s,t), \tag{3}$$

where $R(t)$ denotes the nominal interest rate, $\pi(t)$ the inflation rate, $\overline{y}(s,t)$ output, and $\overline{\tau}(s,t)$ real lump-sum taxes net of public transfers. According to Yaari (1965), consumers of generation s are assumed to receive an actuarial fair premium, given by $\mu\overline{a}(s,t)$, from perfectly competitive life insurance companies in exchange for their total financial wealth at the time of death. The life insurance market rules out the possibility for individuals of passing away leaving undesired bequests to their heirs. Remarkably, as stressed by Blanchard (1985), the alternative hypothesis of actuarial bonds issued by financial intermediaries would give identical results.

Individuals are precluded from engaging in Ponzi's games, so that

$$\lim_{t\to\infty} \overline{a}(s,t) e^{-\int_0^t (R(j)-\pi(j)+\mu)dj} \geq 0. \tag{4}$$

Letting $\overline{x}(s,t)$ denote total consumption, defined as physical consumption plus the interest forgone on real money holdings,

$$\overline{x}(s,t) \equiv \overline{c}(s,t) + R(t)\overline{m}(s,t), \tag{5}$$

the agent's maximizing problem can be solved using a two-stage budgeting procedure (Deaton and Muellbauer 1980; Marini and van der Ploeg 1988).

In the first stage, consumers solve an intratemporal maximizing problem of selecting the efficient allocation between consumption and real money balances, in order to maximize the instantaneous subutility function $\Upsilon(\cdot)$ for a given level of total consumption. Optimality yields the equality between the marginal rate of substitution between consumption and real money balances and the nominal interest rate:

$$\frac{\Upsilon_m\left(\overline{c}(s,t),\overline{m}(s,t)\right)}{\Upsilon_c\left(\overline{c}(s,t),\overline{m}(s,t)\right)} = R(t). \tag{6}$$

Using the fact that preferences are linearly homogenous, the intratemporal condition (6) takes the following form:

$$\overline{c}(s,t) = \Omega\left(R(t)\right)\overline{m}(s,t), \tag{7}$$

where $\Omega'\left(R(t)\right) > 0$.[3]

In the second stage, consumers solve an intertemporal maximizing problem of choosing the time path of total consumption, $\overline{x}(s,t)$, in order to maximize their lifetime utility function (2) given the constraints (3)–(4) and the optimal static condition (7). Optimality implies[4]

$$\dot{\overline{x}}(s,t) = \left(R(t) - \pi(t) - \rho\right)\overline{x}(s,t), \tag{8}$$

$$\lim_{t\to\infty} \overline{a}(s,t)e^{-\int_0^t (R(j)-\pi(j)+\mu)dj} = 0. \tag{9}$$

Integrating forward the instantaneous budget constraint (3) after using definition (5), applying the transversality condition (9), and employing the dynamic equation (8), optimal total consumption turns to be a linear function of total wealth:

$$\overline{x}(s,t) = (\mu+\rho)\left(\overline{a}(s,t) + \overline{h}(s,t)\right), \tag{10}$$

where

$$\overline{h}(s,t) \equiv \int_t^\infty \left(\overline{y}(s,v) - \overline{\tau}(s,v)\right) e^{-\int_t^v (R(j)-\pi(j)+\mu)dj} dv \tag{11}$$

denotes human wealth, defined as the present discounted value of after-tax/ transfers labor income.

Using (5), (7), and (10), it emerges that individual physical consumption can also be expressed as a function of total wealth:

$$\overline{c}(s,t) = \frac{(\mu+\rho)}{\Lambda(R(t))}\left(\overline{a}(s,t) + \overline{h}(s,t)\right), \tag{12}$$

[3] This sign restriction comes from $\Upsilon_{cc} - \Upsilon_{cm}\Upsilon_c/\Upsilon_m < 0$ and $\Upsilon_{mm} - \Upsilon_{cm}\Upsilon_m/\Upsilon_c < 0$.

[4] See Appendix "Appendix A" for analytical details.

where $\Lambda\left(R(t)\right) \equiv 1 + R(t)/\Omega\left(R(t)\right)$. Combining (5), (7), and (8), one obtains the optimal time path of individual consumption:

$$\dot{\overline{c}}(s,t) = \left[(R(t) - \pi(t) - \rho) - \frac{\Lambda'(R(t))}{\Lambda(R(t))}\dot{R}(t)\right]\overline{c}(s,t), \tag{13}$$

where $\Lambda'\left(R(t)\right) > 0$.[5] From (13), it follows that the growth rate of optimal consumption is identical across all generations because it is independent of s.

Aggregation

The evolution of aggregate variables can now be obtained. Integrating over all generations, the population aggregate for a generic variable at individual level $\overline{z}(s,t)$ is given by

$$\overline{Z}(t) \equiv \beta e^{-\mu t}\int_{-\infty}^{t}\overline{z}(s,t)e^{\beta s}ds, \tag{14}$$

where the upper case letter denotes the aggregate value at the population level. The corresponding variable in per capita terms is indicated as

$$\overline{z}(t) \equiv \overline{Z}(t)e^{-nt} = \beta\int_{-\infty}^{t}\overline{z}(s,t)e^{\beta(s-t)}ds. \tag{15}$$

Consistently with Blanchard (1985), each agent is assumed to face identical age-independent income and net tax flows, so that $\overline{y}(s,t) = \overline{y}(t)$ and $\overline{\tau}(s,t) = \overline{\tau}(t)$, for analytical convenience. Therefore, using the fact that $\overline{a}(t,t) = 0$, which implies $\overline{c}(t,t) = [(\mu+\rho)/\Lambda(R(t))]\overline{h}(t,t)$, one obtains the budget constraint and the optimal time path of consumption in per capita terms:[6]

$$\dot{\overline{a}}(t) = (R(t) - \pi(t) - n)\,\overline{a}(t) + \overline{y}(t) - \overline{\tau}(t) - \overline{c}(t) - R(t)\overline{m}(t), \tag{16}$$

$$\dot{\overline{c}}(t) = \left[(R(t) - \pi(t) - \rho) - \frac{\Lambda'(R(t))}{\Lambda(R(t))}\dot{R}(t)\right]\overline{c}(t) - \frac{\beta(\rho+\mu)}{\Lambda(R(t))}\overline{a}(t). \tag{17}$$

From equation (17), it emerges that the dynamics of per capita consumption critically depends upon the level of per capita real financial wealth $\overline{a}(t)$. Specifically,

[5] This sign restriction reflects the fact that $\Omega\left(R(t)\right) - R(t)\Omega'\left(R(t)\right) > 0$, for the elasticity of substitution between real money balances and consumption, $\Omega'\left(R(t)\right)R(t)/\Omega\left(R(t)\right)$, is lower than unity.

[6] See Appendix "Appendix B" for analytical details.

a higher level of real wealth triggers a stimulus to current consumption at expense of future consumption. Future cohorts' consumption is not valued by agents alive today, since perfect intergenerational altruism does not apply. As a consequence, government liabilities are net wealth for living generations, since agents may not be alive to pay future taxes required to ensure fiscal solvency. Older generations are wealthier than younger generations, hence consuming more and saving less. This gives rise to intergenerational heterogeneity. Only in the polar case in which the birth rate β is equal to zero, the evolution of per capita consumption follows the Euler equation prevailing in the infinitely lived single representative agent monetary setup with non-separable preferences (see, e.g., Benhabib et al. 2001b, 2002), in which nominal and real interest-rate changes entirely influence the law of motion of optimal consumption.

The Public Sector

The monetary authority controls the nominal interest rate according to a feedback policy rule of the form

$$R(t) = \Psi(\pi(t)), \tag{18}$$

where $\Psi(\cdot)$ is a continuous, strictly increasing, strictly positive, and differentiable function that satisfies the Taylor principle, $\Psi'(\pi(t)) > 1$ (see Taylor 1999, 2012, 2021; Woodford 2003; Galí 2015, and Walsh 2017). The latter constraint is intended to assure that whenever monetary policy makers observe symptoms of inflationary pressure, they will tighten monetary policy sufficiently in order to guarantee an increase in the real interest rate.

Public transfers and interest payments on government bonds are financed by lump-sum taxes, seigniorage revenues, and newly issued bonds. Government purchases are set equal to zero, without loss of generality. The flow budget constraint of the public sector in per capita terms is thus expressed by

$$\dot{\overline{b}}(t) + \dot{\overline{m}}(t) = (R(t) - \pi(t) - n)\,\overline{b}(t) - \overline{\tau}(t) - (\pi(t) - n)\,\overline{m}(t). \tag{19}$$

Consistently with Benhabib et al. (2001a, 2002) and Canzoneri et al. (2010), equation (19) can be rewritten as

$$\dot{\overline{a}}(t) = (R(t) - \pi(t) - n)\,\overline{a}(t) - \overline{ps}\,(t)\,, \tag{20}$$

where $\overline{a}(t) = \overline{b}(t) + \overline{m}(t)$ are total government liabilities and $\overline{ps}\,(t) = \overline{\tau}(t) + R(t)\overline{m}(t)$ is the primary surplus inclusive of interest savings from the issuance of money.

For the objectives of the present analysis, I shall assume that fiscal policies are Ricardian in the sense specified by Woodford (1994, 1995) and Benhabib et al. (2001a, 2002). That is, fiscal authorities ensure that the present discounted value of total government liabilities in per capita terms converges to zero,

$$\lim_{t\to\infty} \overline{a}(t)e^{-\int_0^t (R(j)-\pi(j)-n)dj} = 0, \tag{21}$$

under all possible, equilibrium and off-equilibrium, time paths of the remaining endogenous variables. Integrating equation (20) forward, given condition (21) that precludes Ponzi's games, one obtains the intertemporal budget constraint of the public sector:

$$\overline{a}(0) = \int_0^\infty \overline{ps}\,(t)\, e^{-\int_0^t (R(j)-\pi(j)-n)dj} dt. \tag{22}$$

Equilibrium Inflation Dynamics

Equilibrium in the goods' market and in the money market requires $\overline{y}\,(t) = \overline{c}(t)$ and $\overline{m}(t) = \overline{c}(t)/\Omega(R(t))$, respectively. Without loss of generality, total output $\overline{Y}(t)$ is assumed to grow at the rate of population growth n. Therefore, per capita output is constant, $\overline{y}(t) = \overline{y}$.

For a generic variable at the population level $\overline{Z}(t)$, let now define as

$$z\,(t) \equiv \frac{\overline{Z}\,(t)}{\overline{Y}\,(t)} = \frac{\overline{z}\,(t)}{\overline{y}} \tag{23}$$

the corresponding variable relative to the size of the economy $\overline{Y}\,(t)$. Hence,

$$m(t) = \frac{1}{\Omega(R(t))}. \tag{24}$$

In addition, using the law of motion of per capita consumption (17), the real interest rate compatible with the equilibrium in the goods market is increasing in the real value of government liabilities relative to output:

$$R(t) - \pi(t) = \rho + \frac{\Lambda'(R(t))}{\Lambda(R(t))}\dot{R}(t) + \frac{\beta(\rho+\mu)}{\Lambda(R(t))}a\,(t)\,. \tag{25}$$

Employing the interest-rate policy rule (18) into equation (25) yields the law of motion of equilibrium inflation dynamics:

$$\dot{\pi}\,(t) = \frac{\Lambda(\Psi(\pi(t)))}{\Lambda'(\Psi(\pi(t)))\Psi'(\pi(t))}\,(\Psi(\pi(t)) - \pi(t) - \rho) - \frac{\beta(\rho+\mu)}{\Lambda'(\Psi(\pi(t)))\Psi'(\pi(t))}a\,(t)\,. \tag{26}$$

Equation (26) reveals that the time path of inflation turns to be markedly affected by the real government liabilities-to-output ratio, except in the special case of the traditional framework in which the birth rate β is equal to zero. As a consequence, in order to close the model and scrutinize the involved macroeconomic dynamics, it is essential specifying the policy rule that traces the behavior of fiscal authorities.

Fiscal Policy and Transitional Dynamics

In this section, we characterize equilibrium dynamics under a budgetary policy regime whereby fiscal authorities adjust primary surpluses in order for the stock of real government liabilities relative to the size of the economy to converge gradually toward a given target level $a^* > 0$ in the long run. Therefore, consistently with Futagami et al. (2008); Minea and Villieu (2013); Maebayashi et al. (2017), and Cheron et al. (2019), the fiscal adjustment targeting rule makes $a(t)$ evolve according to

$$\dot{a}(t) = -\phi \left(a(t) - a^* \right), \tag{27}$$

where a^* is to be interpreted as a government policy parameter and $\phi > 0$ measures the pace of the consolidation in the event in which $a(t)$ is higher than a^*. Because money supply in equilibrium endogenously adjusts to money demand of money according to condition (24)—given the fact that in the present model monetary authorities control the nominal interest rate $R(t)$ according to rule (18)—equation (27) pins down the equilibrium issuance of government bonds according to

$$b\left(t\right) = a(t) - \frac{1}{\Omega\left(\Psi\left(\pi\left(t\right)\right)\right)}. \tag{28}$$

Combining (20) expressed in per unit of output and (27), it emerges that in order to implement the fiscal policy targeting rule, the government must adjust the primary surplus according to

$$ps\left(t\right) = \left(\Psi\left(\pi(t)\right) + \phi - \pi\left(t\right) - n\right) a(t) - \phi a^*. \tag{29}$$

Imposing $\dot{\pi}(t) = 0$ and $\dot{a}(t) = 0$ in equations (26) and (27), the following "modified Fisher equation" must apply in the steady state:

$$\Psi(\pi) - \pi = \rho + \frac{\beta(\rho + \mu)}{\Lambda\left(\Psi\left(\pi\right)\right)} a^*. \tag{30}$$

The left-hand side of the foregoing condition is positive and increasing in π, since $\Psi'(\pi) > 1$, while the right-hand side is positive and decreasing in π, since

$\Lambda'(\Psi(\pi))\Psi'(\pi) > 0$. Consequently, steady-state uniqueness applies. In particular, we let π^* denote the steady-state value of the inflation rate that uniquely solves (30).

We are now ready to derive the dynamic properties of the model in equilibrium. Linearizing the dynamic equation (26) around the steady-state point (a^*, π^*) and using (27) yield the system

$$\begin{pmatrix} \dot{a}(t) \\ \dot{\pi}(t) \end{pmatrix} = J \begin{pmatrix} a(t) - a^* \\ \pi(t) - \pi^* \end{pmatrix}, \tag{31}$$

where

$$J = \begin{pmatrix} -\phi & 0 \\ -\frac{\beta(\rho+\mu)}{\Lambda'(\Psi(\pi^*))\Psi'(\pi^*)} & J_{22} \end{pmatrix}, \tag{32}$$

with

$$J_{22} = \frac{\left(\Psi'(\pi^*) - 1\right)\Lambda\left(\Psi(\pi^*)\right)}{\Lambda'\left(\Psi(\pi^*)\right)\Psi'(\pi^*)} + \frac{\beta(\rho+\mu)}{\Lambda\left(\Psi(\pi^*)\right)}a^* > 0,$$

because $\Psi'(\pi^*) > 1$. The two eigenvalues of the Jacobian matrix J are $-\phi < 0$ and $J_{22} > 0$. Since $\pi(t)$ is a jump variable with a free initial condition and $a(t)$ is a state variable,[7] local determinacy of equilibrium prevails: that is, around (a^*, π^*), there exists a unique equilibrium converging asymptotically to that steady-state point. Specifically, the only trajectory of $(a(t), \pi(t))$ approaching asymptotically to (a^*, π^*) is expressed by the following saddle-path solution:

$$\pi(t) = \pi^* + \frac{\beta(\rho+\mu)}{\Lambda'\left(\Psi(\pi^*)\right)\Psi'(\pi^*)\left(\phi + J_{22}\right)}\left(a(t) - a^*\right), \tag{33}$$

$$a(t) = a^* + \left(a(0) - a^*\right)e^{-\phi t}. \tag{34}$$

Equation (33) represents the stable arm of the saddle path, which is always positively sloped—revealing that real government liabilities positively influence the equilibrium inflation rate via the wealth effect on consumption. From the solution, the lower the speed of adjustment of government liabilities toward the long-run objective a^*, captured by the parameter ϕ, the slower inflation converges to its long-run level.

[7] It is worth noting that the stock of real government liabilities relative to output should be counted as a state variable of the system, since its value cannot jump independently of the inflation rate. To see this, let $A(0)$ and $M(0)$ denote the initial stocks of nominal government liabilities and nominal money, respectively, whose values are predetermined. It follows that the ratio $A(0)/M(0) = a(0)/m(0) = a(0)\,\Omega(\Psi(\pi(0)))$ cannot jump, since $A(0)/M(0)$ is predetermined. Hence, only $\pi(0)$ can jump freely in system (31), and the Blanchard–Kahn conditions ensure that a steady state is locally determined if one root of the Jacobian matrix is positive and one root is negative.

Next, using equations (30) and (33)–(34) yields the following long-run and impact effects of a government policy change in the target level a^* on the inflation rate:

$$\frac{d\pi^*}{da^*} = \frac{\beta(\rho+\mu)}{\Lambda(\Psi(\pi^*))\left(\Psi'(\pi^*)-1\right) + \beta(\rho+\mu)a^*\Lambda'(\Psi(\pi^*))\Psi'(\pi^*)/\Lambda(\Psi(\pi^*))} > 0, \tag{35}$$

$$\frac{d\pi\,(0)^+}{da^*} = \frac{d\pi^*}{da^*} + \frac{\beta(\rho+\mu)}{\Lambda'\left(\Psi(\pi^*)\right)\Psi'(\pi^*)\left(\phi+J_{22}\right)}\left(\frac{da\,(0)^+}{d\pi\,(0)^+}\frac{d\pi\,(0)^+}{da^*}-1\right). \tag{36}$$

Since $A\,(0)\,/M\,(0) = a\,(0)\,/m\,(0) = a\,(0)\,\Omega(\Psi(\pi(0)))$, where $A\,(0)$ and $M\,(0)$ are the initial predetermined stocks of nominal government liabilities and nominal money, implying $da\,(0)^+\,/d\pi\,(0)^+ = -\left(A\,(0)\,/M\,(0)\right)\Omega'(\Psi(\pi(0)))\Psi'\left(\pi(0)\right)$ $/\,\Omega\left(\Psi(\pi(0))\right)^2$, the impact effect is consequently

$$\frac{d\pi\,(0)^+}{da^*} = \frac{\phi\beta(\rho+\mu)}{\Lambda'\left(\Psi(\pi^*)\right)\Psi'(\pi^*)J_{22}\left(\phi+J_{22}\right)}\left[\begin{array}{c} 1+\frac{\beta(\rho+\mu)}{\Lambda'(\Psi(\pi^*))\Psi'(\pi^*)(\phi+J_{22})} \\ \times\frac{(A(0)/M(0))\Omega'(\Psi(\pi(0)))\Psi'(\pi(0))}{\Omega(\Psi(\pi(0)))^2}\end{array}\right]^{-1} > 0. \tag{37}$$

Hence, a fiscal easing that raises the target level of real government liabilities relative to the size of the economy via bond financing drives up long-run inflation. On impact, inflation jumps upward from $\pi(0)$ to $\pi\,(0)^+$ onto the new stable arm described by equation (33), undershooting in terms of $\pi\,(0)^+ - \pi(0)$ the change in the new long-run equilibrium, because $d\pi\,(0)^+\,/da^* < d\pi^*/da^*$. From (35) and (37), it emerges that the more inactive is monetary policy, that is, the lower is the term $\Psi'(\pi^*)-1$, the more pronounced are both the long-run and the impact effects on inflation.

It is worth stressing that only in the special case of a zero birth rate, $\beta = 0$, inflation would be independent of fiscal variables—with $d\pi^*/da^* = d\pi\,(0)^+\,/da^* = 0$ and $\pi\,(t)$ pinned down by the Taylor rule at π^*. Only in this limiting case, in which the setup falls within the infinitely lived single representative agent paradigm abstracting from intergenerational heterogeneity, monetary policy is perfectly able to independently control inflation.

Our analytical results, obtained in the general case in which $\beta > 0$, have the following economic interpretation. Relaxing the long-run target ratio of real government liabilities to output via bond financing causes a redistribution of human wealth from future cohorts to current generations. This reflects the fact that the current burden of fiscal consolidation plans that entail debt reduction falls at expense of the future burden required to finance the higher debt target level. Such an intergenerational redistribution of resources in favor of living generations spurs aggregate demand for it induces them to dissave. As a consequence, in equilibrium, the real interest rate raises, both in the short run and in the steady state via the modified Fisher equation. When the monetary policy stance hinges on a Taylor-type interest-rate feedback rule that guarantees determinacy of perfect-foresight equilibrium, an increase in the real interest rate may occur only if inflation turns to raise. A slow fiscal adjustment tends to exacerbate the redistributive effects in favor of current cohorts. A relatively inactive monetary policy following the fiscal easing amplifies the increase in inflation that leads to the required rise in the real interest rate. Summing up, these findings lend analytical support to the view monetary commitment to Taylor rules does not ensure full inflation control in the absence of a stringent fiscal commitment in terms of long-run fiscal position and pace of debt consolidation—even under a Ricardian policy regime, which always satisfies the government's intertemporal budget constraint.

Conclusions

A key issue in the macroeconomic debate on the interactions between monetary and fiscal policies is whether there exists a relationship between fiscal and nominal variables in the presence of a price-stability-oriented independent central bank and forward-looking optimizing agents. The present chapter has investigated the dynamic implications of fiscal policy regimes targeting real government liabilities relative to the size of the economy, via gradual adjustment rules, interacting with interest-rate policy regimes targeting inflation, via Taylor rules. The analysis has been conducted in a modified version of the Yaari (1965), Blanchard (1985), and Weil (1989) framework with diachronous heterogeneity, extended to incorporate money in the individuals' asset menu in the presence of non-separable preferences over consumption and real cash balances, along the lines of research initially proposed by Marini and van der Ploeg (1988).

It is demonstrated that a positive shift in the target stock of real government liabilities relative to output via bond financing brings about an increase in the inflation rate both in the short run and in the long run, even if the interest-rate policy is overly aggressive according to the Taylor principle and the budgetary policy always guarantees fiscal solvency. Therefore, differently from the fiscal theory of the price level, fiscal regimes need not be non-Ricardian to explain the debt–inflation nexus. On impact, inflation jumps upward and is shown to undershoot in first difference the variation in the new long-run equilibrium. In addition, a slow pace at which the fiscal adjustment toward the target is implemented and a relatively inactive monetary policy are found to negatively affect price stability.

A fiscal easing that enlarges the target ratio of real government liabilities to output causes a redistribution of resources from future to current generations, for the current tax burden featuring debt consolidation strategies declines, while the future tax burden required to finance the increased debt target level raises. Such an intergenerational redistribution of human wealth in favor of living cohorts spurs aggregate consumption, thereby exerting a stimulus on aggregate demand

and dampening aggregate saving. This leads consequently to an increase in the equilibrium real interest rate, both in the short run and in the steady state. Since the central bank is engaged in pursuing an active monetary policy stance à la Taylor in order to assure dynamic stability and uniqueness of perfect-foresight equilibrium, a rise in the real interest rate may take place only if inflation increases.

In sum, the view that the rules-based approach to monetary policy—recently re-invoked by Taylor (2021)—is not sufficient to anchor inflation at the target rate without a proper fiscal commitment in terms of long-run debt position and pace of debt reduction has sound theoretical rationales. When the government is not engaged in Ponzi's games for any prices trajectory, inflation is neither only a monetary nor only a fiscal phenomenon. It is instead a monetary–fiscal phenomenon.

Appendix A

Using the definition of total consumption (5) and the optimal intratemporal condition (7), the instantaneous utility function can be expressed as

$$\log \Upsilon\left(\overline{c}(s,t), \overline{m}(s,t)\right) = \log q(t) + \log \overline{x}(s,t), \tag{A.1}$$

where $q(t) \equiv \Upsilon\left(\frac{\Omega(R(t))}{\Omega(R(t))+R(t)}, \frac{1}{\Omega(R(t))+R(t)}\right)$ is identical across all generations and can be interpreted as the utility-based cost of living index of the basket of physical goods and real balances. Hence, the intertemporal optimization problem can be formulated in the following terms:

$$\max_{\{\overline{x}(s,t)\}} \int_0^\infty \log q(t) + \log \overline{x}(s,t) e^{-(\mu+\rho)t} dt, \tag{A.2}$$

subject to

$$\dot{\overline{a}}(s,t) = (R(t) - \pi(t) + \mu)\, \overline{a}(s,t) + \overline{y}(s,t) - \overline{\tau}(s,t) - \overline{x}(s,t), \tag{A.3}$$

the no-Ponzi game condition (4), and given $\overline{a}(s,0)$.

Optimality yields the Euler equation in terms of total consumption (8) and the transversality condition (9). Integrating forward (A.3) and using both the transversality condition (9) and the law of motion of total consumption (8), the optimal level of total consumption turns to be a linear function of total wealth, according to equation (10). From (7), one has

$$\overline{x}(s,t) = \Lambda(R(t))\overline{c}(s,t), \tag{A.4}$$

where $\Lambda(R(t)) \equiv 1 + R(t)/\Omega(R(t))$. Time differentiating (A.4) yields

$$\dot{\overline{x}}(s,t) = \Lambda'(R(t))\overline{c}(s,t)\dot{R}(t) + \Lambda(R(t))\dot{\overline{c}}(s,t). \tag{A.5}$$

Substituting (A.4) and (A.5) into (8), one obtains the law of motion for individual consumption (13).

Appendix B

Aggregate wealth in per capita terms is, by definition, given by

$$\overline{a}(t) = \beta \int_{-\infty}^{t} \overline{a}(s,t) e^{\beta(s-t)} ds. \tag{B.1}$$

Differentiating with respect to time yields

$$\dot{\overline{a}}(t) = \beta\overline{a}(t,t) - \beta\overline{a}(t) + \beta \int_{-\infty}^{t} \dot{\overline{a}}(s,t) e^{\beta(s-t)} ds. \tag{B.2}$$

Since $\overline{a}(t,t)$ is equal to zero, by assumption, using (3) into (B.2) yields

$$\begin{aligned} \dot{\overline{a}}(t) &= -\beta\overline{a}(t) + \mu\overline{a}(t) + (R(t) - \pi(t))\,\overline{a}(t) + \overline{y}(t) - \overline{\tau}(t) - \overline{c}(t) - R(t)\overline{m}(t) \\ &= (R(t) - \pi(t) - n)\,\overline{a}(t) + \overline{y}(t) - \overline{\tau}(t) - \overline{c}(t) - R(t)\overline{m}(t). \end{aligned} \tag{B.3}$$

From (12), the per capita aggregate consumption is given by

$$\overline{c}(t) = \frac{(\mu+\rho)}{\Lambda(R(t))}\left(\overline{a}(t) + \overline{h}(t)\right). \tag{B.4}$$

Differentiating with respect to time the definition of per capita aggregate consumption, one obtains

$$\dot{\overline{c}}(t) = \beta\overline{c}(t,t) - \beta\overline{c}(t) + \beta \int_{-\infty}^{t} \dot{\overline{c}}(s,t) e^{\beta(s-t)} ds, \tag{B.5}$$

where $\overline{c}(t,t)$ represents consumption of the newborn generation. Because $\overline{a}(t,t) = 0$ and $\overline{h}(t,t) = \overline{h}(t)$, (12) implies

$$\overline{c}(t,t) = \frac{(\mu+\rho)}{\Lambda(R(t))}\overline{h}(t). \tag{B.6}$$

Substituting (13), (B.4), and (B.6) into (B.5), one obtains the time path of per capita aggregate consumption, expressed by (17).

References

Andolfatto, D. (2021), “Does the National Debt Matter?”, Federal Reserve Bank of St. Louis, *Regional Economist*, 4 December.

Annicchiarico B. and G. Marini (2005a), “Fiscal Policy and the Price Level”, *The B.E. Journal of Macroeconomics* 5, 1–15.

Annicchiarico B. and G. Marini (2005b), “Government Deficits, Consumption, and the Price Level”, *Portuguese Economic Journal* 4, 193–205.

Annicchiarico, B., G. Marini and A. Piergallini (2008), “Monetary Policy and Fiscal Rules”, *The B.E. Journal of Macroeconomics* 8, 1–42.

Annicchiarico, B., G. Marini and A. Piergallini (2009), “Wealth Effects, the Taylor Rule and the Liquidity Trap”, *International Journal of Economic Theory* 5, 315–331.

Ascari, G. and N. Rankin (2013), “The Effectiveness of Government Debt for Demand Management: Sensitivity to Monetary Policy Rules”, *Journal of Economic Dynamics and Control* 37, 1544–1566.

Ball, L., G. Gopinath, D. Leig, P. Mitra and A. Spilimbergo (2021), “US Inflation: Set for Takeoff?”, VoxEU.org, 7 May.

Barro, R. J. (1974), “Are Government Bonds Net Wealth?”, *Journal of Political Economy* 82, 1095–1117.

Benhabib, J., S. Schmitt-Grohé and M. Uribe (2001a), “Monetary Policy and Multiple Equilibria”, *American Economic Review* 91, 167–186.

Benhabib, J., S. Schmitt-Grohé and M. Uribe (2001b), “The Perils of Taylor Rules”, *Journal of Economic Theory* 96, 40–69.

Benhabib, J., S. Schmitt-Grohé and M. Uribe (2002), “Avoiding Liquidity Traps”, *Journal of Political Economy* 110, 535–563.

Blanchard, O. J. (1985), “Debt, Deficits, and Finite Horizons”, *Journal of Political Economy* 93, 223–247.

Blanchard, O. J. (2021), “In Defense of Concerns over the $1.9 Trillion Relief Plan”, *Realtime Economic Issues Watch* 18, Peterson Institute for International Economics.

Brito, P., G. Marini and A. Piergallini (2016), “House Prices and Monetary Policy”, *Studies in Nonlinear Dynamics and Econometrics* 20, 251–277.

Buiter, W. H. (2002), “The Fiscal Theory of the Price Level: A Critique”, *The Economic Journal* 112, 459–480.

Buiter, W. H. and A. C. Sibert (2018), “The Fallacy of the Fiscal Theory of the Price Level: One Last Time”, *Economics - The Open-Access, Open-Assessment E-Journal* 12, 1–56.

Buiter, W. H. (2005), “New Developments in Monetary Economics: Two Ghosts, Two Eccentricities, a Fallacy, a Mirage and a Mythos”, *Economic Journal* 115, 1–31.

Brock, W. A. (1974), “Money and Growth: The Case of Long-Run Perfect Foresight”, *International Economic Review* 15, 750–777.

Brock, W. A. (1975), “A Simple Perfect Foresight Monetary Model”, Journal of Monetary Economics 1, 133–150.

Canzoneri, M., R. Cumby and B. Diba (2001), “Is the Price Level Determined by the Needs of Fiscal Solvency?”, *American Economic Review* 91, 1221–1238.

Canzoneri, M., R. Cumby and B. Diba (2010), “The Interaction Between Monetary and Fiscal Policy”, in B. M. Friedman and M. Woodford (eds), *Handbook of Monetary Economics* 3, Amsterdam/Boston: North-Holland/Elsevier, 935–999.

Cheron, A., K. Nishimura, C. Nourry, T. Seegmuller and A. Venditti (2019), “Growth and Public Debt: What Are the Relevant Trade-Offs?”, *Journal of Money, Credit and Banking* 51, 655–682.

Cochrane J. H. (1999), “A Frictionless View of U.S. Inflation”, *NBER Macroeconomics Annual 1998* 13, 323–421.

Cochrane, J. H. (2005), “Money as Stock”, *Journal of Monetary Economics* 52, 501–528.

Cochrane, J. H. (2011), “The Fiscal Theory of the Price Level and its Implications for Current Policy in the United States and Europe”, The Becker-Friedman Institute.

Cochrane, J. H. (2021), “The End of ‘the End of Inflation”’, The Grumpy Economist Blog, 10 June.

Cochrane, J. H. (2022), *The Fiscal Theory of the Price Level*, manuscript, Hoover Institution, Stanford University.

Cushing, M. J. (1999), “The Indeterminacy of Prices under Interest Rate Pegging: The Non-Ricardian Case”, *Journal of Monetary Economics* 44, 131–148.

Daniel, B. C. (2007), “The Fiscal Theory of the Price Level and Initial Government Debt”, *Review of Economic Dynamics* 10, 193–206.

Deaton, A. and J. Muellbauer (1980), *Economics and Consumer Behavior*, Oxford: Oxford University Press.

Futagami, K., T. Iwaisako and R. Ohdoi (2008), “Debt Policy Rule, Productive Government Spending, and Multiple Growth Paths”, *Macroeconomic Dynamics* 12, 445–462.

Galí, J. (2015), *Monetary Policy, Inflation and the Business Cycle*, Princeton: Princeton University Press.

Galí, J. (2018), “The State of New Keynesian Economics: A Partial Assessment”, *Journal of Economic Perspectives* 32, 87–112.

Galí, J. (2021), “Monetary Policy and Bubbles in a New Keynesian Model with Overlapping Generations”, *American Economic Journal: Macroeconomics* 13, 127–167.

Gopinath, G. (2021), “Structural Factors and Central Bank Credibility Limit Inflation Risks”, IMFBlog, 29 February.

Jacobson, M., E. M. Leeper and B. Preston (2019) “Recovery of 1933”, *NBER Working Papers*, N. 25629.

Leeper, E. M. (1991), “Equilibria under ‘Active’ and ‘Passive’ Monetary and Fiscal Policies”, *Journal of Monetary Economics* 27, 129–147.

Leeper, E. M. (2015), “Real Theory of the Price Level”, The Becker-Friedman Institute.

Leeper, E. M. and C. Leith (2016), “Understanding Inflation as a Joint Monetary-Fiscal Phenomenon. In: J. B. Taylor and H. Uhlig (eds) *Handbook of Macroeconomics* 2, Amsterdam: North-Holland/Elsevier, 2305–2415.

Leeper, E. M. and T. Yun (2006), “Monetary-Fiscal Policy Interactions and the Price Level: Background and Beyond”, *International Tax and Public Finance* 13, 373–409.

Leith, C. and S. Wren-Lewis (2000), “Interactions between Monetary and Fiscal Policy Rules”, *Economic Journal* 110, 93–108.

Leith, C. and L. von Thadden, Leopold (2008), “Monetary and Fiscal Policy Interactions in a New Keynesian Model with Capital Accumulation and non-Ricardian Consumers”, *Journal of Economic Theory* 140, 279–313.

Maebayashi, N., T. Hori and K. Futagami (2017), “Dynamic Analysis of Reductions in Public Debt in an Endogenous Growth Model with Public Capital”, *Macroeconomic Dynamics* 21, 1454–1483.

Marini, G. and F. van der Ploeg (1988), “Monetary and Fiscal Policy in an Optimizing Model with Capital Accumulation and Finite Lives”, *The Economic Journal* 98, 772–786.

McCallum, B. T. (2001), “Indeterminacy, Bubbles, and the Fiscal Theory of Price Level Determination”, *Journal of Monetary Economics* 47, 19–30.

Minea, A. and P. Villieu (2013), “Debt Policy Rule, Productive Government Spending, and Multiple Growth Paths: A Note”, *Macroeconomic Dynamics* 17, 947–954.

Niepelt, D. (2004), “The Fiscal Myth of the Price Level”, *The Quarterly Journal of Economics* 119, 277–300.

Nisticò, S. (2012), “Monetary Policy and Stock-Price Dynamics in a DSGE Framework”, *Journal of Macroeconomics* 34, 126–146.

Nisticò, S. (2016), “Optimal Monetary Policy and Financial Stability in a Non-Ricardian Economy”, *Journal of the European Economic Association* 14, 1225–1252.

Petrucci, A. (1999), “Inflation and Capital Accumulation in an OLG Model with Money in the Production Function”, *Economic Modelling* 16, 475–487.

Petrucci, A. (2003), "Devaluation (Levels vs. Rates) and Balance of Payments in a Cash-in-Advance Economy", *Journal of International Money and Finance* 22, 697–707.
Piergallini, A. (2006), "Real Balance Effects and Monetary Policy", *Economic Inquiry* 44, 497–511.
Reis, R. (2007), "The Analytics of Monetary Non-Neutrality in the Sidrauski Model", *Economics Letters* 94, 129–135.
Rigon, M. and F. Zanetti (2018), "Optimal Monetary Policy and Fiscal Policy Interaction in a Non-Ricardian Economy", *International Journal of Central Banking* 14, 389–436.
Sargent, T. J. and N. Wallace (1981), "Some Unpleasant Monetarist Arithmetic", *Quarterly Review of Minneapolis Federal Reserve Bank*, Fall, 1–17.
Sims, C. (1994), "A Simple Model for the Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy", *Economic Theory* 4, 381–399.
Summers, L. (2021). "The Biden Stimulus is Admirably Ambitious. But It Brings Some Big Risks, Too", *Washington Post*, 4 February.
Taylor, J. B. (ed) (1999), *Monetary Policy Rules*, Chicago: University of Chicago Press.
Taylor, J. B. (2012), "Monetary Policy Rules Work and Discretion Doesn't: A Tale of Two Eras", *Journal of Money Credit and Banking* 44, 1017–1032.
Taylor, J. B. (2021), "Simple Monetary Rules: Many Strengths and Few Weaknesses", *European Journal of Law and Economics* 52, 267–283.
Walsh, C. E. (2017), *Monetary Theory and Policy*, Cambridge: The MIT Press.
Weil, P. (1989), "Overlapping Families of Infinitely-Lived Agents", *Journal of Public Economics* 38, 183–198.
Woodford, M. (1994), "Monetary Policy and Price Level Determinacy in a Cash-in-Advance Economy", *Economic Theory* 4, 345–380.
Woodford, M. (1995), "Price Level Determinacy without Control of a Monetary Aggregate", *Carnegie Rochester Conference Series on Public Policy* 43, 1–46.
Woodford, M. (2003), *Interest and Prices*, Princeton: Princeton University Press.
Yaari, M. E. (1965), "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer", *The Review of Economic Studies* 32, 137–150.

Macroeconomic Policy and Development in India: Some Analytical Issues

Partha Sen

Giancarlo Marini was a close friend, when we were both in the PhD programme at the LSE. Initially, our academic paths were very similar. We started off with Janet Yellen as our supervisor, and ended under Willem Buiter. Both of us held lectureships at Bristol and the LSE. We also (and that included Paolo Garella, his housemate) played tennis and saw movies together. Four decades later, I still cannot leave an Italian restaurant without asking for a shot of Strega—his abiding influence in my life.

After our PhD, we were not in touch for a long time. I spoke to him after many years from our common friend Pasquale Scaramozzino's office, just days before the shocking news of his passing came.

This chapter is dedicated to his memory. We discussed, and, indeed, fought over, many of the topics that I survey below.

Previous "versions" were delivered as public lectures at the University of St. Petersburg and Viswa-Bharati University. I have tried to retain a "chatty style" of a public lecture. Since this chapter is not a formal piece, I have avoided using equations, except in the discussion of rational expectations, where equations do save a lot of space.

P. Sen (✉)
Centre for Development Economics, Delhi School of Economics, Delhi, India

CESifo, Munich, Germany
e-mail: Partha@econdse.org

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_6

Introduction

What should be the macroeconomic policy framework in a developing economy?[1] Are there modifications required in applying textbook macroeconomic theories to these countries? Or can one effectively relegate their "underdevelopment" to just a matter of detail? In this chapter, I will look at the received wisdom for the developing countries. I shall discuss both the theoretical models and their applicability in the growth process of the advanced capitalist countries.[2] A foray into economic history is relevant, because developing countries, more often than not, are interested in a "structural transformation", i.e. moving resources from the traditional to higher productive "modern" sectors, i.e. those with innovation possibilities that may enable sustained growth.[3] Although not universally true of these countries, but just to fix notions, we shall refer to this as moving labour from subsistence agriculture to industry. Structural transformation involves not just the direction of change but also its speed—what has taken the OECD countries decades, or centuries, is sought to be achieved in a few years.

Whilst the above statements are broadly true, these are too sweeping—mainly because there is no prototype of a developing economy. I will therefore be specific, and discuss India's experience. India itself is a continent-size country, with a lot of diversity. There are at least two Indias in the aggregate data—one that is almost like a developed economy, with financial instruments and education comparable to the OECD countries, and the other where there is malnutrition and lack of access to primary education and basic health.[4] Having pointed this out, I shall talk of "India", since macroeconomics involves aggregation, and regional variations, however important, are not the focus of my analysis. My endeavour is to find out whether we are invoking the right lessons from economic theory and history, given the institutional setting of a developing country like India.

---

[1] I have been working on the issue of financial reforms and capital flows to India for about twenty years (see, e.g., Sen 2007). Whilst there is some overlap with that paper, especially on capital flows, the areas covered here are substantially different. The earlier paper, not unexpectedly, has not aged well.

[2] Interchangeably referred to below as the "OECD countries" or simply "the North".

[3] When I was an undergraduate, the phrase structural transformation was not in vogue—it was referred to as economic development, without any further qualifications.

[4] A fact that was brought home by the effect of COVID-19 on the Indian economy. Years of gains in poverty alleviation were wiped out In months.

Macroeconomics and Development Economics: Some Background

Let us first talk about macroeconomic theory. In particular, I want to ask: what should be its nature in a developing economy context? The received tools do not really distinguish between an advanced capitalist economy and a less developed one—except a small tweak about supply responses, and possibly about access to the world capital markets.[5] This is in spite of considerable evidence that the South's macroeconomic time series tend to be more volatile than the Northern counterparts—this is not surprising, given that markets tend to be "thin" (or nonexistent) in the South.[6]

The critique below of applying macroeconomic policy transplanted from the OECD countries will probably find more readers agreeing, than my take on how to achieve structural transformation. On the latter, my thinking is based on the experience of the East Asian countries and the contrast of these countries' growth process with those in Latin America. To the extent demand creation for the "infant" industries is important, a policy of generating current account surpluses appears to be a promising candidate. And this requires an industrial policy (including an exchange rate policy). The point is moot whether the Indian authorities, having failed to provide even the minimum tasks, could ever be expected to deliver these.

Macroeconomics is a relatively new branch of economics. It was only after the Great Depression, and Keynes' General Theory, that stabilization policy (i.e. with the avowed goal of attaining full employment and low inflation) made its appearance. And from the end of the Second World War to the mid-1970s—the so-called Golden Age of Western capitalism—it delivered not just material prosperity, but also brought with it the Welfare State, with its the near-universal provision of public health and social security schemes.

The good times were, however, not to last. The first oil price shock in mid-1970s sounded the death-knell of this period of high employment. The financing of the Vietnam War also played a role, in that it finished off the dollar standard of fixed exchange rates.

It is well understood that (analytically) the Keynesian theoretical apparatus was based on demand management (fiscal and monetary policies to achieve high employment, and incomes policy to keep a lid on wages and prices). The oil price shock was a supply shock. It represented a difficult choice, in that the authorities could not stabilize both the level of output and the rate of inflation.

[5] When I wrote Sen (2007), there was an implicit belief that the North had more developed and, hence, transparent institutions. The Global Financial Crisis, the Trump Presidency, and the UK's handling of COVID-19 suggest that these countries are as inept as those in the South. And as corrupt. The best example in recent times is the UK preferring those with experience in horse-racing (in Newmarket, Suffolk) to supply COVID-19 protective gears.

[6] See the discussion in Broner and Rigobon (2004) and Caballero (2000).

For quite a few years prior to this collapse, Milton Friedman (and others) had been trying to undermine the Keynesian dominance in the policy circles. He started by emphasizing the important role of money supply in demand management, but without much effect. He, finally, zeroed in on a supply-side theory of output determination. This he christened the "natural rate of unemployment".[7] This level was determined by labour supply decisions (and taxes that affect those decisions), but not by aggregate demand.[8] Friedman argued that if the authorities tried to use aggregate demand to keep unemployment below this, it would be futile, and would involve ever-increasing inflation.

The profession embraced this with such alacrity that probably surprised even Friedman himself. I am certainly surprised at how durable these ideas have proved to be. Even today, these constitute the cornerstone of models used by Central Banks (with some lip service to price stickiness observed in the data).

At least two implications follow from this thinking: (1) if fiscal policy is unable to change output, except fleetingly, the emphasis should be on balanced budgets.[9] More borrowing raises the real interest rate and makes it costly for private borrowers. Taxes should be low, and predictable. Income taxes should be eschewed in favour of taxes on expenditure; and (2) since the Central Bank cannot change the natural rate of output, it should preannounce policies for the rate of growth of money, so that it minimizes the "noise" in the system.[10] It is obvious that open-loop policies, such as these, are usually not time consistent (i.e. in a game-theoretic set-up, they are not sub-game perfect). This has led to a sizeable academic output on the issues of establishing credibility for such policies.

In the following decade, using the notion of rational expectations became the norm in macroeconomic modelling. And this brought forth the so-called policy ineffectiveness proposition. This depended on the assumption of output being a function of price surprises of the type $\gamma(p_t - E(p_t/I_{t-1}))$, where p_t is the logarithm of the price of output in period t, and $E(x_t/I_{t-1})$ is the mathematical expectation of x_t formed given the information at date t-1 (I_{t-1}). This is essentially Friedman's

[7] See Friedman (1968). Phelps (1967) had also come up with such a concept.

[8] This is not true in general. For instance, if in an open economy the labour supply N^S depends on the consumption wage rate $N^S(W/Q)$, where W is the money wage, Q is a price index of domestic and imported goods, i.e. $Q = Q(P, EP^*)$. Labour demand N^D depends on the product wage rate $N^D(W/P)$. Now the equilibrium in the labour market depends on EP^*/P. That is a macro variable like fiscal policy that will change the equilibrium N.

[9] Fiscal policy still has allocation effects. But as a tool for stabilization, it is not recommended.

[10] From a simple flexible price money market equilibrium, we get a rational expectations solution for today's price level p_t (all variables in logarithms),

$$p_t = (1/(1+\alpha)) \sum_{j=0}^{\infty} \left(\frac{\alpha}{1+\alpha}\right)^j E_t\left(m_{t+j}\right)$$

where m_{t+i} is the money supply in period $t + i$, E(.) is the mathematical expectation conditional on $I_{t\text{-}1}$, the information available at t-1, including the model, and α is the semi-elasticity of money demand.

formulation, with added bells and whistles.[11] Note that here at time t, policy reacts to current information but expectations do not. A death-blow was delivered to this proposition soon enough. A small point, but devastating for this formulation, can be outlined as follows: If agents observe current disturbances, and form expectations of future policies based on this, then the authorities can affect these expectations. Let me elaborate a little: if a shock increases aggregate demand by an amount u, a known forward-looking policy rule would have future (e.g.) money supply falling by an amount that would induce an expenditure reduction today exactly by the amount u, thereby cancelling out the increased demand—thus, known rules can stabilize output perfectly (see Turnovsky 1980; Weiss 1980).

Notwithstanding the resounding defeats in theoretical modelling (and later in their applications), the election of very right-wing leaders in the USA and UK in the 1980s ensured that Friedman's message survived. Ergo, the private sector delivers socially desirable results. Then why should the government mess around with the economy? Leave it to technical experts, who are unsullied by politics and ideology, and, presumably, stand outside the rough and tumble of society.

In this chapter, I will be using standard macroeconomic models. I do want to point out that it would be misleading to suggest that there are other non-Walrasian candidates in macroeconomics. There was the disequilibrium school, which looked at quantity adjustments, rationing, and spillovers with fixed prices. The new search theory also has bilateral matches, and costly search. Finally, there is the literature on multiple equilibria and beliefs. But it would be fair to say that in the context of policy formulation, they have not been as influential. In addition, in the "dim underworld of heretics", there are post-Keynesians and Marxists. They are, however, not interested in details of policy that is my focus here.

The other branch of economics that is central to our discussion is development economics.[12] This is even younger than macroeconomics. Any discussion of a framework to spur development had to, by definition, wait for decolonization to occur.[13] As decolonization gathered speed, starting off slowly after the Second World War, sovereign governments had to grapple with a mix of inexperience, and lack of role models—i.e. they were starting from scratch—whilst the expectations of their citizens were sky-high. Indeed, the very definition of a developing economy itself was not a trivial task. Colonization had left deformities in the economic structure that were difficult to categorize easily. I like to invoke Tolstoy's observation that all happy families (read advanced capitalist countries) were alike, whereas each unhappy family (read developing economies) was unhappy in its own way.

---

[11] On this see Barro (1976) and Marini (1985).

[12] Development economics nowadays concerns itself with micro issues. My concern here is the framework of development—hence somewhat old-fashioned.

[13] Although there was often a very detailed discussion of plans in anticipation of decolonization. In India, discussion on this started in the late 1920s. A formal committee was set up in 1937 by the Congress Party.

A central issue that came up concerned the role of government intervention. Initially it was thought that the State would have to step in, in the presence of market failure—markets simply did not exist, the ownership of the means of production was in colonial hands, most of the investment was in extractive industries, plantations, etc. The State's performance, however, turned out to be patchy—bureaucratization, inefficiency, and rampant corruption were common. Over time the role of the State came to be questioned, and there was talk of government failure. Indeed, the pendulum swung to the other extreme, and everything was sought to be privatized—the baby was thrown out with the bathwater.[14]

In the above discussion, I do not, for one moment, want to convey the impression that these choices (about State ownership versus privatization) are made independent of the social and economic (read class) structures in the economies concerned. How come most developing economies, including those with high growth rates of per capita income, have abysmal levels of primary education and public health (as was laid bare by COVID-19)? Here I just want to emphasize the fact that just as it is true that the Keynesian aggregate demand policies faced challenges, and the management of the State-run enterprises needed a rethink, the replacement of these dominating paradigms could not have been achieved without powerful backing of those who were opposed to State intervention in the first place. Half a century of thinking and proven policies got eviscerated almost overnight.

Macroeconomic Policy in Developing Countries

I now turn to the issue that is my main concern in this chapter, namely what is the appropriate macroeconomic policy framework in a large developing country? If one takes the discussion above seriously (with Tolstoy thrown in, for good measure!), it would be foolhardy to propose such a framework for even a few developing economies. Thus, let me discuss these policies in the Indian context, although some lessons derived below may be relevant for other countries also.

It is not my desire to discuss the nitty-gritty details of the conduct of macroeconomic policy in India (although I will stray from this self-imposed boundary a few times). Rather, I want to look at the framework within which the policies are conducted. What have the Indian authorities borrowed from economics (both theory and best practices elsewhere)? And how does this framework (or a sequence of evolving frameworks) fare? Does it just pass muster, or with flying colours? To anticipate my answer below, it is neither of these.

Even for India, it would be a fool's errand to try and discuss all the burning issues involved in the areas covered by the intersection of development economics and macroeconomics. I will choose three topics to address. The first would examine the emphasis on budget balance, and keeping the government debt under control.

[14] Either fully privatized, or a public–private partnership (PPP).

This is not a problem concerning developing economies only. In the context of the Eurozone economies, the obsession with budget deficits and debts is well known (as is the long shadow cast by the Bundesbank's thinking on the ECB). In India, as elsewhere, there are attempts to balance the budget by treating various items as off-balance sheet. An economy like India's, where the State has traditionally held the "commanding heights", the possibility of subterfuge, and window-dressing, is that much greater.

The second topic concerns monetary policy and external balance, generally. What is the role of an open capital account (of the balance of payments), and the resultant capital inflows (and occasional outflows)? This will be discussed in the context of the inflation targeting framework adopted by India. Are the Indian authorities of the view that any current account deficit can always be financed by capital inflows? Does the exchange rate not have a role in creating additional demand for domestic goods?

The third area is related to the first two—if the economy has to develop how is it going to be financed? What is the role of fiscal and industrial policies in this process? And should a capital-deficient country import capital?[15] Should capital inflows be unbridled? I will try and argue for an outward-oriented growth strategy, with a reasonably closed capital account.

As mentioned above, due to a variety of reasons, the overarching Keynesian framework had fallen on hard times; free market ideas had permeated the profession's thinking in macroeconomics. Around the same time, the developing economies were also turning towards the market, away from regulation and ownership by the State. In fostering this move, intellectual and logistical support was provided by the IMF and World Bank.

This switch to a market economy is not trivial decision. It is one thing to say "use the market mechanism" and quite another to trace out a viable transition path from an economy with sizeable State ownership—and thus ridden with "distortions" (as was the case with the Indian economy).

Fiscal Policy

The first point flagged above concerns budget deficits. The received wisdom suggests that a market economy, as part of a stable environment, must have low and stable taxes. A balanced budget increase in taxes and spending is ruled out. Higher tax rates discourage saving and enterprise. A discussion of wealth tax or taxes on high incomes is greeted with alarm, as if only confiscatory rates are under discussion. India has reduced direct taxes, and with the botched GST regime (and cess on petroleum, etc.), its tax system today is quite regressive.

[15] This was popular in the 1960s and 1970s under the rubric of "Stages of Balance of Payments Theory". This is related to our second and third points below.

The emphasis then is on the budget deficit. There are many instances of developing economies running sizable deficits. If these are large and sustained, one ends up with the Central Bank monetizing them. This is especially true, because in developing economies the market for government debt is in a rudimentary stage, and the rest of the world is unwilling to hold its debt in large quantities (because of currency risk and default risk). Thus, beyond a certain stage, deficits are accompanied by inflation—*à la* Sargent and Wallace. It does not follow, however, that any deficit will cause inflation (although this is routinely invoked). There is surely a threshold for each country—and India has historically not been a high inflation economy. The international rating agencies, who observe debt and deficit policies with a hawk-like eye, will punish a government for exceeding its promised deficit by even an infinitesimal amount. The government expecting this ties itself to a mast. No sirens here, only self-flagellation.[16]

There are conceptual and measurement issues regarding the deficit in India. The deficit is not adjusted for cyclical variations in tax collection. It is also not honest about what constitutes taxes, and what, like selling a State-owned enterprise, is a means to finance the deficit. It is a market-driven concept—how much is going to be borrowed? Of course, as is almost universal now, off-budget items come into play, especially in a country like India, where, as mentioned above, the State-owned enterprises are still not insignificant. In the budget exercise, with its emphasis on the deficit, current consumption and capital expenditure are lumped together. Political expediency ensures primary health and primary education will never be adequately funded. The capital expenditure on infrastructure is also allowed to fall to precarious levels.

In this gerrymandering, the victim is democracy. The budget process is the only economic statement that the Government of India is constitutionally obliged to make, and is held accountable for. And that, it turns out, has nothing to do with a desirable trajectory for the economy; in addition, there are convoluted tricks to make it balance. If underdevelopment is about low levels of various stocks, e.g. health of the people, physical capital, and education, there is no accountability on these from the government (the stock of government debt is an exception because the international rating agencies care). We continue with looking at flows of income and expenditure—actually net flows (that is what a deficit is, after all). The colonial state was happy with this annual charade of a budget because it had no interest in monitoring the stocks. And even after decolonization we carry on with this tradition, quite unmindful of, or willfully ignoring, the fact that a new set of rules are necessary. Even if balancing the budget is a desirable target in the North, should a developing country adopt it? A deficit is, as we are reminded frequently, making the future generations pay (partly) for current excess expenditure. Presumably, in a developing economy context, that would not be such problem, since we expect the future generations to be better off than those alive today.

[16] The Indian government has been most reluctant to use fiscal policy generously in the recent pandemic. It was regularly looking over its shoulder, and monitoring the budget deficit.

India had recognized the need to think of a horizon longer than one year, and had set up a Planning Commission. Its performance may have left a lot to be desired, but conceptually, it addressed the issue of a longer horizon than one year. There was also a recognition that, in principle, markets are supposed to give consistency to individual plans; if these do not exist, or are at a rudimentary stage, a "plan" was required (for consistency).

Financing of development projects, say infrastructure, on a large scale requires funding—some of it comes, undoubtedly, from multilateral agencies. These are projects with long gestation periods, and also require financing that may not be available in the market. The Indian government, in a rush to embrace the market, got rid of some of the financial intermediaries (called "development banks") that had been mandated to finance infrastructure spending. Commercial banks then started lending for these projects. Commercial banks, as is well known, borrow short and lend long, but not as long as infrastructure projects require. This gave rise to an asset–liability (horizon) mismatch on their balance sheets.[17]

Monetary Policy

Initially, the proponents of the market mechanism were so blasé that they supported a "one-hoss shay" end for the State-directed regime—full financial liberalization could be done immediately. This was jettisoned quickly because country after country faced crises. An example of this "cold turkey" policy that concerns us here pertains to international capital flows. In the early 1980s, there was a debt crisis in South America (the Southern Cone), because these countries had removed all controls on international borrowing and lending; the foreign banks proceeded to lend too much to the private sector believing that there was a "sovereign" guarantee. The private borrowers defaulted and a debt crisis ensued.

Amongst the Latin American countries, Chile (after the military coup that overthrew President Allende in 1973) become a laboratory for free market reforms (including financial markets), as espoused by Milton Friedman and his Chicago colleagues. Other big countries, e.g. Argentina, Brazil, and Mexico, also experimented with these policies but, being democracies (off and on), with less commitment to the right-wing ideology.

Whilst it is claimed that reforms are necessary to attract foreign capital, it has been observed that international finance capital is not too discriminating about which economies have undertaken deep market reforms. When the world is flush with liquidity, all developing countries received capital flows, and when, for whatever reason, capital flows ground to a halt, in the withdrawal phase, every recipient country was tarred with the same brush.

[17] This added to the woes of the commercial banks. They had seen their normal loans going sour because of cronyism, and, no doubt, expecting the tax-payer to bail them out.

Calvo and Talvi (2006) document this for Latin America. They say: "Russia's default in August 1998 . . . represented a fatal blow for Latin America . . . In tandem with the rest of emerging markets, interest rate spreads for LAC-7 rose from 450 basis points prior to the Russian crisis to 1600 basis points in September 1998 . . . As a result, capital inflows to LAC-7 countries came to a Sudden Stop, falling from 100 billion dollars (or 5.5 percent of GPD) in the year ending in II-1998 prior to the Russian crisis, to 37 billion dollars (or 1.9 per cent of GDP) one year later . . . (Further they point out that in response to this shock to capital account) "by definition undesirable if not impossible to smooth"—most of the adjustment in LAC-7 came not from additional savings but from reduced investment, which fell from 23 percent of GDP in 1997, prior to the Russian crisis, to 18 percent of GDP in 2002". They also note "That a partial debt default in Russia, a country that represented less than 1 percent of world GDP and had no meaningful financial or trading ties with Latin America, could precipitate a financial contagion shock wave of such proportions, posed a puzzle for the profession."

India undertook "structural reform", starting in the early 1990s. This involved (some) privatization of State-owned enterprises, lowering tariffs on imported goods, and opening up the capital account to foreign inflows. Outflows from India were also liberalized, but restrictions remained on a number of categories—indicating that some lessons had been learnt from the Latin American crises. But, in my opinion, even with these restrictions, the capital account was opened up too much. In the last quarter of a century, a lot of the remaining restrictions have been removed, e.g. on inflows, the FDI restrictions have been successively eased, external commercial borrowings, that were strictly regulated, have been liberalized, and some outward FDI is also allowed.

It is useful to remember that inflows and outflows of foreign capital have different negative effects on the recipient economy. Inflows cause currency appreciation (nominal and real); this in turn puts a squeeze on tradable goods (the so-called Dutch disease). Outflows hit those who had borrowed in foreign currency. The outflows often tend to be a scuttle, rather than an orderly withdrawal (see the discussion on the Sudden Stop above).

The Indian Central Bank—the Reserve Bank of India (RBI)—in a bid to stem the appreciation of the rupee, intervenes regularly to mop up foreign currency. But if this intervention were left unsterilized, there is the likelihood of inflation. The RBI, therefore, proceeded to sterilize the money supply by conducting contractionary open market operations. The magnitude of this was not insignificant; in fact, the RBI ran out of government bonds—and a new category of bonds under the so-called Market Stabilization Scheme was created (in 2004).

At least two points merit attention regarding this sterilization policy. First, there is a quasi-fiscal cost to this—foreign exchange reserves pay little or nothing, whilst domestic bonds pay considerably more. Second, and this is worth repeating, because it is not understood in India, that India's foreign exchange reserves are acquired through intervention, and not current account surpluses.[18] Thus to spend it on wasteful foreign currency expenditure could have serious consequences. This is not just an academic point—over time, as mentioned above, India has opened up the capital account considerably to outflows. It must be confident that the inflows are stable, and that no reversal would take place—a big ask. Otherwise, a run on the rupee is likely. For instance, at the time of the so-called taper tantrum (in 2013), private players were caught with substantial sums of unhedged foreign currency borrowing, and the rupee was in a free-fall.[19]

Let me now turn to the overall conduct of monetary policy. After experimenting with different nominal anchors (including a money supply target), the RBI has moved to a regime of (flexible) inflation targeting since 2016. This was proposed by a committee, chaired by Urjit Patel (see Reserve Bank of India 2014), then Deputy Governor (later Governor) of the RBI. The price index to be targeted was the Consumer Price Index (before this, the RBI used to "look at" the Wholesale Price Index). A Monetary Policy Committee was set up, with the mandate to monitor the inflation rate. It uses a Calvo-type Phillips curve to generate some price stickiness, although no empirical evidence is provided for this in the Indian context.[20] The monetary policy rule consists of using the repo rate, whenever inflation goes outside the acceptable range. Following Taylor's rule, when inflation is above the upper threshold, it raises the nominal repo rate to get the real rate to rise, so as to compress aggregate demand.

Is inflation targeting the right candidate in its genre? Probably not, given that core inflation is about half of the CPI inflation. Supply shocks (agricultural and imported oil price) are important. As the Urjit Patel Committee noted: "... food and fuel account for more than 57 percent of CPI, on which the likely influence of monetary policy is limited" (RBI 2014, p. 20). Demand compression, via the Taylor Rule, just looks at these feeding into expected inflation. On this score (but not for the external balance discussed below), nominal income targeting might have been better. The importance of these supply shocks is unlikely to wither away anytime soon, with inflation targeting continuing to focus on less than half of the CPI inflation. This point is more than just of academic interest, as we have seen in the wake of the Russian invasion of the Ukraine. This caused worldwide increases in the price of oil and foodgrains. Central Banks in the developed countries put up their interest rates. This was transmitted to the Indian economy as a supply shock and an exchange rate shock.

In the Urjit Patel Committee Report, there is quite an extended discussion on how various developing countries have coped with volatility of international flows

[18] Currently (in October 2022) around $ 640 billion.

[19] In the summer of that year, the rupee depreciated against the dollar by 30 per cent. Other emerging market currencies depreciated much less.

[20] See the briefest of brief discussion of this in the following sentence: "The general result is that the smallest losses (of the objective function) are obtained when monetary policy responds to changes in inflation only" RBI (2014), p. 12.

(of the Sudden Stop variety). But for this discussion of turbulence, the external sector merits no consideration. Fighting volatility is different from anchoring the traded goods sector's expectations about the level of the exchange rate. Surely, in a rules-based environment, where the authorities want to minimize noise, the path of the nominal exchange rate is an important input for the traded goods sector?[21] Fighting and winning against a cyclone does not guarantee potable drinking water to the citizens. In particular, there is no thinking on the external sector as a potential source of aggregate demand? If so, where do we see this in the inflation targeting framework—and this is the sum total of the Government's thinking on monetary policy? Could there be a link from the use of the interest rate to output via the exchange rate? But even output does not figure in the RBI's optimization exercise.[22] Even with a massive trade deficit, in times of inflation, is the RBI not unhappy to see an appreciating exchange rate—after all its mandate is to keep inflation in check?[23]

Capital inflows give rise to what has been called "exchange market pressure". The response of the Central Bank to this lies between the two extremes of a free float and a pegged exchange rate. In the former case, reserves do not change, and the nominal exchange appreciates. In the latter case, the exchange rate is fixed, and Central Bank accumulates reserves. Sterilization of the money supply is possible, if domestic and foreign assets are imperfect substitutes. The RBI has chosen to perform sterilized intervention, as described above. Thus, the "impossible trinity", which Indian commentators use routinely, is a non-sequitur. But the RBI does not disclose its intervention rule—even if not the actual rule (if a speculative attack is feared), at least the range, as was the case with the Monetary Authority of Singapore. Hence, the private sector is left guessing what the nominal exchange rate path will be—thus introducing noise in their decision-making.

The Urjit Patel Committee, of course, pretends to be following global best practices. It may want to appear au courant with these, but, in fact, given that it is for the Indian setting, it is a shoddy cut-and-paste job.

Macroeconomic Policy in a Developing Country

We then come back to the issue flagged above, viz. what are the objectives of macroeconomic policy in a developing country, like India? As discussed in the

[21] See Airaudo et al. (2016) for a discussion of accommodating the exchange rate in an inflation targeting framework.

[22] In the literature, there is some discussion in the OECD context whether to only allow the exchange rate to affect decision-making after it has had its effect on output. No such subtleties detain the RBI.

[23] I have heard at least two Principal Economic Advisors in the Finance Ministry on television 1(Ila Patnaik and Sanjeev Sanyal), saying that in India, there is an "Almost Impossible Trinity". This is creative theorizing, i.e. nonsense. The Impossible Trinity precludes sterilized intervention—there is, indeed, no need for it.

preceding paragraphs, inflation has been the focus of monetary policy. Much like the Eurozone, budget deficits and government debt are to be strictly monitored and controlled, so as not to make the markets unhappy. Economic growth and current account problems are to be addressed by the invisible hand.

In the 1950s and 1960s, several economists (the name that comes readily to one's mind is James Meade) talked about the objectives of macroeconomic policy. These were internal balance (full employment, low inflation, etc.) and external balance (one cannot go on borrowing from foreign residents forever). A good representation of this thinking is the so-called Australian model (also called the dependent economy model with a traded vs. non-traded goods distinction). One can then think of the economy needing two independent policy instruments to meet the two objectives, say full employment and current account balance. A single instrument is usually unable to help realize both objectives. In a situation of underemployment, the authorities use fiscal policy to get internal balance, and a (real) devaluation to get external balance. Depending on the details of the model, the model can be extended to accommodate monetary policy and the labour market.[24]

The period until the breakdown of the Keynesian consensus was also a period of (relative) control of the financial systems. For example, in the UK, the inflexibility was referred to as the "corset"; in the USA, the incompatibility of macroeconomic system with controls on the financial markets (e.g. Regulation "Q") gave rise to the Euro-currency markets. Over time, for the advanced capitalist countries, financial integration occurred with mobile capital across the OECD countries. With that, one could say that the external balance constraint disappeared for these countries as the capital accounts (of the balance of payments) were opened up.[25] The external balance requirement refuses to disappear for the developing countries, even after years of "reform"; e.g. for Chile, Caballero (2000) points out that most macro time series follow the price of copper, its main export.

There have been attempts to model the external constraint. For instance, Caballero and Krishnamurthy (2001) model this by pointing out that in the OECD countries, there is one budget constraint (i.e. their currency is convertible, and so all domestic assets and liabilities can be aggregated), but for the developing countries there are two budget constraints—one in the convertible foreign currency, and the other in domestic currency. A shock to the economy makes the foreign currency borrowing more attractive—this is accompanied by fire sales of the domestic assets. This does not happen in a developed country setting (see, e.g., Caballero and Simsek (2020) where fickleness (outflows) and retrenchment (inflows) behave quite differently).

---

[24] No wonder the model has been used extensively for open economies. One can for instance use this to explain the stop-go cycle for the Post-War UK. The go part was expansionist policy, restrained by the state part of a balance of payments deficit—under the Bretton Woods system the exchange rates were fixed.

[25] It has been pointed out that Meade in his Nobel Prize speech only talked about internal balance, with no mention of the external balance (see Bean 2009).

This class of models is an important step forward in explaining the difference in reaction to a shock between the less developed financial markets and a developed one—not all the collateral that the former can offer is acceptable to international lenders. Thus, this affects the external balance constraint. But this class of models needs further elaboration. Whilst these explain how developing countries react to a "Sudden Stop", they use the Diamond and Dybvig (1983) type of liquidity provision structure—that is partial equilibrium in nature. Whilst they flag an important distinction, from our general equilibrium perspective, it is inadequate.

International Trade, Capital Flows, and Economic Development

Before I go on to discuss monetary policy in India and its role in the (missing) internal balance, let me emphasize once again that India has opened up to the international markets in the last thirty years. In trade openness, India and China are neck and neck.[26] Capital inflows are also significant.

As mentioned above, India embarked on an import-substitution development strategy, with a significant participation of the State (in industry and, later, in the banking sector). This exercise provided a modern sector and a small educated workforce. But its singular failure was the inability to generate a structural transformation. The agricultural sector continued to be the single-largest source of employment (now (in 2019) at about 43 per cent employment share, but 18 per cent of GDP (in 2020)),[27] accompanied by continuing distress. This is a classic case of Arthur Lewis' model (see Lewis 1954) with zero marginal productivity in agriculture. Actually, it is Arthur Lewis-plus. It is an economic and an ecological disaster. The so-called "Green Revolution Belt" in Northern India uses subsidized inputs (electricity, fertilizer, pesticides, etc.). And the State guarantees a fixed price for the produce. In recent times, the end of autumn sees stubble burning (of the previous rice crop) that produces a haze that hangs over large part of India and Pakistan. Even without this added contribution, Delhi is the most polluted capital city in the world. Commentators on agricultural subsidies often invoke an argument "It is everywhere thus" (my cross-section version of "It was ever thus"!). Whilst, superficially at least, there is merit in the argument that agriculture is subsidized, and protected, in most countries (e.g. the EC, the USA, Japan), it is the sheer number of people involved that should be a matter of concern. I suspect, the Government looks at the problem through the prism of the level of subsidies. Again the stock variables are neglected, e.g. the level of groundwater, respiratory diseases and mortality, and the productivity of land.

[26] Of course, China runs persistent trade surpluses, with India doing just the opposite.

[27] During COVID-19, both employment and output in agriculture have gone up.

Therefore, what India needs is a large share of the agricultural labour force to move to higher value-producing sectors. A part of India's manufacturing sector, as well its services sector, is skill-intensive, and can and is holding its own in the world economy. But the surplus labour in agriculture has no education, and is mostly severely malnourished. The only hope is, at least in the initial phase, some crude form of labour-intensive industry.[28] Industry has accounted for about a quarter of the GDP, and fifteen per cent of the workforce for about a quarter of a century.[29] What industrialization needs is a push, or at least a nudge.

Openness had been emphasized even before India dismantled its inward-looking industrialization strategy. The State-owned heavy industries failed to generate the necessary forward and backward linkages, and industrialization did not happen on a desired scale. With the arrival of the so-called "Asian tigers" (led by Japan, Taiwan, South Korea, followed later by China), it was pointed out that India was following the wrong strategy of import substitution. What was needed was lower trade taxes, and that would lead India to an East Asian type of growth trajectory. This analysis was based on the theory that the optimal tariff for a small open economy was zero. India should produce labour-intensive goods initially, based on a Heckscher–Ohlin comparative advantage reasoning (i.e. based on factor endowments).[30] In this view, the Government was supposed to stay out of directing the economy—this included international trade and the production of goods. Although, usually not explicitly mentioned, this view would have India running trade (and current account) deficits, which would add to domestic savings.[31]

I have two observations on this interpretation of calling upon India to emulate the Asian Tigers, with their avowed outward orientation. First, as pointed out by Dani Rodrik, that this causality of trade flows and growth resulting from lowering tariffs does not survive a detailed empirical analysis. He showed that it is more than just trade liberalization that delivers. There are other prerequisites, e.g. the education of the labour force. One size does not fit all cases; the initial conditions matter.[32]

---

[28] This is how Bangladesh, next door to India, grew.

[29] Recently, there is evidence that employment in industry is falling. Is this premature deindustrialization? The services, including its exports, have done well.

[30] In the event, trade restrictions were not lifted in a big way until the early 1990s. And the much-awaited structural transformation has not happened.

[31] Something that flies in the face of the East Asian export-led growth experience. In the Indian policy circles, a current deficit was almost an end in itself. Sample this from Rakesh Mohan, a former Deputy Governor of the RBI: "...it would become feasible for India to sustain a wider current account deficit which is required for the non-inflationary absorption of external capital inflows. It is suggested that a sustainable level of current account deficit would increase from the current level of 1.5 per cent of GDP to 2.5 per cent in 2000–01 and 3 per cent in 2005–06" (Government of India 1996).

[32] Matsuyama shows that the export sectors have to be dynamic; static gains from trade could trap an economy in a "wrong" trade pattern. A point to bear in mind is that developing economies have ill-defined property rights (usually due to the penetration of capitalism into areas where there was community open access)—this gives rise to overexploitation of these resources (see Chichilinsky (1994)). Hence exports of natural resource-intensive goods happen because of this apparent comparative advantage.

The second concerns structural transformation. The dominant thinking in macroeconomics comes from the USA. Most US macro textbooks (these are used across the globe) base their exposition on a one-sector, closed economy model. Towards the end of the book, the economy is "opened up". Therefore, neither is there a role for preferring one sector over another, nor is there the possibility of getting away from incremental growth. For a structural transformation, by definition, we need more than one sector. The speed of this structural transformation would depend on the demand (and the supply) in the expanding sector. At least since Rosenstein-Rodan (1943), we are familiar with the big-push hypothesis. If there is increasing returns to scale in the yet-to-be-born industry, and unless enough demand is generated, this dynamic sector would be stillborn. In this set-up, presumably, the increasing returns are external to the firm[33]; thus the firms cannot, in isolation, get over the "hump". A coordination or planning is called for. Increased demand via a real exchange rate depreciation could generate the right conditions for the sector to come into being. Thus, industrial policy (including the exchange rate) requires the State to be more than just a bystander. Whilst demand conditions are central to the story, supply-side factors are also hovering in the background. Industrial jobs are more sophisticated than agricultural labour. An educated workforce is needed. Only then would learning-by-doing have a chance. Maybe FDI, with the latest technology, would be required for accessing the world markets with the new products.

A real depreciation (e.g. by limiting international capital inflows) could create demand at home and abroad.[34] This would just be reversing the Dutch disease effects of financial capital inflows. If priced right, at the very least, some products could replace imports from China. But India needs to export these industrial goods. Nothing in this world comes for free, though. In this case, imagine what industrialization would do to India's air and water quality, given the pathetic condition of these prior to industrialization. But I, for one, do not see an alternative at the macro level.[35] Agriculture cannot sustain these numbers. It is a tinderbox, in terms of both economics and ecology.

An appreciated real exchange rate increases imports, reduces exports, and kills off potential traded goods firms. But given that it has been in place for a quarter of a century, it does have fairly widespread support (especially amongst the wealthy). A real appreciation raises the real value of a given income in domestic currency units. For instance, foreign holidays become cheaper, so does foreign education for

[33] In the New Trade Theory models with imperfect competition, a firm can borrow (implicit in static models) and reap the economies of scale. How many firms are supported depends on the market equilibrium (usually a free entry condition). If we had borrowing constraints, the difference with external economies of scale becomes somewhat blurred.

[34] See Rodrik's (2008) detailed empirical analysis in support for the hypothesis that undervaluation of the exchange rate is good for growth in developing countries.

[35] The World Bank (see World Bank 2021) recently has advocated not even trying for industrialization; India should rely on a service-based growth strategy. I am not at all sure about this because of the numbers involved, and the low levels of initial skills of the labour force.

one's children. It is not surprising that a sizeable amount of outward flow of funds from India occurs every year. And that the Government is willing to use the foreign exchange (acquired through sterilized intervention, as mentioned above) for these non-essential expenditure heads. Outward FDI is also a telling comment on the lack of competitiveness at home—it is after all exporting potential jobs from India.

Thus, we need an exchange rate policy, and an industrial policy, to focus on exports. Current account surpluses create additional demand (and raise GNP). The industrial policy is to provide support for this, including a beachhead in foreign markets.

This big push is unlikely to be sustained, if tried with an expansion of domestic demand. At least two imponderables present themselves. First, where is the additional demand going to come from? The Government has limited means, and would have to spend on infrastructure. Second, it is bound to hit the external constraint wall—the current account deficits will certainly kill this strategy. An outward orientation can potentially overcome both of these shortcomings. An export-led growth strategy helps relax both the internal and the external balance constraints. This happy coincidence should be exploited.

Some Postscripts and Conclusions

So far, I have tried to stick to my self-imposed boundary and refrained from discussing details of how policy is conducted. I want to briefly mention a few recent events that do have some bearing on the discussion above.

First, whilst the Monetary Policy Committee meets (since 2016) and discusses the evolution of inflation, the Government has clipped the RBI's wings by putting a pliant Governor. This was done to transfer some of the surplus of the RBI to the Government. Thus, instead of the Central Bank being given more autonomy, as was envisaged under the inflation targeting framework, it has effectively been "nationalized"! The RBI today possibly pays more attention to the output gap, and not to inflation alone.[36]

A second point concerns the poor in the rural areas. The low productivity in agriculture gives rise to migration to the cities. A large body of footloose workers is available in the urban areas. Industry can whistle up the necessary labour. With COVID-19, this set-up has suffered a big setback. Due to the pandemic, the large firms were not affected, but there is considerable distress among the smaller ones. Once the Government recognized (albeit belatedly) the severity of the pandemic, it proceeded to announce an immediate lockdown. The sources of labour demand dried up, and the workers were stuck in the cities, without jobs and housing. They were not allowed to move back to their villages, where most urban workers still

[36] Some studies have found the output gap as a relevant variable in the RBI's response even after the inflation targeting regime. See, e.g., Eichengreen et al. (2021).

have a toehold. From the discussion on fiscal policy above, the question that arises is: What should the macro policy response be to this once-in-a-lifetime shock to the economy? Here, as discussed above, the Government is in thrall to the idea of balancing the budget, and its response has been very tight-fisted. The extent of distress can be gauged from the fact that about two-hundred million people have worked this year (since April) in government projects under a scheme called the Mahatma Gandhi National Rural Employment Guarantee Scheme. This pays low wages, and is available to one member of a household for one hundred days in a financial year—it is akin to an unemployment allowance.

Third, the Ukraine crisis required the RBI to increase the repo rate. It has been reluctant to do that, its explicit mandate not withstanding—the repo rate is 5.90 per cent currently (October 2022), whereas the CPI inflation has never been less than six per cent in 2022. The RBI has also been waging an uphill task (but, unsurprisingly, losing the battle) in trying to prevent an exchange rate depreciation. In the event, this year the rupee has depreciated by eight per cent. This is less than most other developing countries, but India's foreign exchange reserves have come down from 642 billion USD to 532 billion USD in a year since October 2021.

Finally, recently (after some border tensions with China), the Government of India has embarked on a scheme called Self-Reliant India. Some trade restrictions have been imposed, and production subsidies linked to domestic production have been introduced. It is too early to pass a judgement on this. My gut feeling is that this is just a knee-jerk reaction to a diplomatic problem. Import restrictions alone are not going to generate sustained growth—some growth will undoubtedly occur. If import restrictions strengthen domestic monopolies (or oligopolies), then this will benefit the large business in India (they are the only ones who can fill the space vacated by previous Chinese exports to India). One point that merits discussion related to this issue concerns the role of import tariffs. The principle of comparative advantage is one of the big ideas in the history of economic thought (since Ricardo). It is often forgotten that this principle as the *only* explanation of trade presumes that trade is balanced. In the recent Indian context, with the creeping protectionism, several prominent economists (e.g. Arvind Panagariya, Amartya Lahiri (in newspaper articles)) have invoked the Lerner symmetry (viz. an import tariff is the same as an export tax) to criticize this trend. The Lerner symmetry, of course, presupposes balanced trade. In the Indian context, asserting that as an initial condition is akin to saying "Welcome to Disneyland". This is a serious policy issue. As India tries to sign free trade agreements with various countries (e.g. RCEP), one is often left wondering in what goods does India have a comparative advantage (barring software-related services)? For the Indian policymakers, the takeaway from this conundrum is that we must liberalize labour laws, loosen environmental safeguards, etc. The overvalued exchange rate as a cause is never invoked.

To summarize, in this chapter, I have tried to set out a framework for the conduct of macroeconomic policy in India. This entails stabilization, growth, and aiding structural transformation. The last objective would require the State to be more interventionist than in the recent past. In the present global scenario, that is a big ask.

References

Airaudo, Marco, Edward F. Buffie and Luis-Felipe Zanna (2016) "Inflation Targeting and Exchange Rate Management in Less Developed Countries", IMF Working Paper 16/55.

Barro, Robert (1976) "Rational Expectations and the Role of Monetary Policy" *Journal of Monetary Economics***2**, 1–32.

Bean, Charles A. (2009) "'The Meaning of Internal Balance' Thirty Years On" *The Economic Journal*, **119**, F442–F460,

Broner, Fernando A. and Roberto Rigobon (2004), "Why are Capital Flows So Much More Volatile in Emerging than in Developed Countries?" University of Pompeu Fabra.

Caballero, Ricardo J. (2000), "Macroeconomic Volatility in Latin America: A View and Three Case Studies", *Economia***1**, 31–108.

Caballero, Ricardo J. and Arvind Krishnamurthy (2001) International and Domestic Collateral Constraints in a Model of Emerging Market Crises, *Journal of Monetary Economics***48**, 513–548.

Caballero, Ricardo J.and Alp Simsek (2020) "A Model of Fickle Capital Flows and Retrenchment" *Journal of Political Economy***128**, 2288–2328.

Calvo, Guillermo A. and E. Talvi (2006), "Sudden Stop, Financial Factors and Argentina and Chile", National Bureau of Economic Research, Working Paper No. 11153.

Chichilinsky, Graciela (1994) "North-South Trade and the Global Environment", *American Economic Review***84**, 851–874.

Diamond, Douglas W. and Philip H. Dybvig (1983) "Bank Runs, Deposit Insurance, and Liquidity" *Journal of Political Economy***91**, 401–419.

Eichengreen, Barry, Poonam Gupta and Rishabh Choudhary (2021) "Inflation Targeting in India: An Interim Assessment", World Bank Policy Research Paper 9422.

Friedman, Milton (1968) "The Role of Monetary Policy," *American Economic Review***58**, 1–17.

Government of India (1996), "The India Infrastructure Report" (Chairman: R. Mohan), Ministry of Finance.

Lewis, W. Arthur (1954) "Economic Development with Unlimited Supplies of Labour". *Manchester School*, **22** 139–191.

Marini, Giancarlo (1985) "Intertemporal Substitution and the Role of Monetary Policy", *Economic Journal***95**, 87–100.

The Reserve Bank of India (2014) "Report of the Expert Committee to Revise and Strengthen the Monetary Policy Framework", (Chairman: Urjit R. Patel).

Phelps, Edward S (1967) "Phillips Curves, Inflation Expectations and Optimal Employment over Time", *Economica***34**, 254–2821.

Rodrik, Dani (2008) "The Real Exchange Rate and Economic Growth," *Brookings Papers on Economic Activity*, 2008:2.

Rosenstein-Rodan, Paul (1943) "Problems of Industrialization of Eastern and South-Eastern Europe," *Economic Journal***53**, 202–211.

Sen, Partha (2007) "Capital inflows, Financial Repression and Macroeconomic Policy in India Since the Reforms", *Oxford Review of Economic Policy***23**, 292–310.

Turnovsky, Stephen J. (1980) "The Choice of Monetary Instrument under Alternative Forms of Price Expectations" *The Manchester School***48**, 39–62.

Weiss, Laurence (1980) "The Effects of Money Supply on Economic Welfare in the Steady State" *Econometrica***48,** 565–578.

The World Bank (2021) "Shifting Gears: Digitization and Service-Led Development", South Asian Economic Focus Fall 2021.

Part II
Applications

COVID-19 Threats and Opportunities: Toward a Circular and Resilient Bioeconomy

Fabio Giudice, Cesare Imbriani, Piergiuseppe Morone, and Ana Gabriela Encino-Muñoz

Introduction: COVID-19 Crisis, Setting the Scene

On January 2020 a previously unknown virus, then named SARS-CoV-2, was identified in China. A few weeks after, an outbreak, later defined by the World Health Organization (WHO) as a pandemic, put to test the healthcare systems of both advanced and developing countries. Lockdown measures were enforced to slow down the spread and mortality of the infectious disease. As a result, people have been forced to stay at home, and businesses to shut down (except essential ones). This means that a symmetric shock on both demand and supply occurred, and in some sectors, it is still ongoing, with important disruptions in the world economy.

Due to the emergence of other global issues such as the war in Ukraine, the pandemic seems to be losing relevance; however, COVID-19 is still not over. Even when many countries have reduced or fully removed containment measures, risks derived from the emergence of new variants, new waves of contagion, challenges derived from the first shocks of the pandemic, and the application of zero-COVID policies are still posing pressures on the economies around the world, particularly in terms of global trade.

The pandemic also unfolded in unexpected ways due to different factors such as the emergence of new SARS-CoV-2 variants, the speed of vaccination around the globe, the diverse lockdown regulations, and other public health measures in countries. Although these factors impacted on a different scale in each country, the global economy has been under pressure since the emergence of the virus,

C. Imbriani
Department of Law and Economics, UnitelmaSapienza University of Rome, Rome, Italy
e-mail: cesare.imbriani@unitelmasapienza.it

F. Giudice · P. Morone (✉) · A. G. Encino-Muñoz
UnitelmaSapienza, Università degli Studi di Roma La Sapienza, Rome, Italy
e-mail: piergiuseppe.morone@unitelmasapienza.it

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_7

leaving behind many uncertainties about the economic recovery after the shock. The COVID-19 pandemic caused a contraction of 3.3% in global economic activity in 2020 (International Monetary Fund 2021). The nature of these shocks has been unique, leading primarily to a reduction of labor supply and a curtailment of mobility and social interactions. Workplace closure disrupted supply chains and lowered productivity. On the other hand, consumers' demand has been fluctuating as a result of uncertainty and changes in incomes.

After the contraction of the economy in 2020, the estimated global growth rose 5.5% in 2022. This recovery, however, has not been globally equal as emerging markets and developing economies are going through slower recoveries compared to advanced economies (The World Bank 2022b). With new global challenges such as the Ukraine war, the projections for global growth and economic recovery are still unknown for the upcoming years.

There is yet much uncertainty caused by the pandemic due to the potential long-term repercussions on supply chains, shocks in financial markets, changes in consumption, and other factors. In addition, there are still important risks derived from the pandemic to consider such as the appearance of new variants, and the effects of the implementation of zero-COVID policies in countries like China, which could lead to a reduction in global demand and keep disruptions in supply (Organisation for Economic Co-operation and Development 2022b).

The International Labour Organization (ILO) has reported that for 2020, the global decline in the employment rate was unprecedented; compared to 2019, 2.2% of global working hours were lost, corresponding to 255 million full-time jobs meaning that disruptions in the labor market were greater than those related to the global financial crisis 2009 (International Labour Organization 2021). As a consequence of this decline in incomes, the impact of COVID-19 has been posing challenges to the "ending poverty by 2030" goal of the 2030 Agenda: global poverty has increased from 7.8% to 9.1% according to some estimates (Sánchez-Páramo et al. 2021). The adverse impacts of COVID-19 could result in poverty levels similar to those recorded 30 years ago, in 1990 (Sumner et al. 2020). Furthermore, evidence suggests that the negative effects of the pandemic on the economy will be more severe for emerging economies since data have shown that the recovery of advanced economies has been faster compared to middle- and low-income countries. (The World Bank 2022a).

Available data show how the COVID-19 pandemic has been different from previous pandemics, as they did not involve to such extent as many countries as this one. Considering also that the outbreak started in China, the world's leading manufacturer, disruptions in the supply of intermediate goods in different industries caused further disruptions in production and supply chains (Gopinath 2020). As the virus spread across the world, it heavily affected the world economy. The disruption of supply and demand, manufacturing activities, and exports in large economies also affected all nations. In addition, the manufacturing sector was disrupted in three ways: (i) direct supply disruptions which hindered production, (ii) supply chain contagion which amplified the supply shocks, and (iii) demand disruptions (Baldwin and Di Mauro 2020).

The economy was also affected by disruptions in the private sector. According to Ivanov (2020), 94% of Fortune 1000 companies reported supply chain disruptions at the beginning of the pandemic. These disruptions, although less severe, have been long-lasting and subject to a “ripple effect” propagation and simultaneously affecting supply, demand, and logistics infrastructure. The International Monetary Fund (IMF) suggests that supply disruptions cut approximately in 0.5–1% the global GDP growth in 2021, while adding 1% to core inflation (2022).

In terms of international trade, from the beginning of the pandemic in 2020 until 2022, many fluctuations have occurred, starting with a great decline of 9% of total global trade in the first half of 2020 and followed by a fast recovery in the second half of the same year (United Nations 2022). Even though many countries have eased the COVID-19-related restrictions, the long-lasting effects of these measures are impacting trade activities. The World Trade Organization (2022) still foresees a slower recovery in merchandise trade volume for 2022.

If banks and financial institutions this time did not appear to be at the heart of the crisis, they have been anyway involved in the process of sustaining other firms, which have been hugely affected both in terms of confidence and liquidity (Baldwin and Di Mauro 2020). Firms have to pay wages and debts, whereas families have to pay rents and mortgages: bankruptcies and insolvencies could finally lead to a financial catastrophe. That is why governments, such as the Italian one, intervened with drastic fiscal and welfare measures to alleviate the economic burden that lockdown measures cause, especially in favor of SMEs, which are the most exposed to liquidity issues.

Some studies have shown how small businesses are more financially fragile: larger firms entered the crisis with the capacity of covering expenses for up to 65 days, compared to 50 days for a microenterprise (The World Bank 2022a; Bartik et al. 2020). In addition, some sectors were more vulnerable creating a different expectation of survival depending on the sector: retail, accommodation, food services, arts, and entertainment were among the most vulnerable ones. It is clear, therefore, that this crisis is complex in various ways and that it is leaving a mark in micro- and macroeconomic terms. As Baldwin and Di Mauro pointed out, companies, individuals, and governments experienced disruptions that may eventually lead to deglobalization (2020). Companies are experiencing the risks that global supply chains involve; financial intermediaries and regulators will incorporate pandemic shocks into their future risk assessments and stress tests.

As exposed by a recent study, network interconnectedness, economic openness, and transport integration were key determinants in the early global temporal spread of the pandemic (Tsiotas and Tselios 2022). Hence, countries that are more integrated into the globalized economic structure—those with higher economic openness—were earlier exposed to the COVID-19 outbreak compared to those with lower economic openness.

An additional complexity experienced during the pandemic is the one related to energy sources. Traditional energy resources, such as fossil fuels, were hit hard: the crude oil market was the most affected one. Generally speaking, the collapse in economic activity and transport led to widespread declines in commodity prices, not only in the energy field but also in secondary sectors such as metal and food. This also puts uncertainty on the potential long-term repercussions on clean technologies: in 2009, new venture capital and private equity investments in clean energy companies were down 56% compared to 2008 (Foray et al. 2020). Some countries might even loosen environmental regulations to favor economic recovery (i.e., China). The recalled plunge in the price of a barrel of crude oil could also make renewable energies less profitable, therefore reducing financial incentives for investments.

Since the pandemic-induced crisis could be long-lasting, new economic solutions might have to be considered. The current economic model focused on a linear and globalized production scheme has been put under high stress, as mentioned above. Supply chain disruptions, slower economic recovery in developing regions, and zero-COVID policies in countries like China are evidence that some crises are still being faced by economic systems and that some risks persist.

As the OECD affirms, the spread of COVID-19 raised awareness of the consequences of a lack of resilience and preparedness to deal with pandemics; in the future, climate change, water pollution, deforestation, and illegal wildlife trade may increase the risk of further pandemics. The organization stresses the importance of continued investment in economic transformations and technological innovations, notwithstanding the need for swift economic recovery; the various stimulus packages which States are implementing could be a timely opportunity to favor a more sustainable and environmental-friendly economy—encouraging at the same time a resilient recovery.

Even when the challenges are significant, this crisis creates opportunities to accelerate a transition toward sustainability by implementing changes in current lifestyles, health systems, environmental conservation, and new economic policies to stimulate investments aligned with these objectives. Considering that economic policy is a matter of choice, the current crisis can be overtaken in many ways and with different long-term goals. On the other hand, as the trade-off between economic recovery and sustainable growth might not be aligned, there are risks that can be counterproductive. The European Council, on 26th March 2020, while addressing the response to COVID-19, stressed the need for coordinated action and integration of green transition and digital transformation in the EU recovery plan. As stated by Tjisse Stelpstra, "*the devastating situation created by COVID-19 must bring all policymakers together and be the wake-up call for a new economic model that places social wellbeing and environmental sustainability at the core of the EU's economic recovery*" (European Committee of the Regions 2020). Considering that the circular economy model is gaining momentum in the EU, also being supported by funds, policies, and an increase in related jobs, it can be one pivotal element for this recovery.

COVID-19 as a Sustainability Driver: An Analysis of Emerging Challenges

The debate on the origin of the SARS-CoV-2 is still inconclusive. Some studies state that the virus has a zoonotic origin (Morens et al. 2020), while other views suggest that the virus was engineered (Borsetti et al. 2021; Harrison and Sachs 2022). Although further investigation is needed to clearly understand the origin of the virus, some important lessons can be learned from how the pandemic evolved, how economic and social systems were affected by it, and from the responses to these impacts.

The extent to which humans have transformed and exploited natural resources creates greater risks for the emergence of more frequent and severe animal-to-human zoonosis which can eventually evolve into viral epidemics (United Nations Environment Programme 2020). This risk estimation is based on the fact that more than 70% of infectious diseases that emerged in humans since the 1940s can be traced back to animals, above all wildlife, including SARS and associated coronavirus (Food and Agricultural Organization 2017, 2018; Jones et al. 2008).

One of the catalysts for the emergence of new epidemics is the current food system. On the one hand, current food systems are based on a large-scale production scheme, representing a threat of spillover infections since intensive livestock production amplifies the risk of diseases because large numbers of animals are confined in small spaces, with narrowing genetic diversity and fast animal turnover. On the other hand, habitat destruction, unchecked urbanization, and land grabbing lead to amplified human–wildlife interaction, which eventually causes zoonotic spillover (International Panel of Experts on Sustainable Food Systems 2020). Hence, the COVID-19 pandemic can help to redefine the relationship between humans and wildlife.

Another factor that aggravates the negative effects of COVID-19 and that simultaneously represents a threat to sustainability is urbanization. Thirty-five years ago, more than 60% of the world's population lived in rural areas: it has now dropped to 46%, while the urban population is set to grow up to 68% by 2050 (Food and Agricultural Organization 2017). Cities are already consuming 75% of the world's natural resources (Ellen McArthur Foundation 2017) and 78% of the energy supply (United Nations 2021). Concerning resource demand, some studies have shown how urbanization also impacts food consumption patterns since it increases the demand for processed and animal source foods (Food and Agricultural Organization 2017). As an example, China, the alleged epicenter of this disease, has one of the highest urbanization rates in the world, having doubled its level in the last 40 years, from 22.7% to 54.4% (Wu et al. 2017). This process is strictly linked to rising animal protein consumption (due to higher wages), increased land conversion and livestock production, a higher zoonotic risk (due to closer contact with wild animals), and finally a rapid spread of pathogens through the globalized channels of the world economy.

COVID-19 has also highlighted the negative effects that urbanization represents in terms of health. Cities are frequently places with high levels of pollution. They are responsible for 60–80% of greenhouse gas emissions. Pollution levels have been proven to cause several health issues such as lung and heart damage, which are responsible for seven million early deaths every year; additionally, city inhabitants with pre-existent respiratory conditions became more vulnerable to COVID-19 (Avetisyan 2020). So far, several studies have investigated the relationship between the spread and severity of COVID-19 and air pollution. Although research on this matter is still inconclusive, several studies (Piscitelli et al. 2022; Becchetti et al. 2022) have observed an association between air quality and COVID-19.

The link between pollution and COVID-19 contagion might simply rest in high urbanization and industrialization, where air quality is poorer and everyday human contact is frequent. According to the Italian Superior Health Institute (Settimo et al. 2020), the complexity of the phenomenon, together with inconclusive knowledge of certain factors that have played a role in the transmission and spread of SARS-CoV-2 infection, makes it difficult to establish a direct association between high levels of air pollution and COVID-19 outbreak or its amplifying role in the infection. Nonetheless, some researchers sustain that particulate matter can act as carriers of chemical and biological contaminants, such as viruses. Moreover, particulate matter (PM) could also work as a substratum that keeps the virus in the air for a longer time and as a booster of contagion (Setti et al. 2020). It has been suggested that there is an association between PM and virus spread: pre-existing levels of PM10, PM2.5, and NO2 are positively correlated with COVID-19 contagion and mortality (Becchetti et al. 2022; De Angelis et al. 2021). Finally, other studies observed that chronic exposure to air pollution is associated with COVID-19 morbidity and mortality (Barnett-Itzhaki and Levi 2021).

One more aspect that the COVID-19 pandemic has revealed issues in our current ways of living and our relationship with nature is consumption. The pandemic caused unprecedented changes in consumption habits. It was evident that individual actions can jeopardize the system stability and this was the case for basic goods consumption. As for the immediate reaction to the crisis, when people knew about forced lockdown measures, they rushed to groceries stores to fill their home shelves. In a report dated March 2020, the Institute of Services for the Agri-Food Market (2020) showed that panic buying was the first instinctive reaction. Worldwide supermarket shelves were emptied of key food and nonfood items, such as pasta, rice, canned goods, flour, frozen foods, bottled water, hand sanitizers, hand soap, and toilet paper (Hobbs 2020).

Cities are already responsible for 50% of global waste production (Ellen McArthur Foundation 2017) and even when in 2020 plastic use for large-scale plastics-using sectors—e.g., vehicles, trade, and construction—declined due to the slowdown in economic activities, the production of plastic waste rose significantly in other sectors such as healthcare and packaging (Filho et al. 2021; Organisation for Economic Co-operation and Development 2022a). Changes in habits, such as lockdowns, increased online shopping, and delivery services, increased the plastic waste generation in households (Filho et al. 2021). COVID-19 increased healthcare waste volume in facilities up to 10 times; the volume of waste generated is estimated to be around 87,000 tons only for personal protective equipment (World Health Organization 2022). At the same time, the pandemic caused important disruptions in plastics recycling due to difficulties in separate collection processes, the shift toward single-use plastics, and the low competitiveness of recycled plastics associated with low prices of primary raw materials (Organisation for Economic Co-operation and Development 2022a). Altogether, these factors have exacerbated the already existing pressure on the environment derived from plastic waste pollution.

In the longer run, global consumers might change their habits in two main senses. The first one is the rapid growth of online delivery: while many big companies had already implemented this service, their systems struggled to cope with the sudden expansion in online orders, leaving long time lags before delivery slots were available (Hobbs 2020). From a second stance, local supply chains might also have known a revived interest by consumers. For instance, interest in local consumption is an already established trend as people perceive economic, social, environmental, and health benefits to the higher resilience of local supply chains. Some cities have already developed strategies to promote new businesses to encourage local SMEs during the economic recovery. However, long-lasting effects are still unknown since many goods rely on global supply chains and localized chains, such as food, are still less cost-efficient than globalized ones (Hobbs 2020).

Only time will tell if the many changes induced by this crisis will be long-lasting or not: surely, it exposed the need for a systemic change, putting health at the center of society. Some speak about "Health in All Policies," meaning that besides sustaining the healthcare itself, States should think about promoting health in every aspect of people's life (Mundo et al. 2019). Moreover, policymakers and businesses should reconsider at least some of the foundations of the economic system—putting sustainability at the core of the new economic development model and therefore rethinking global value chains (Rethinking Value Chains Collective 2016) toward a model where workers, small farmers, and communities have access to the social, economic, and environmental resources they require for a decent standard of living while preserving and regenerating natural ecosystems.

Striving for Solutions: An Agenda Toward Circular Bioeconomy in the Post-COVID-19 Era

As discussed in previous sections, the negative effects derived from the still ongoing COVID-19 pandemic have been intensified by our current globalized system, causing alterations in both production and consumption activities, leading to relevant issues such as financial shocks, environmental burdens, and increased levels of inequality and poverty. Hence, from this experience, there are several points to remark to use the COVID-19 pandemic as a turning point to set a path toward sustainability. The need to react to the COVID-19 crisis is a unique catalyst to transition to a more sustainable economy, where wellbeing and Pareto optimality are reconsidered through new lenses. Putting forward a new economic model requires transformative policies, purposeful innovation, access to finance, risk-taking capacity, and new and sustainable business models and markets. But above all, we need to address the past failure of our economy to value nature, because our health and wellbeing fundamentally depend on it (McGlade et al. 2020).

The turning point is necessarily a rethinking of the ruling linear economic model, the so-called "take-make-dispose" system—where resources and product value are not optimized—to a more sustainable one. The problem with this linear economic model is that it causes an irreversible autocatalytic process, where an increase in consumer demand causes an increase in industrial production which results in reduced costs and therefore a lower perceived value of products by consumers (Clark 2017). Once the value of a product is lowered, its usefulness is short-lived, and the desire to dispose of it greatly increases, leading to the widely adopted replacement before redundancy. Therefore, with this model, sustainability can never be achieved, since traditional, fossil-based resources are becoming ever more scarce and expensive, especially as most of the readily accessible fossil-based resources have already been extracted, leading to the need for much more energy-intensive and expensive processes to obtain them. In addition, the disposal of huge volumes of goods has led to a large accumulation of waste in landfill sites and uncontrolled release into the environment, with the worryingly vast quantities of plastics accumulated in the seas and oceans being a prime example of this (Attard et al. 2020).

Pursuing a recovery from COVID-19 based on a circular bioeconomy is possible since it represents a framework to rethink and reform our relationship with the land, food, health, living spaces, and industrial systems to achieve sustainable wellbeing in harmony with nature. After the crisis, we are more aware of the fragility of natural and economic systems. For this reason, the implementation of new ways of development based in more shock-resistant communities needs to be supported by new paradigms such as the circular bioeconomy. All these changes require shared responsibility from governments, financial aid, and the creation of new opportunities for recovery.

With this aim, the *NextGenerationEU* recovery program, released in 2021, aims to support the recovery from the coronavirus crisis to create "a post-COVID-19 EU that is greener, more digital, more resilient and better fit for the current and forthcoming challenges" (European Commission 2021). The program aims to tackle important issues to support the green transition, foster investments, strengthen human capital, advance digital transition, and support an open strategic autonomy. This ambitious agenda requires the cooperation and interaction of multiple stakeholders to reach a sustainable recovery from the COVID-19 pandemic.

The European Union had already laid out strategic plans to implement a circular economy that can continue to help the COVID-19 recovery process. The EU Commission focuses on three phases—production, consumption, and waste—of a product's life. A better design can make products more durable or easier to repair, away from the usual linear pattern of "take-make-use-dispose" which discourages circularity. Indeed, 80% of products' environmental impacts are determined at the design phase (European Commission 2022a). COVID-19 is an example of how unintended waste generation can be dangerous. With the pandemic, there has been a rise in the demand for medical protective equipment, much of this made of plastic. An opportunity for reducing consumption and waste generation of this type of waste can emerge by following the abovementioned principles. Some studies have already indicated the environmental benefits of adopting ecodesign principles for the reduction of environmental impact in this field (Morone et al. 2022) particularly in the masks' use and disposal.

The EU has enacted the "Ecodesign Directive" to enhance sustainability principles such as improving durability, increasing recycled content in products, enabling remanufacturing and high-quality recycling, and incentivizing product-as-a-service or other models where producers keep the ownership of the product or the responsibility for its performance throughout its lifecycles (European Commission 2022b). In addition, the Commission highlights that even when smartly designed, products could lead to the inefficient use of resources and waste generation during their processing. For this reason, it promotes best practices in various industrial sectors through BREFs (Best Available Technique Reference Documents) and by promoting innovative industrial processes.

A first step would be overcoming fossil fuels as the primary resource of our economy and substituting them with biomass: a "bio-based" economy where materials, chemicals, and energy are derived from renewable biological resources (McCormick and Kautto 2013). The linear model involves extracting raw materials from nature, producing the desired products, and disposing of them. Waste generated during the production stage is also treated and discharged to nature. The circular economy involves using this waste for producing energy or raw materials for other products. It also includes the recovery of valuable components from discarded products as well as the regeneration of resources in the case of biomass (Moula et al. 2017).

The second step, consumption, is equally relevant, considering how it can affect businesses' marketing choices. At the same time, consumers' choices are based on the information they can access, the range and prices of existing products, and the regulatory framework. For this reason, the Commission is trying to improve the reliability of "green labels," starting from the EU Ecolabel. In a way, it also intends to "extend" the consumption of products, through reuse and repair thanks to legal guarantees and the compulsory availability of spare parts and repair information as opposed to planned obsolescence. Moreover, the Commission sustains innovative forms of consumption, such as sharing products or infrastructure, consuming services rather than products, and using IT and digital platforms. It also stresses the relevance of public procurement spending (20% of EU GDP), with the promotion of "Green Public Procurement" (GPP), where sustainable criteria are created at the EU level and then applied by national authorities.

Thirdly, waste management plays a crucial role in determining whether (and to what extent) resources are reused or instead are left out of the system. According to the Commission, only around 40% of the waste produced by EU households is recycled (with spikes from 80% to 5% depending on the area). Fields of action include increased recycling targets for packaging materials, raised levels of high-quality recycling, improved calculation of recycling rates, and administrative capacity. The EU is now restricting funds for landfills and incinerators while fighting the illegal transport of waste. When waste cannot be prevented or recycled, recovering its energy content is deemed as the best option.

In addition, the Commission aims at creating a market for secondary raw materials, which might be traded and shipped as any other good; nonetheless, uncertainty on their quality can hinder the market suitability. Recycled nutrients are seen as key secondary raw materials, as they can be returned to soils as fertilizers, reducing the need for mineral-based ones; however, a more comprehensive regulation is needed to ensure uniform quality standards. The Commission Action Plan also focuses on bio-based materials, which can be used for a wide array of products and energy uses such as biofuels. Indeed, the depletion of fossil fuels and the global environmental awareness push towards renewable bioresources and agro-industrial wastes for the production of alternative fuels in a sustainable manner.

Biomass sources are involved in numerous sectors and can provide different products and energy. Sectors of biomass include agriculture, livestock, forestry, pulp and paper, textile, and aquaculture. From the circular economy viewpoint, all these sectors generate waste and by-products useful as raw material for chemical or energy production in another sector, thus being interconnected (Organisation for Economic Co-operation and Development 2009). Circular economy might play a role in the sense that biomass conversion processes can utilize waste and by-products from plants and biomass activities as well as the recycled used products and wastes, thus reducing the environmental impacts of all the involved sectors from harvesting to product end life.

Additionally, within a circular economy model, biorefineries are the key to turning negative-valued waste into a potential renewable feedstock and are thus seen as a powerful alternative to replace petroleum-based refineries. Opposite to traditional refineries, biorefineries see a great opportunity in using biomass of non-edible feedstock or biogenic waste as raw materials to produce biofuels (Venkata Mohan et al. 2016). According to the EU Commission, biorefineries should adopt a cascading approach to the use of their inputs, favoring the highest value-added and resource-efficient products, such as bio-based products and industrial materials, over bioenergy. The principle of cascading use is based on single or multiple materials uses followed by energy use through burning at the end of life of the material, including taking into account the greenhouse gas emissions (GHG) mitigation potential. By-products and wastes from one production process are used to feed into other production processes or for energy. Biorefineries can thus contribute to the principles of a “zero-waste society” (European Commission 2012).

This way, an all-round “circular bioeconomy” could be implemented, overlapping a mere “circular economy” with a “bioeconomy” model: circular economy, indeed, is focused on strengthening resource efficiency and using recycled materials to reduce fossil carbon overuse; bioeconomy aims at substituting fossil carbon with renewable carbon from biomass agriculture, forestry, and marine environment (Carus and Dammer 2018). This is the core of the EU 2018 sustainable Bioeconomy

Strategy, which "*needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernization of our primary production systems, the protection of the environment and will enhance biodiversity*" (European Commission 2018, p. 4).

Circular economy is not complete without the bioeconomy and vice versa. The huge volumes of organic side and waste streams from agriculture, forestry, fishery, food, and organic process waste can only be integrated into the circular economy through bioeconomy processes, while the bioeconomy will hugely profit from increased circularity. New knowledge-based processes (such as biotechnology, algae, or insects for food and feed), new applications, and new links between bioeconomy and other industrial sectors are needed (Carus and Dammer 2018).

The bioeconomy can contribute in several ways to the circular economy, including the utilization of organic side and waste streams from agriculture, forestry, fishery, food, and organic process waste. Also, biodegradable products can be returned to the organic and nutrient circle. And paper, other wood products, natural fibers textiles, and many more materials can be successfully cascaded. Furthermore, innovative additives from oleo-chemicals can help enhance the recyclability of other materials. Once a certain threshold volume of new bio-based polymers is reached, the collection and recycling of bioplastics will become economically attractive (Carus 2017).

In this sense, the bio-based sector is key for the use of renewable biological resources and processes to substitute fossil-based products. Bio-based products go far beyond biomass processing. They capitalize on the unprecedented advances in life sciences and biotechnology (including microbiology, microbiomes, and enzyme technologies) that, coupled with the digital revolution, allow us to use nature's biological assets, its biochemicals and biomaterials, and its biomimetic assets (its functions and processes) to generate significant new sources of economic value and future revenue (Hetemäki et al. 2017).

The bio-based sector has seen huge advances in recent years. The interest in the transition from fossil to bio-based products has revitalized traditional sectors by bringing opportunities to diversify their products. Innovation capitalizes on the skills of making use of various biomass for bio-based production in traditional sectors such as pulp, woodworking, textiles, and wood-based construction. The pulp, paper, and board developed new cellulose-based applications that can replace fossil-based textiles and plastics and boost the use of nanofibril applications in bio-based adhesives, laminates, 3D printing and flexible electronics, and corrugated cardboard for the large-scale packaging business for Internet products. The revitalization of pulp, paper, and board has also brought solutions for the better utilization of their side streams for biofuel production and is also now seen increasingly in markets including fine and commodity chemicals, health care, automotive, consumer goods, construction, etc. Some low-tech products, such as composites, packaging materials, etc., have lower added value but also lower cost and risk; hence they are interesting for their large potential for replication in a diversity of regions and contexts (European Commission 2018). Therefore, advances in bio-based innovation enhance the circularity of the bio-based sector and the whole bioeconomy by enabling the processing of current side streams, residues, and wastes into products.

The technologies also enable biowaste and residues from farms and forest-based sectors, from cities, or from the food sector to be transformed into bio-based products such as chemicals, organic fertilizers, biofuels, and also heat and power, if a more circular use is not possible. The food-processing industries, for instance, are exploring the potential of converting residues into bio-based products such as chemicals and biofuels (Pagotto and Halog 2016; Stegmann et al. 2020) As Sillanpää and Ncibi (2017) highlight, when promoting biofuels, one should bear in mind that a balance with the food industry and world's food needs has to be found. The authors suggest that *"we could cultivate food crops for energy in marginal land and with marginal waters reclaimed from industrial or municipal wastewaters. The ethical issue is limited to the scenario where nonfood crop, with high energy output, are cultivated in arable lands and irrigated with fresh waters. Nowadays, with the threatening climate change impacts on agriculture, the serious shortages of water in many countries, and the recurring starvations and undernourishments in many others, it would be common sense (not to say humane) to prioritize feeding the population"* (p. 80).

New and more efficient ways of biomass processing are key for recovering complex molecules from biomass (e.g., polymers such as cellulose, hemicellulose, and lignin derivatives), for new product value chains, and to avoid the loss of value resulting from breaking complex biomolecules down. Greater value can also be obtained from unavoidable biological wastes and residues through the efficient collection and conversion technologies and systems, as well as through the development of upcycling technologies for them (Attard et al. 2020).

The development and deployment of biorefineries will depend heavily on the profit margins of bio-based products and the successful development and commercialization of new technologies, the availability of local and regional feedstock at competitive prices, suitable infrastructure and logistics, skilled personal, private, and public support services, and financing and permitting and fostered by a supportive policy and regulatory enabling environment (European Commission 2018; Yamakawa et al. 2018). Furthermore, a biorefinery requires a uniform, year-round, cost-efficient, and reliable supply of desired quality biomass feedstocks. The transport, storage, and handling of biomass require careful assessment to minimize investment risk associated with a biorefinery project. There are numerous sources of variability in the biomass supply chain such as weather uncertainty; seasonal seasonality, physical and chemical characteristics, geographical distribution, and low bulk density of biomass feedstocks; structure of biomass suppliers and their willingness to grow biomass crops; local transportation and distribution infrastructure; and supplier contracts and government policies (Sharma et al. 2013; Huang et al. 2010). To address these challenges, companies have to embrace resiliency and responsibility in supply chain management. The pandemic risk is just the last factor that drives the need for sustainable and resilient supply chains, as part of a broader bioeconomy.

Most supply chains are still linear in structure, with increased globalization of business operations meaning that product components are sourced worldwide. As observed during the critical period of the COVID-19 pandemic, global supply chains became fragile and affected a wide range of economic sectors. While closing the loop across global supply chains is still in its early stages and when implemented will involve high-value products, it seems that it is within regional and local loops that the majority of opportunities for the development of “circular supply chains” lie, because of the reduced geographic barriers. This is not surprising considering that circular economy takes its inspiration from the functioning of living systems where cyclical patterns are not only closed and thus waste is turned into food, but they are also local and decentralized (Nielsen and Müller 2009).

In addition, regional and local circular supply chains would be in line with the developing concept of redistributed manufacturing, which consists of reshoring large-scale manufacturing sites to more local, smaller ones. Redistributed manufacturing is crucial for creating a more sustainable manufacturing industry and is intertwined with the CE, with one city-based project analyzing the impact of localized and small-scale manufacturing plants on UK city resilience (Freeman et al. 2016). Circular supply chains expand the range of environmental and economic value that is created beyond those attainable within so-called closed-loop supply chains. Value creation stems from flowing materials across different supply chains. For instance, textiles can be designed without the use of chemical substances and when reuse is no longer possible, natural fibers can be used as secondary raw material serving insulation and filling purposes eventually returning to nature at the end of their useful life. Cascading materials across different supply chains creates additional revenue streams via selling secondary raw materials that can be used for the manufacturing of a different product and thus expanding further downstream a company’s supply chain (Christopher and Peck 2004; Antikainen and Valkokari 2016).

Circular supply chains also require a conceptual shift from products and ownership to access to services. These supply chains are not only closed-loop but also open concerning the opportunity for materials to flow across different supply chains, and within technical and biological cycles. New product development processes therefore should involve suppliers as part of early supplier involvement, looking at new ways to extend product life through additional services and finding different uses for products as they reach the end of the cascade. In the end, the way products and supply chains are designed will reduce the demand for recycling, although a prolonged period of transition involving the accommodation of traditional waste-based thinking is reasonably expected before the full benefits of circular systems can be effective.

Policy Agenda and Final Remarks

The need for a shift in the current world economy, as seen above, is ever more urgent. The COVID-19 crisis might boost the efforts in shifting towards a sustainable economic model aligned with the 2030 Sustainable Development Goals. Hence, circular bioeconomy becomes a good strategy to overcome the challenges that the COVID-19 pandemic has posed in economic, ecological, and societal structures. However, these strategies should not take sustainability as a given, but rather address it explicitly. There have already been concerns about possible side effects of the bioeconomy. Some researchers and NGOs have questioned its environmental sustainability, and have voiced concerns that it could lead to the exploitation of EU forests at the cost of biodiversity or that bioenergy may in the short-term cause more CO2 emissions (European Academies Science Advisory Council 2017).

These views are important to consider, especially given sustainability problems experienced in the past. Science also has mixed views on these issues, and the impacts also depend very much on how bioeconomy development will be advanced and monitored. The objective should be to maximize the synergies and minimize the trade-offs between bioeconomy, biodiversity, and climate mitigation. A circular bioeconomy can help to support biodiversity and climate mitigation, and biodiversity and climate mitigation are necessary for a successful circular bioeconomy.

Research, development, and innovation have to strengthen the foundations of a circular bioeconomy, a goal that requires policymakers' intervention and long-term planning. In what follows we propose a three-bullet-point policy agenda and a final remark on its implementation.

First, funding needs to increase all along the innovation network (basic research, applied research, education, and piloting of new products and services). Green finance investments can have a pivotal role in creating the necessary ecosystem for a shift in the economic development model. The policies include two aspects: the reform and innovation of existing financial tools, an exploration of the type of fiscal policy and the feasible way to raise money for green finance development, and the reform of existing fiscal revenue management and distribution policy, namely the efficiency and direction in the use of fiscal funds (Wang and Zhi 2016; Owen et al. 2018).

Second, policymakers should be reviewing their subsidizing policies, converting environmentally harmful subsidies (EHSs) into environmentally friendly subsidies (EFSs): often incentives, exemptions, and benefits can be counterproductive or unbalanced. A study by the Italian Senate of the Republic reported in 2018 that 16.2 billion Euros were spent on EHSs, while only 15.7 on EFSs.

Third, product eco-labeling should be continuously addressed and updated by policymakers, as consumers' role in the shift towards sustainability is indispensable in both the short and the long run. In recent years, interest in environmental issues has increased, along with the idea that consumer choices can improve the performance of the production system as a whole (Iraldo et al. 2020). Policy and regulatory efforts should reinforce the perception of eco-labels as a signal of quality and value worth paying for, as well as ensure that eco-labeled products are indeed eco-friendly.

Indeed, policymakers and researchers should work closely to improve and enhance sustainability measurement and measurability. To elaborate effective policies, a feasible and reliable quantification of eco-friendliness and sustainability is pivotal. All along supply chains, data on environmental impact should be carefully collected and processed, giving policymakers an affordable picture of their decisions' benefits and inconveniences, and researchers better guidelines for future studies. These are the main fields of action in which policymakers, and all stakeholders in the economic system and society, should be engaged and actively committed to building a world run by sustainable principles and a bio-based circular economy.

References

Antikainen M, Valkokari K (2016) A Framework for Sustainable Circular Business Model Innovation. Technology Innovation Management Review 6 (7):5–12

Attard TM, Clark JH, McElroy CR (2020) Recent developments in key biorefinery areas. Current Opinion in Green and Sustainable Chemistry 21:64–74. doi:https://doi.org/10.1016/j.cogsc.2019.12.002

Avetisyan S (2020) Coronavirus and Urbanisation: Do Pandemics Are Anti-Urban? Available at SSRN 3584395

Baldwin R, Di Mauro BW (eds) (2020) Economics in the Time of COVID-19. CEPR Press, London

Barnett-Itzhaki Z, Levi A (2021) Effects of chronic exposure to ambient air pollutants on COVID-19 morbidity and mortality – A lesson from OECD countries. Environmental Research 195:110723. doi:https://doi.org/10.1016/j.envres.2021.110723

Bartik AW, Bertrand M, Cullen ZB, Glaeser EL, Michael Luca, Stanton CT (2020) How Are Small Businesses Adjusting to COVID-19? Early Evidence from a Survey. National Bureau of Economic Research (26989). doi:https://doi.org/10.3386/w26989

Becchetti L, Conzo G, Conzo P, Salustri F (2022) Understanding the heterogeneity of COVID-19 deaths and contagions: The role of air pollution and lockdown decisions. Journal of Environmental Management 305:114316. doi:https://doi.org/10.1016/j.jenvman.2021.114316

Borsetti A, Scarpa F, Maruotti A, Divino F, Ceccarelli G, Giovanetti M, Ciccozzi M (2021) The unresolved question on COVID-19 virus origin: The three cards game? Journal of Medical Virology 94:1257–1260. doi:https://doi.org/10.1002/jmv.27519

Carus M (2017) The bioeconomy is much more than a circular economy. BLICKWINKEL, vol 3.

Carus M, Dammer L (2018) The Circular Bioeconomy—Concepts, Opportunities, and Limitations. Industrial Biotechnology 14 (2):83–91. doi:https://doi.org/10.1089/ind.2018.29121.mca

Christopher M, Peck H (2004) Building the resilient supply chain. International Journal of Logistics Management 15 (2):1–13

Clark JH (2017) From waste to wealth using green chemistry: The way to long term stability. Current Opinion in Green and Sustainable Chemistry 8:10–13. doi:https://doi.org/10.1016/j.cogsc.2017.07.008

De Angelis E, Renzetti S, Volta M, Donato F, Calza S, Placidi D, Lucchini RG, Rota M (2021) COVID-19 incidence and mortality in Lombardy, Italy: An ecological study on the role of air pollution, meteorological factors, demographic and socioeconomic variables. Environmental Research 195:110777. doi:https://doi.org/10.1016/j.envres.2021.110777

Ellen McArthur Foundation (2017) Cities in the Circular Economy: An Initial Exploration.
European Academies Science Advisory Council (2017) Multi-functionality and sustainability in the European Union's forests.
European Commission (2012) Innovating for Sustainable Growth: A Bioeconomy for Europe. European Commission,
European Commission (2018) A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment: updated bioeconomy strategy. European Commission, Directorate-General for Research Innovation. DOI:https://doi.org/10.2777/792130
European Commission (2021) The EU's 2021–2027 long-term budget and NextGenerationEU: facts and figures. Publications Office of the European Union. DOI:https://doi.org/10.2761/808559
European Commission (2022a) Sustainable Product Policy. https://joint-research-centre.ec.europa.eu/scientific-activities-z/sustainable-product-policy_en. Accessed 10.08.2022
European Commission (2022b) Sustainable product policy & ecodesign. https://single-market-economy.ec.europa.eu/industry/sustainability/sustainable-product-policy-ecodesign_en. Accessed 10.09.2022
European Committee of the Regions (2020) New Circular Economy Action Plan: stakeholder's consultation now open. Helping the environment and the COVID-19 economic recovery
Filho WL, Salvia AL, Minhas A, Paço A, Dias-Ferreira C (2021) The COVID-19 pandemic and single-use plastic waste in households: A preliminary study. Science of the Total Environment 793
Food and Agricultural Organization (2017) The Future of food and agriculture: Trends and challenges. Rome
Food and Agricultural Organization (2018) World Livestock: Transforming the livestock sector through the Sustainable Development Goals. Rome
Foray D, Rassenfosse GD, Younes GA, Ayoubi C, Ballester O, Cristelli G, Heuvel MVD, Zhou L, Pellegrino G, Gaule P, Webster E (2020) COVID-19: Insights from Innovation Economists.
Freeman R, McMahon C, Godfrey P Design of an Integrated Assessment of Re-distributed Manufacturing for the Sustainable, Resilient City. In: Setchi R, Howlett RJ, Liu Y, Theobald P (eds) Sustainable Design and Manufacturing 2016, Cham, 2016. Springer International Publishing, pp. 601–612
Gopinath G (2020) Limiting the economic fallout of the coronavirus with large targeted policies. In: Baldwin R, Mauro BWd (eds) Mitigating the COVID Economic Crisis: Act Fast and Do Whatever It Takes. CEPR Press, London,
Harrison NL, Sachs JD (2022) A call for an independent inquiry into the origin of the SARS-CoV-2 virus. Proceedings of the National Academy of Sciences 119. doi:https://doi.org/10.1073/pnas.220276911
Hetemäki L, Hanewinkel M, Muys B, Ollikainen M, Palahí M, Trasobare A (2017) Leading the way to a European circular bioeconomy strategy. European Forest Institute,
Hobbs JE (2020) Food supply chains during the COVID-19 pandemic. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie 68 (2):171–176. doi:https://doi.org/10.1111/cjag.12237
Huang Y, Chen C-W, Fan Y (2010) Multistage optimization of the supply chains of biofuels. Transportation Research Part E: Logistics and Transportation Review 46 (6):820–830. doi:https://doi.org/10.1016/j.tre.2010.03.002
International Labour Organization (2021) ILO Monitor: COVID-19 and the world of work. Seventh edition. Updated estimates and analysis. International Labour Organization,
International Monetary Fund (2021) Economic Outlook: Managing Divergent Recoveries. International Monetary Fund,
International Monetary Fund (2022) World Economic Outlook Update: Rising Caseloads, a Disrupted Recovery, and Higher Inflation. International Monetary Fund,
International Panel of Experts on Sustainable Food Systems (2020) COVID-19 and the crisis in food systems: Symptoms, causes, and potential solutions.

Iraldo F, Griesshammer R, Kahlenborn W (2020) The future of ecolabels. The International Journal of Life Cycle Assessment 25 (5):833–839. doi:https://doi.org/10.1007/s11367-020-01741-9
Istituto di Servizi per il Mercato Agricolo Alimentare (2020) Emergenza COVID-19: Rapporto sulla domanda e l'offerta dei prodotti alimentari nelle prime settimane di diffusione del virus.
Italian Senate of the Republic (2018) Does the polluter profit? EHSs and EFSs: bonuses that save the environment and subsidies that foster pollution. Italian Senate of the Republic: Impact Assessment Office,
Ivanov D (2020) Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. Transportation Research Part E: Logistics and Transportation Review 136:101922. doi:https://doi.org/10.1016/j.tre.2020.101922
Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, Daszak P (2008) Global trends in emerging infectious diseases. Nature 451 (7181):990–993. doi:https://doi.org/10.1038/nature06536
McCormick K, Kautto N (2013) The Bioeconomy in Europe: An Overview. Sustainability 5 (6):2589–2608. doi:https://doi.org/10.3390/su5062589
McGlade JPM; Costanza, R; Kubiszewski, I; Trebeck, K; Fiaromonti, L; Lovins, H; Wallis, S; Pickett, K; Wilkinson, R (2020) Investing in Nature to Transform the Post COVID-19 Economy: A 10-point Action Plan to create a circular bioeconomy devoted to sustainable wellbeing The Solutions Journal 11 (2)
Morens DM, Breman JG, Calisher CH, Doherty PC, Hahn BH, Keusch GT, Kramer LD, LeDuc JW, Monath TP, Taubenberger JK (2020) The Origin of COVID-19 and Why It Matters. The American journal of tropical medicine and hygiene 103:955–959
Morone P, Yilan G, Imbert E, Becchetti L (2022) Reconciling human health with the environment while struggling against the COVID-19 pandemic through improved face mask eco-design. Scientific Reports 12 (1):2445. doi:https://doi.org/10.1038/s41598-022-06536-6
Moula ME, Sorvari J, Oinas P (eds) (2017) Constructing A Green Circular Society. Unigrafia Oy, Helsinki
Mundo W, Manetta P, Fort MP, Sauaia A (2019) A Qualitative Study of Health in All Policies at the Local Level. INQUIRY: The Journal of Health Care Organization, Provision, and Financing 56:0046958019874153. doi:https://doi.org/10.1177/0046958019874153
Nielsen SN, Müller F (2009) Understanding the functional principles of nature—Proposing another type of ecosystem services. Ecological Modelling 220 (16):1913–1925. doi:https://doi.org/10.1016/j.ecolmodel.2009.04.022
Organisation for Economic Co-operation and Development (2009) The Bioeconomy to 2030: Designing a Policy Agenda
Organisation for Economic Co-operation and Development (2022a) Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options. Paris. doi:https://doi.org/10.1787/de747aef-en
Organisation for Economic Co-operation and Development (2022b) OECD Economic Outlook. OECD,
Owen R, Brennan G, Lyon F (2018) Enabling investment for the transition to a low carbon economy: government policy to finance early stage green innovation. Current Opinion in Environmental Sustainability 31:137–145. doi:https://doi.org/10.1016/j.cosust.2018.03.004
Pagotto M, Halog A (2016) Towards a Circular Economy in Australian Agri-food Industry: An Application of Input-Output Oriented Approaches for Analyzing Resource Efficiency and Competitiveness Potential. Journal of Industrial Ecology 20 (5):1176–1186. doi:https://doi.org/10.1111/jiec.12373
Piscitelli P, Miani A, Setti L, Gennaro GD, Rodo X, Artinano B, Vara E, Rancan L, Arias J, Passarini F, Barbieri P, Pallavicini A, Parente A, D'Oro EC, Maio CD, Saladino F, Borelli M, Colicino E, Gonçalves LMG, Tanna GD, Colao A, Leonardi GS, Baccarelli A, Dominici F, Ioannidis JPA, Domingo JL (2022) The role of outdoor and indoor air quality in the spread of SARS-CoV-2: Overview and recommendations by the research group on COVID-19 and particulate matter (RESCOP commission). Environmental Research 211

Rethinking Value Chains Collective (2016) Manifesto. https://www.rethinkingvaluechains.com/wp-content/uploads/2020/10/ENG-RVC-Manifesto-.pdf. Accessed 10.09.2022

Sánchez-Páramo C, Hill R, Mahler DG, Narayan A, Yonzan N (2021) COVID-19 leaves a legacy of rising poverty and widening inequality. vol 2022. The World Bank,

Setti L, Passarini F, Gennaro Gd, Gilio AD, Palmisani J, Buono P, Fornari G, Perrone MG, Piazzalunga A, Barbieri P, Rizzo E, Miani A (2020) Relazione circa l'effetto dell'inquinamento da particolato atmosferico e la diffusione di virus nella popolazione. SIMA, University of Bologna, University of Bari,

Settimo G, Soggiu ME, Masocco M, Spinelli A (2020) Inquinamento atmosferico e diffusione del virus SARS-CoV-2. EpiCentro

Sharma B, Ingalls RG, Jones CL, Khanchi A (2013) Biomass supply chain design and analysis: Basis, overview, modeling, challenges, and future. Renewable and Sustainable Energy Reviews 24:608–627. doi:https://doi.org/10.1016/j.rser.2013.03.049

Sillanpää M, Ncibi C (2017) A Sustainable Bioeconomy: The Green Industrial Revolution. Springer,

Stegmann P, Londo M, Junginger M (2020) The circular bioeconomy: Its elements and role in European bioeconomy clusters. Resources, Conservation & Recycling: X 6:100029. doi:https://doi.org/10.1016/j.rcrx.2019.100029

Sumner A, Hoy C, Ortiz-Juarez E (2020) Estimates of the impact of COVID-19 on global poverty. (Working Paper #43)

The World Bank (2022a) Finance for an Equitable Recovery. The World Bank Group. doi:https://doi.org/10.1596/978-1-4648-1730-4

The World Bank (2022b) Global Economic Prospects. The World Bank,

Tsiotas D, Tselios V (2022) Understanding the uneven spread of COVID-19 in the context of the global interconnected economy. Scientific Reports 12 (1):1–15

United Nations (2021) Climate Action, Cities and Pollution. https://www.un.org/en/climatechange/climate-solutions/cities-pollution. Accessed 15.09.2022

United Nations (2022) Impact of the COVID-19 Pandemic on Trade and Development. United Nations,

United Nations Environment Programme UNHROotHC (2020) Human Rights, the Environment and COVID-19 – Key Messages: Human Rights at the Heart of Response.

Venkata Mohan S, Nikhil GN, Chiranjeevi P, Nagendranatha Reddy C, Rohit MV, Kumar AN, Sarkar O (2016) Waste biorefinery models towards sustainable circular bioeconomy: Critical review and future perspectives. Bioresource Technology 215:2–12. doi:https://doi.org/10.1016/j.biortech.2016.03.130

Wang Y, Zhi Q (2016) The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies. Energy Procedia 104:311–316. doi:https://doi.org/10.1016/j.egypro.2016.12.053

World Health Organization (2022) Tonnes of COVID-19 health care waste expose urgent need to improve waste management systems. World Health Organization. https://www.who.int/news/item/01-02-2022-tonnes-of-covid-19-health-care-waste-expose-urgent-need-to-improve-waste-management-systems. 15.09.2022

World Trade Organization (2022) Russia-Ukraine conflict puts fragile global trade recovery at risk. World Trade Organization, Geneva

Wu T, Perrings C, Kinzig A, Collins JP, Minteer BA, Daszak P (2017) Economic growth, urbanization, globalization, and the risks of emerging infectious diseases in China: A review. 46:18–29. doi:https://doi.org/10.1007/s13280-016-0809-2

Yamakawa CK, Qin F, Mussatto SI (2018) Advances and opportunities in biomass conversion technologies and biorefineries for the development of a bio-based economy. Biomass and Bioenergy 119:54–60

A (Perfect) Case of Unnecessary, and Harmful Fiscal Consolidation: Italy's Growth and Debt Since the 90s.

Giovanni Piersanti

Introduction

The issue of Italy's disappointing growth performance and soaring sovereign debt-to-GDP ratio (DGR) since the early 1990s has been debated extensively in the literature and shifted high on the policy agenda in the aftermath of the great financial crisis (GFC) of 2008–2009. The reason looks to be obvious in the face of the following data (see Table 1).

Table 1 is disquieting and is a precious source of support for the view of a potential phase of "secular stagnation" in Italy, similar to that of Japan if no radical and costly adjustments are enforced.

This view is visible in a popular and well-established narrative emphasizing the adverse combination of a number of structural weaknesses affecting the supply side—such as low competitive pressure, weak productivity growth, low labor and price flexibility, and inefficiency of public administration and civil justice—and

I wish to thank Paolo Canofari, Riccardo De Bonis, Audrey De Dominicis, Giovanni Di Bartolomeo, Marco Di Domizio, Alessandro Piergallini, Pasquale Scaramozzino, and participants at the 60th Annual Scientific Conference of the Italian Economic Association (IEA), University of Palermo, October 24–26, 2019 for valuable comments and suggestions on an earlier version titled "Low Growth and High Sovereign Debt in Italy: Facts, Causes, and Cures." The usual disclaimer applies.

G. Piersanti (✉)
Department of Communication Science, University of Teramo, Teramo, Italy
e-mail: gpiersanti@unite.it

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_8

Table 1 Main Advanced Economies, 1990–2019

Real GDP Growth Rates						
Years	IT	DE	FR	JP	UK	US
1991–2000	1.6	1.9	2.1	1.3	2.5	3.4
2001–2010	0.3	0.9	1.3	0.6	1.7	1.7
2011–2019	0.1	1.7	1.3	1.0	1.8	2.2
Public Debt-to-GDP Ratio						
1990	91.6	41.3	35.6	64.2	28.9	62.2
2000	109.0	59.1	58.9	137.9	36.8	53.2
2010	119.2	82.4	85.3	207.9	74.6	95.4
2019	134.8	59.8	98.1	236.5	85.4	111.1

Source: European Commission, AMECO database
IT = Italy; DE = Germany; FR = France; JP = Japan; UK = United Kingdom; US = United States

an oversized state player, held responsible for the high tax burden and the strong downward rigidity on the expenditure side.[1]

The policy implication to emerge from this literature is straightforward: structural reforms aimed to improve the supply side of the economy and downsize the public sector are crucial to cut back government spending and the fiscal burden, strengthen competition and productivity dynamics, and raise potential output.

The disappointing effectiveness of the wide-ranging reforms implemented since the end of the 1990s, and more intensely after 2011 in an attempt to boost economic growth in the wake of the European Sovereign Debt crisis, call into question the accuracy of the mainstream diagnosis and its policy strategy. In particular, two issues arise directly: (a) is the sluggish growth rate of the Italian economy basically driven by supply-side factors?; (b) is there too much debt?

Addressing the issues in (a) and (b) is the main contribution of this chapter. Building the econometric analysis on the relationships between changes in fiscal balance, capital accumulation, growth and debt, described in endogenous growth models, we show that the switch to a long-lasting contractionary stance of fiscal policy in the 1990s and 2000s to meet EU fiscal rules played a key role in determining the dismal growth performance of Italy. We also show that if properly measured, Italy's sovereign debt is highly sustainable and that the (unnecessary) austerity policies always impacted negatively on the growth rate and on the DGR.

The remainder of the chapter is structured as follows. Section "The Growth Slowdown" compares the growth performance of Italy vis-a-vis the main advanced economies since 1960 and calls attention to the growth-unfriendly fiscal policies adopted in the last three decades to meet EU policy rules. Section "Fiscal Policy and Growth" describes the econometric strategy for analyzing the links between budget

[1] See, e.g., Rossi and Toniolo (1996), European Commission (1999), European Commission (2014), Faini (2004), Toniolo and Visco (2004), Larch (2004), Faini and Sapir (2009), Bassanetti et al. (2014), Giordano et al. (2015), Pinelli et al. (2016), and Bugamelli et al. (2018).

Table 2 Main Advanced Economies

Real GDP Growth Rates						
Years	IT	DE	FR	JP	UK	US
1961–1970	6.4	4.4	5,7	10.1	3.1	4.3
1971–1980	3.4	2.9	3.6	4.4	2.1	3.2
1981–1990	2.2	2.3	2.5	4.6	2.9	3.3
1991–2000	1.6	1.9	2.1	1.3	2.4	3.4
2001–2010	0.3	0.9	1.3	0.6	1.6	1.7
2011–2019	0.1	1.7	1.3	1.0	1.8	2.2
2000–2007	1.5	1.4	2.1	1.5	2.8	2.7
2008–2019	–0.3	1.2	0.9	0.5	1.2	1.7

Source: European Commission, AMECO database

balance, capital accumulation, and growth in Italy over 1985–2019 and discusses the empirical results. Section "Fiscal Consolidation, Debt, and Growth" deals with the effects on the cumulative growth rate and the DGR dynamics of fiscal austerity measures implemented in Italy to meet the Maastricht thresholds. Section "The Issue of Sovereign Debt (Un)sustainability" deals with the critical issue of debt sustainability. Section "Conclusions" concludes.

The Growth Slowdown

Data in Table 2 provide instrumental information to start off with point (*a*). The table reports ten-year growth rate averages in the main advanced economies over 1960–2019 and splits the 2000s in the pre-crisis (2000–2007) and post-crisis (2008–2019) period. Two relevant features stand out from Table 2:

- Over the period 1960–2007, Italy's growth slowdown turns out to be commonplace when compared to that in the other advanced economies.
- The growth slowdown accelerates after 1990 and collapses in 2008–2019, which marks the phase of prolonged recession triggered by the GFC of 2008–2009 and developed in the double-dip downturn of 2011–2013.

The first point is outside the scope of this chapter being the subject of a growing number of studies warning of the possible return to a phase of secular stagnation for most developed countries in the next decades.[2] The second is our main concern and has been the subject of an extensive research on the alleged decline of the Italian economy and the policy tools key to escape the low-growth trap and raise the growth potential.[3]

[2] See, e.g., the papers gathered in Teulings and Baldwin (2014) and the overview in Pagano and Sbracia (2014).

[3] See, note 1.

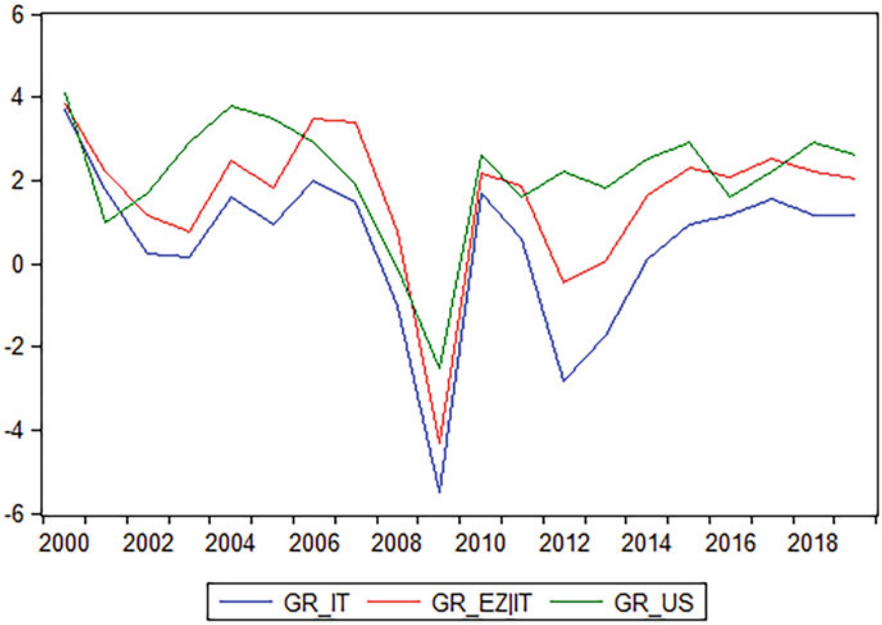

Fig. 1 Real GDP growth rates (%) in Italy, EZ|IT, and US, 2000–2019. (Source: European Commission, AMECO database)

To make a start, let us have a look at Figs. 1, 2, 3, and 4 that help to highlight the role of fiscal policy (FP) in the prolonged stagnation of the last three decades and to cast doubts on the deep-rooted view that structural reforms are crucial to raise potential output and growth perspectives. Focusing on Fig. 1, which compares the evolution of GDP growth rate in Italy with that in the Eurozone (EZ|IT ≡ EU19, excluding Italy) and the US since 2000, it is striking to observe that up to 2010 Italy's growth pattern was very similar to that experienced in the other two groups of countries.[4] In particular, Italy exited very quickly from the Great Recession by a mix of monetary and fiscal stimulus like the US and the Eurozone; thereafter, it enforced harsh austerity measures that led to a new recession (2012–2013) and a prolonged stagnation.[5] If Italy's poor growth performance is the result of structural weaknesses constraining the supply side, then it is hard to understand how Italy recovered so quickly from the GFC despite its structural rigidities and why suddenly from 2011 on these same rigidities acted so powerfully to yield a strong divergence in the growth rate relative to the other developed countries.

[4] Adding to the chart other countries, such as Japan or EU countries not belonging to the Eurozone, does not change the whole story. Therefore, they were not included only to avoid blurring the lines.

[5] Notice that contrary to the US, the other Eurozone countries also experienced the double-dip recession of 2012–2013, but Italy's downturn is deeper and longer.

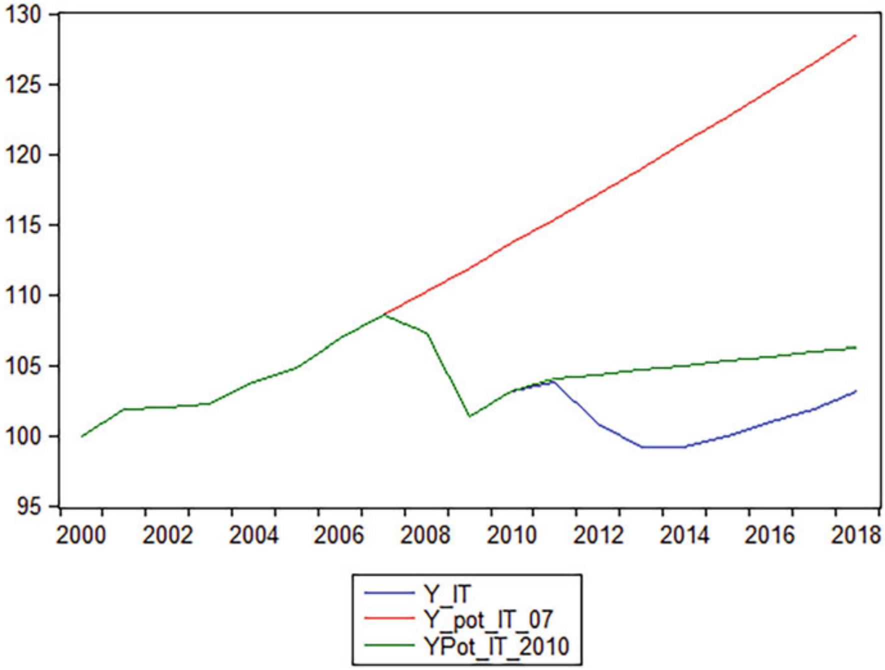

Fig. 2 Actual and potential GDP in Italy, 2000–2018. (Source: European Commission, AMECO database)

Figure 2 makes tangible the output costs of fiscal austerity measures. The figure depicts the gap between actual and potential output estimated as of 2007 and 2010 for Italy and reveals that the output is far short of where its potential was expected to be as of 2007 ($\simeq -18\%$, in 2014, and -19.7% in 2018). More troubling, however, is the observation that most of the gap represents a permanent loss as shown by the downward revision of potential output ($\simeq -13\%$, in 2014, and -16%, in 2018).[6] In numbers and as of 2014 (the turning upward point) and 2018, this means for Italy a total loss in output of €324 and €366 billion, respectively.[7]

[6] This is the so-called hysteresis effect supported by several empirical studies ran after GFC; see, e.g., European Commission (2009), Ball (2014), Blanchard et al. (2015), Reifschneider et al. (2015), Stiglitz (2016), Fatás and Summers (2018), Engler and Tervala (2018), Anzoategui et al. (2019), and Tervala (2021).

[7] Identical computations for the whole Euro Area (EU19) show a total loss of €1.76 (15.8%) and €2.05 (17.2%) trillion in 2014 and 2018, equal to the aggregate output of Italy, Greece, and Portugal or Spain, Ireland, Belgium, and Portugal. Losses of this magnitude swamp the damage done by even World War II and should be reported as the worst policy mistake of the last century. Similar estimates can be found, e.g., in IMF (2015), Stiglitz (2016), and Fatás and Summers (2018).

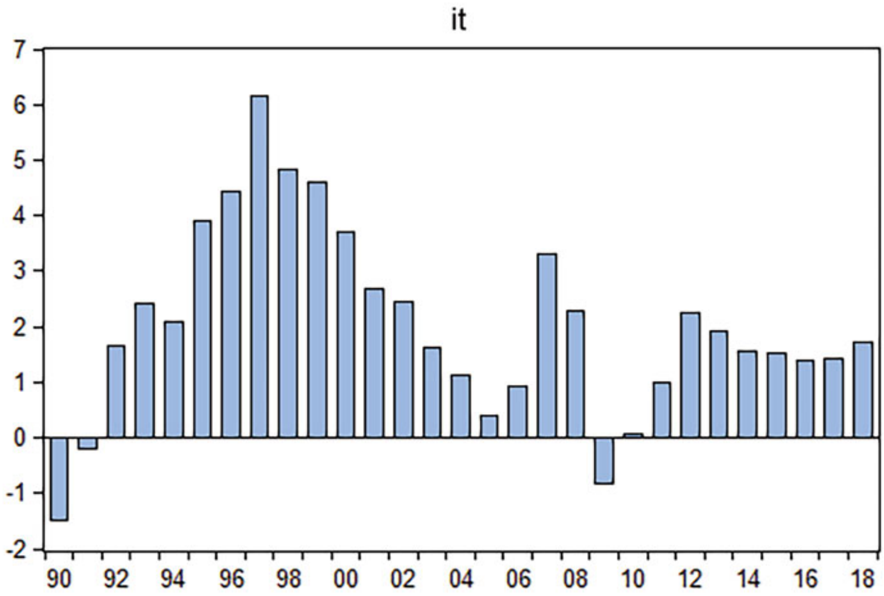

Fig. 3 Primary balance/GDP (%) Italy, 1990–2019. (Source: European Commission, AMECO database)

Finally, Fig. 3 that displays the primary balance-to-GDP ratio visibly shows that Italy's fiscal stance over the last three decades was persistently restrictive. Compared with the other advanced economies, Italy stands out as the only country never running a deficit for almost 30 years: apart from 2009, the primary budget balance has been always in surplus with an average surplus-to-GDP ratio of more than 2% (see, Fig. 4).[8] It is, therefore, puzzling to learn that Italy is ranked among the countries with the highest public debt according to the DGR indicator: something wrong is somehow locked up with this measure, as we shall show below when dealing with point *b*).

Against this background, which at-a-glance looks somewhat at variance with the dominant storytelling focusing on the supply-side flaws of the Italian economy, the next section makes use of the theoretical approach provided by endogenous growth models to examine and test the predictions about the growth effects of the fiscal policy stance in Italy during 1985–2019.

[8] Over the same period, the primary balance-to-GDP ratio averaged: 0.6% in Germany, −1.0% in France, −2.5% in Japan, −1.3% in the UK, −0.8% in the USA.

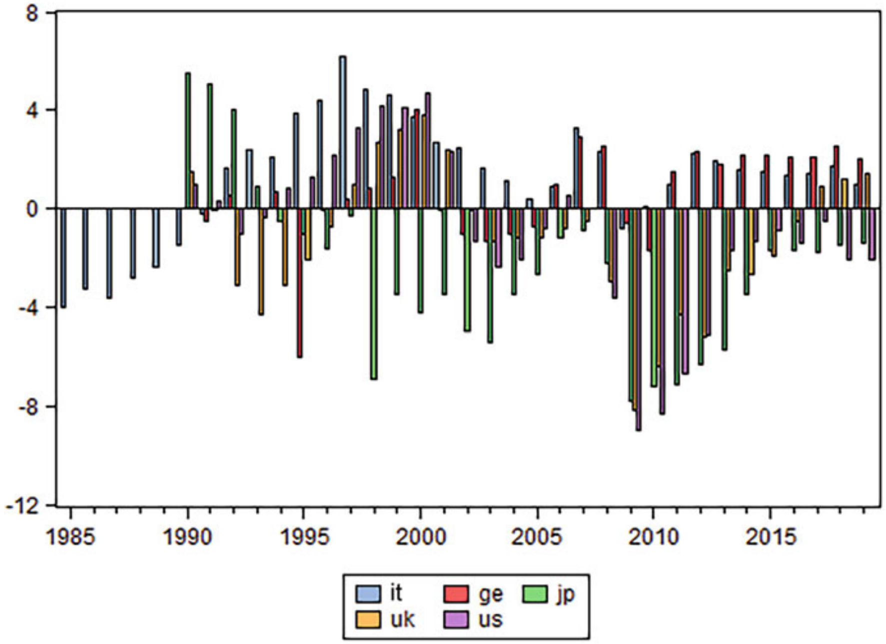

Fig. 4 Primary balance/GDP ratio (%) in Italy, Germany, France, Japan, the United Kingdom, the United States, 1990–2019. (Source: European Commission, AMECO database)

Fiscal Policy and Growth

A suitable analytical framework to think about the growth effects of fiscal policy stance in Italy is provided by the endogenous growth theory, pioneered by Romer (1986) and further developed by Barro (1990), King and Rebelo (1990), and Lucas (1990). A key feature of this approach is the role assigned to fiscal policy as a determinant of capital accumulation and economic growth (see, e.g., Rebelo 1991; Jones et al. 1993; Pecorino 1993; Ireland 1994; Stokey and Rebelo 1995; Mendoza et al. 1997; Bruce and Turnovsky 1999; Turnovsky 1996, 2000, 2004). The theory predicts that changes in fiscal policy relative to some initial policy stance have substantial and enduring effects not only on the levels of basic economic variables, such as the capital stock and output but also on the growth rates.

A simple approach to test the above-theorized impact on growth rates consists in running a regression with a growth indicator (output or capital stock) as a dependent variable and an indicator of the fiscal policy stance and a set of control variables as explanatory variables. A generic linear specification is

$$\mu_t = \alpha + \beta \Delta FS_{t-1} + \gamma Z_{t-1} + \epsilon_t, \tag{1}$$

where μ is the growth rate of interest, FS a measure of fiscal stance, Z a vector of control variables that affect the growth rate, and ϵ the error term.

To identify discretionary changes in fiscal policy (ΔFS), we used a variety of measures built on the *conventional* or *data-based approach.* More fully, we used the following indicators: the primary balance-to-GDP ratio (PB), held as a benchmark and three alternative measures of the cyclically adjusted primary balance-to-GDP ratio (CAPB), which corrects for cyclical effects in the case of expenditure-to-GDP ratios (CAPB_X), applies the semi-elasticity approach used by the European Commission (EC) and OECD to correct for the cycle (CAPB_EC), or adjust the CAPB for one-off and temporary measures and labelled structural primary balance (STPB).[9] Notice that in order to disclose the relative weight of the two main components of PB, a distinction between the effects of total government expenditures and revenues can be added into (1). The vector of controls includes lags in the growth rate indicator, the real effective exchange rate, the current account balance-to-GDP ratio, the inflation rate, the real interest rate, and the size of government, defined as the sum of total government revenues and expenditures as a share of GDP.[10]

The Fiscal Policy Indicator

To measure discretionary changes in fiscal policy and assess the "underlying" fiscal stance, the empirical research built around the conventional (data-based) approach calls into play the CAPB indicator widely used in the international institutions framework for fiscal surveillance such as the IMF, OECD, or EC. The reason is straightforward: the CAPB allows for decomposing the fiscal position into the automatic reaction of the budget to changes in economic activity and the impact of discretionary fiscal policy.

In the official, standard methodology, the CAPB is computed as the difference between the actual primary balance-to-GDP ratio and an estimated cyclical component, defined as the product of the output gap and a cyclical adjustment parameter. In symbols,

$$CAPB_t = PB_t - \varepsilon OG_t,$$

where PB is the primary balance-to-GDP ratio, ε the budgetary reactivity parameter, and OG the output gap, measuring the economy's cyclical position and

[9] Details on the computation of both CAPB_X, CAPB_EC, and STPB are in the next subsection.

[10] The relevance of government size for analyzing the effects of fiscal policy on growth is found in a wide body of literature masterfully overviewed by Bergh and Henrekson (2011).

defined as the deviation of actual GDP (Y_t) from its potential $\left(Y_t^P\right)$, expressed as a percentage of potential GDP:

$$OG_t = \frac{Y_t - Y_t^P}{Y_t^P}.$$

The parameter ε is equal to the difference of the semi-elasticity of total revenues and the semi-elasticity of total expenditures and computed as

$$\varepsilon = (\eta_R - 1)\frac{R}{Y} - (\eta_G - 1)\frac{G}{Y} = (\varepsilon_R - \varepsilon_G),$$

where $\eta_R = (dR/R)/(dY/Y)$ and $\eta_G = (dG/G)/(dY/Y)$ denote the elasticity of revenues (R) and expenditure (G) with respect to GDP, (R/Y) and (G/Y) are revenue- and expenditure-to-GDP ratios, "minus one" the elasticity of the denominator of (R/Y) and (G/Y) to itself, and $\varepsilon_R \equiv (\eta_R - 1)(R/Y)$, $\varepsilon_G \equiv (\eta_G - 1)(G/Y)$ the semi-elasticity for total revenues and expenditures.[11]

Accordingly, using a budgetary sensitivity parameter averaging out to 0.55 over the last two decades for Italy, we computed the fiscal indicator termed CAPB_EC and covering the 1980–2019 period as[12]

$$CAPB\_EC_t = PB_t - 0.55OG_t.$$

In the empirical research on the macroeconomic effects of fiscal policy changes, the CAPB indicator has been challenged on the grounds that it does not adjust for the impact of factors other than cyclical fluctuations in GDP, such as those related to asset or commodity price changes and one-off fiscal measures.[13] To account for these effects referred to as "one-offs," the EC, as well as the IMF and OECD, computes the so-called structural primary balance (STPB) obtained by subtracting

[11] This means that the overall elasticity parameter is computed as a weighted sum of elementary elasticities, namely

$$\eta_R = \sum_{i=1}^{k} \eta_{R,i}\frac{R_i}{R}, \eta_G = \sum_{i=1}^{k} \eta_{G,i}\frac{G_i}{G},$$

where $\eta_{R,i}$ denotes the individual revenue elasticity (typically, personal income taxes, corporate income taxes, indirect taxes, social security contributions, non-tax revenue) and $\eta_{G,i}$ the individual expenditure elasticity (typically, unemployment-related expenditure). A comprehensive review of the official methodology can be found in Mourre et al. (2013). See, also, Girouard and André (2005), and Price et al. (2015) for OECD Member States, and Fedelino et al. (2009) for IMF calculations.

[12] Estimates of the ε parameter can be found in Girouard and André (2005), and Price et al. (2015) for OECD countries, and Mourre et al. (2013), and Price et al. (2014) for EU countries.

[13] See, e.g., Girouard and Price (2004), Turner (2006), Morris and Schuknecht (2007), Joumard et al. (2008), and Guajardo et al. (2014).

one-off operations (OFF) from CAPB, namely[14]

$$STB_t = CAPB\_EC_t - OFF_t.$$

Finally, we used the indicator referred to as CAPB_X, which corrects for cyclical effects in the expenditure-to-GDP ratio. To clear up the point, let us recall that the basic equation for computing the CAPB is

$$CAPB_t = \frac{R_t}{Y_t}\left(\frac{Y_t^p}{Y_t}\right)^{\eta_R - 1} - \frac{G_t}{Y_t}\left(\frac{Y_t^p}{Y_t}\right)^{\eta_G - 1} \Longrightarrow$$
$$CAPB_t = \frac{R_t}{Y_t}(1 + OG_t)^{-(\eta_R - 1)} - \frac{G_t}{Y_t}(1 + OG_t)^{-(\eta_G - 1)}.$$

Under $\eta_R = 1$ (unit-elastic revenues) and $\eta_G = 0$ (inelastic expenditures), as found, e.g., in Girouard and André (2005), Mourre et al. (2013), and Price et al. (2015), the equation boils down to

$$CAPB_t = \frac{R_t}{Y_t} - \frac{G_t}{Y_t}(1 + OG_t).$$

Hence, if revenues move alongside with output ($\eta_R = 1$) and expenditures are insensitive to output ($\eta_G = 0$), the computation of the CAPB would require adjusting expenditures (as a ratio of GDP), rather than revenues (as a ratio of GDP), in contrast to the approach proposed by Alesina and Perotti (1995) and used in a large stream of the literature to investigate the effect of fiscal policy.[15] Furthermore, since under $\eta_G = 0$ the expenditure-to-GDP ratio behaves inversely proportional to the output gap, it follows that the cyclical adjustment should be computed (e.g., Breuer 2017) as

$$CAPB_t = \frac{R_t}{Y_t} - \frac{G_t}{Y_t}(1 - OG_t).$$

However, given that some expenditure items—like unemployment benefits—are affected by the economic cycle, it might be necessary to take into account

[14] Notice that since data on STPB provided by the EC (AMECO) database go back up to 1997, we set STB=CAPB_EC from 1996 to 1980. This is because no significant one-off operations are known to be present or detectable in the Italian budget policy over the 1980–1996 period (see, e.g., Momigliano and Rizza 2007; Rossi 2011).

[15] See, e.g., Alesina and Perotti (1997), Alesina and Ardagna (1998, 2010, 2013), and Ardagna (2004, 2009). A detailed critical assessment of the Alesina and Perotti's strategy to the CAPB is in Breuer (2017).

elastic expenditures in adjusting the budget balance. Following this line, the standard approach assumes that unemployment-related expenditures, as well as revenues, follow the cyclical movements of output, whereas expenditures other than unemployment benefits or other social transfers are taken as discretionary and independent from GDP movements. Accordingly, the CAPB becomes

$$CAPB_t = \frac{R_t}{Y_t} - \frac{GU_t}{Y_t}\left(1 + OG_t\right)^{-(\eta_{GU}-1)} - \frac{GD_t}{Y_t}\left(1 - OG_t\right),$$

where GU denotes the unemployment-related expenditure, η_{GU} the elasticity of GU to the output gap, and GD the so-called discretionary spending.

In contrast to this view, a number of empirical investigations analyzing government spending and its categories have recently shown that not only unemployment compensation, but also age- and health-related social expenditures react to the cycle.[16] Hence, in order to properly adjust for the cyclical effect in the expenditure-to-GDP ratio, a distinction between discretionary and automatic public outlays is required. Following Coricelli and Fiorito (2013), who evaluated the persistence and volatility properties of the expenditure series to identify the discretionary component, we let:

- Discretionary government spending (GD) include public intermediate consumption (non-wage consumption), subsidies paid to firms, public investment, and capital transfer; and
- Automatic or non-discretionary government spending (GN) encompass public wages and salaries, retirement benefits, and transfers (payments to individual health, subsistence, children care, invalidity, and unemployment compensation).[17]

As a result,

$$CAPB_t = \frac{R_t}{Y_t} - \frac{GN_t}{Y_t}\left(1 + OG_t\right)^{-(\eta_{GN}-1)} - \frac{GD_t}{Y_t}\left(1 - OG_t\right),$$

[16] See, e.g., Darby and Melitz (2008), Furceri (2009), Del Granado et al. (2013), Coricelli and Fiorito (2013), and Çulha (2019).

[17] The basic idea of this approach is that discretionary spending should be less persistent and more volatile than automatic expenditure. Coricelli and Fiorito (2013) test the new measure of discretionary government expenditure in a large panel of OECD countries (including Italy) over the period 1980–2011.

whence, under $\eta_{GN} = 0$ as found in the estimated elasticity for Italy over 1980–2019,[18]

$$CAPB\_X0_t = \frac{R_t}{Y_t} - \frac{GN_t}{Y_t}(1 + OG_t) - \frac{GD_t}{Y_t}(1 - OG_t)\,.$$

Despite its wide use in both empirical studies and official documents, the conventional approach has been challenged on several grounds. It has been argued that the indicators used to identify the effect of FP might be flawed by measurement error, spurious correlation, or simultaneity issues (see, e.g., Perotti 2013; Holden and Midthjell 2013; Hernández de Cos and Moral-Benito 2013; Guajardo et al. 2014; Yang et al. 2015; Jordà and Taylor 2016; Carrière-Swallow et al. 2021). In line with these observations, a growing literature favors the so-called *narrative* or *action-based approach*, which draws on policy documents to identify exogenous changes in fiscal measures in a more direct and accurate way (e.g., Romer and Romer 2010; IMF 2010; Devries et al. 2011; Guajardo et al. 2014; Carrière-Swallow et al. 2021). Nonetheless, such a method while overcoming the weaknesses of the standard approach, it is not without challenges itself, as it may be plagued by political biases, subjective and arbitrary reconstruction of selected episodes, or simultaneity issues (e.g., Romer and Romer 2010; Perotti 2013; Holden and Midthjell 2013; Coricelli and Fiorito 2013; Cugnasca and Rother 2015; Hernández de Cos and Moral-Benito 2016; Jordà and Taylor 2016).

This explains why we opted for a set of indicators that whereas built around the conventional (data-based) approach takes into account the problems emphasized in the more recent empirical literature on fiscal policy. After all, if we find an indicator of fiscal impulse that is not affected by (i) GDP (no "reverse causality") and (ii) "imperfect cyclical correction," we can manage or mitigate the challenges of the alternative, action-based measures.[19]

---

[18] As suggested in the literature, estimating an equation of the form

$$\Delta \ln(\mathfrak{X}_t / Y_t^p) = c + \eta \Delta \ln\left(Y_t / Y_t^p\right) + \varepsilon_t,$$

where $\mathfrak{X}_t$ is the variable of interest, we found a value for η_{GN} (t-statistics in parentheses) of -0.152 (0.827) and a value for η_{GD} of -0.128 (0.241) . Similar estimates are found, i.e., in Price et al. (2015). As an alternative, the opposite case where $\eta_{GN} = 1$ and implying

$$CAPB\_X1_t = \frac{R_t}{Y_t} - \frac{GN_t}{Y_t} - \frac{GD_t}{Y_t}(1 - OG_t)$$

was also considered.

[19] Another approach to measuring fiscal discretion is through the estimated residuals from feedback equations (e.g., Fatás and Mihov 2003; Afonso et al. 2010; Corsetti et al. 2012). However, approximating discretion via residuals has major drawbacks as unpredictability and discretion are not synonymous (Coricelli and Fiorito, 2013). In fact, discretionary interventions may react to economic conditions and be therefore state dependent.

Table 3 Correlation matrix: 1985–2019

	PB	CAPB_EC	STPB	CAPB_X0	CAPB_X1
PB	1.000				
CAPB_EC	0.909	1.000			
STPB	0.871	0.982	1.000		
CAPB_X0	0.991	0.956	0.924	1.000	
CAPB_X1	0.993	0.854	0.813	0.969	1.000

For variable definitions, refer to section "Fiscal Policy and Growth"

Table 4 OLS estimates of Eq. 2: 1985–2019

	Measure of ΔFS_t				
	PB	$CAPB\_EC$	$STPB$	$CAPB\_X0$	$CAPB\_X1$
δ_0	0.092 (0.529)	0.092 (0.529)	0.067 (0.391)	0.095 (0.551)	0.092 (0.532)
δ_1	0.252 (1.972)	−0.298 (2.341)	−0.155 (1.157)	0.093 (0.732)	0.395 (3.107)
ΔFS_{t-1}			0.318 (1.934)		
$\bar{R}^2$	0.076	0.113	0.137	−0.013	0.198
$LM(1)$	0.114	0.114	0.753	0.112	0.110
$LM(4)$	0.395	0.395	0.951	0.382	0.378
$CUSUMSQ$	✓	✓	✓	✓	✓

t-statistics in parentheses; $\bar{R}^2$ = Adjusted R-squared; LM(i) = i-th-order serial correlation, LM test: p-values of $\chi^2(i)$; CUSUMSQ = Cusum of squares test for parameters stability: ✓ denotes parameters stability. Plots of CUSUMSQ against t and the pair of 5% critical lines are available upon request

For variable definitions, refer to section "Fiscal Policy and Growth"

Estimation Results

In this section, we summarize the main results of our empirical investigation, which uses data drawn from the European Commission Annual macroeconomic (AMECO) dataset. To start off, let us consider Tables 3 and 4. Table 3 shows that the adjusted ($CAPB\_EC$, $STPB$, $CAPB\_X$) and unadjusted primary balances (PB) are strongly correlated, thus suggesting that the contrast between the various FS measures is overstated.[20]

Table 4 explores the cyclical pattern of the FS indicators by running the following regression:

$$\Delta FS_t = \delta_0 + \delta_1 \Delta OG_t + \nu_t \tag{2}$$

[20] Identical results for OECD countries are in Coricelli and Fiorito (2013). This feature also belongs to indicators relying on the narrative approach, which are highly correlated with those based on traditional methods. See Carrière-Swallow et al. (2021).

and taking the estimated coefficient δ_1 as a measure of cyclical behavior or faulty cyclical adjustment of ΔFS. It shows that the unadjusted primary balance (PB) entails, as expected, a cyclical pattern (no cyclical adjustment) and that the same is also true for the $CAPB\_X1$ indicator, thus implicitly rejecting the restriction $\eta_{GN} = 1$. This pattern is not visible in the $CAPB\_EC$, $STPB$, and $CAPB\_X0$ measures that appear to be uncorrelated to changes in the economic cycle. The $CAPB\_EC$, and $STPB$ even show a countercyclical behavior, being negatively correlated with the output gap, while the $CAPB\_X0$ depicts no relationship with the economic cycle.[21]

These findings signal that the $CAPB\_EC$, $STPB$, and $CAPB\_X0$ indicators do not suffer from the reverse causality and the imperfect cyclical adjustment problems; therefore, they should be used to avoid (potential) biases in the estimate of β in Eq. 1. Nonetheless, in the empirical strategy, we still retained the PB, and $CAPB\_X1$ measures as benchmark indicators. The results are displayed in Tables 5, 6, 7, 8, and 9.

Table 5 reports the unit root test for the variables under consideration and shows that all the variables but inflation and primary expenditure-to-GDP ratio are first-difference stationary. Tables 6, 7, 8, and 9 report the estimated impact of FP changes on capital accumulation and GDP growth in Italy over 1985–2019. In particular, Tables 6 and 7 show that contractionary FP has a negative (short-term) impact on the growth rate of both output and capital stock, with fiscal multipliers averaging 0.54 for Y_t and 1.43 for K_t.[22] They also show that: (i) the control variables display the right sign and statistical significance, the only exception being the inflation rate (π); (ii) the coefficients associated to government spending are higher than those on government revenues; and (iii) budget deficits and government expenditure do not crowd out but crowd in private capital accumulation (Table 8).[23] Finally, Table 9 (indirectly) confirms the contractionary effect of restrictive FP (and the size of its multiplier) shown in Tables 6 and 7, by reporting the estimated positive impact of capital accumulation on GDP growth.

Notice that in the estimates of Tables 6, 7, and 8, we addressed potential residual endogeneity bias, arising from government countercyclical purposes and time-to-build features, by choosing lagged variables, and the simultaneity issue affecting the estimates in Table 9 by comparing the OLS with the GMM estimator.

---

[21] The results do not change if we use GDP growth as an alternative cyclical indicator, rather than the output gap.

[22] The cumulative (integral) effect of FP changes is discussed in the next section.

[23] Since the estimated equations imply regressing a stationary variable on both stationary and non-stationary variables, we also checked for potential spurious relationships by applying the ADF and PP unit root tests to residuals. The tests, available upon request, strongly rejected (p-value = 0.000) the null hypothesis of nonstationarity in the regression residuals. The alternative of including control variables in first differences turned out in a coefficient either statistically insignificant or of the wrong sign.

Table 5 Unit root test: 1985–2019

	ADF		PP	
Variable	Level	1st diff.	Level	1st diff.
PB	0.801	0.001	0.801	0.001
$CAPB\_EC$	0.599	0.012	0.812	0.014
$STPB$	0.519	0.016	0.727	0.016
$CAPB\_X0$	0.858	0.002	0.816	0.002
$CAPB\_X1$	0.738	0.000	0.766	0.000
Y	0.751	0.008	0.740	0.007
K	0.542	0.021	0.742	0.018
RER	0.685	0.002	0.538	0.003
CA	0.794	0.000	0.648	0.000
π	0.023	0.010	0.024	0.000
$RLINT$	0.163	0.000	0.162	0.000
$RSINT$	0.091	0.000	0.086	0.000
TR	0.787	0.000	0.756	0.000
TPX	0.085	0.000	0.066	0.000
$SIZE$	0.652	0.001	0.544	0.001

ADF = Augmented Dickey–Fuller test; PP = Phillips–Perron test: p-values (test includes a constant and a linear trend); Y = Real GDP (2010 reference level); K = Gross fixed capital formation at constant (2010) price: total economy; RER = Real effective exchange rate total economy (based on unit labor costs); CA = Current account balance-to-GDP ratio; π = inflation rate (annual changes in price deflator total consumption, 2010=100); RLINT = Real long-term interest rate, deflator private consumption; RSINT = Real short-term interest rate, deflator private consumption; TR = Total government current revenues-to-GDP ratio; TPX = General government total primary expenditure-to-GDP ratio; SIZE=TR+TX, TX = General government total expenditure-to-GDP ratio

For the definition of the other variables, refer to section "Fiscal Policy and Growth"

Fiscal Consolidation, Debt, and Growth

The enforcement of fiscal austerity measures during 2011–2013 with the primary objective of reducing government debt and boost economic growth has been a natural corollary of the dominant view about the roots of Italy's poor growth performance. The basic argument is straightforward: fiscal adjustment will reduce the budget deficit and the government's demand on the economy's resources, thereby allowing the interest rate to fall and the private sector to make better use of these resources with positive effects on both demand and supply sides. This view is the well-known *expansionary fiscal contraction* or *expansionary austerity* hypothesis, first expressed by Giavazzi and Pagano (1990) and then tested by

Table 6 FP and GDP growth in Italy, 1985–2019

OLS estimates of Eq. 1					
Variable	Dependent variable: $\Delta y_t \equiv (y_t - y_{t-1})$				
Δy_{t-1}	0.625 (3.644)	0.343 (1.929)	0.381 (2.170)	0.520 (3.101)	0.725 (4.052)
ΔPB_{t-1}	−0.581 (2.121)				
$\Delta CAPB\_EC_{t-1}$		−0.574 (1.786)			
$\Delta STPB_{t-1}$			−0.439 (1.522)		
$\Delta CAPB\_X0_{t-1}$				−0.610 (2.063)	
$\Delta CAPB\_X1_{t-1}$					−0.586 (2.289)
TR_{t-1}	−0.274 (1.936)	−0.255 (1.512)	−0.311 (1.922)	−0.261 (1.614)	−0.265 (2.129)
TPX_{t-1}	0.520 (2.139)	[a]0.477 (1.606)	[a]0.575 (2.029)	[a]0.490 (1.736)	[b]0.503 (2.428)
RER_{t-1}	−0.115 (1.921)	−0.104 (1.494)	−0.121 (1.773)	−0.107 (1.603)	−0.111 (2.093)
π_{t-1}	−0.167 (0.977)	−0.139 (0.780)	−0.145 (0.803)	−0.175 (0.988)	−0.172 (1.020)
$RLINT_{t-1}$	0.521 (2.708)	0.581 (2.706)	0.534 (2.526)	0.559 (2.747)	0.486 (2.624)
$\bar{R}^2$	0.404	0.346	0.328	0.367	0.428
$LM(1)$	0.288	0.483	0.999	0.350	0.230
$LM(4)$	0.355	0.509	0.510	0.397	0.303
$CUSUMSQ$	✓	✓	✓	✓	✓

Δy = Annual percentage change of GDP; y= log of real GDP. Similar results (available upon request) can be found if the current account-to-GDP ratio (CA), the real short-term interest rate (RSINT), or the government size (SIZE) are substituted for RER, RLINT, or TR & TPX in OLS estimates

[a] stands for cyclically adjusted TPX under $\eta_{GD} = 0$ (see the equation for CAPB_X0)

[b] for cyclically adjusted TPX under $\eta_{GD} = 1$ (see the equation for CAPB_X1). For the definition of the other variables, refer to Table 5 and section "Fiscal Policy and Growth"

Alesina and Perotti (1995, 1997) and Alesina and Ardagna (1998, 2010, 2013) in a large panel of OECD countries.

As shown in section "The Growth Slowdown," *prima facie* evidence of Italian economic data does not appear to be consistent with the expansionary budget consolidation view. Nevertheless, a formal statistical analysis is required in order to go deeper into this issue. This is in Tables 10, 11, and 12, which display the estimated relationships between growth, austerity, and debt.

Tables 10–11 report the estimated short-run and cumulative responses of Italy's GDP growth to large fiscal consolidation measures captured with regressions of the following form:[24]

$$y_t - y_{t-(i+1)} = \alpha_0 + \alpha_1 \left(y_{t-1} - y_{t-1-(i+1)}\right) + \alpha_2 FC_t + \alpha_3 D_t + \alpha_4 S_t + \epsilon_t,\; i = 0, 1, 2, \quad (3)$$

[24] As stressed in the literature (e.g., Blanchard and Leigh 2013; Fatás and Summers 2018; Gechert et al. 2018; Carrière-Swallow et al. 2021), determining the integral (or cumulative) reaction of output to a cumulative fiscal shock over a given horizon is key to understanding the effects of fiscal policy, since these can either build or be reverted over time.

Table 7 FP and capital accumulation in Italy, 1985–2019

OLS estimates of Eq. 1					
Variable	Dependent variable: $\Delta k_t \equiv (k_t - k_{t-1})$				
Δk_{t-1}	0.636 (4.273)	0.406 (2.525)	0.443 (2.764)	0.552 (3.738)	0.704 (4.583)
ΔPB_{t-1}	−1.129 (1.765)				
$\Delta CAPB\_EC_{t-1}$		−1.654 (2.105)			
$\Delta STPB_{t-1}$			−1.267 (1.781)		
$\Delta CAPB\_X0_{t-1}$				−1.366 (1.942)	
$\Delta CAPB\_X1_{t-1}$					−1.001 (1.704)
TR_{t-1}	−0.554 (1.569)	−0.413 (1.019)	−0.574 (1.475)	−0.506 (1.282)	−0.535 (1.678)
TPX_{t-1}	1.371 (2.267)	[a]1.060 (1.483)	[a]1.345 (1.969)	[a]1.261 (1.838)	[b]1.334 (2.524)
RER_{t-1}	−0.377 (2.548)	−0.304 (1.826)	−0.353 (2.165)	−0.348 (2.164)	−0.369 (2.746)
π_{t-1}	−0.111 (0.291)	−0.223 (0.573)	−0.218 (0.549)	−0.185 (0.472)	−0.068 (0.180)
$RLINT_{t-1}$	0.696 (1.465)	0.955 (1.873)	0.822 (1.628)	0.809 (1.633)	0.593 (1.276)
$\bar{R}^2$	0.404	0.399	0.375	0.386	0.408
$LM(1)$	0.364	0.326	0.589	0.488	0.288
$LM(4)$	0.771	0.791	0.693	0.869	0.646
$CUSUMSQ$	✓	✓	✓	✓	✓

Δk= Annual percentage change of gross fixed capital formation at 2010 prices, total economy; k= log of K. Similar results are found if the current account-to-GDP ratio (CA), the real short-term interest rate (RSINT), or the government size (SIZE) are substituted for RER, RLINT, or TR & TPX in OLS estimates For the definition of the other variables, refer to Table 5

where $y_t = \ln(Y_t)$ is the log of real GDP, D_t is the debt-to-GDP ratio, S_t is the government size, and $FC_t = \sum_{j=0}^{2} \Delta FS_{t-j}$ is the change in the primary budget balance (as a percentage of GDP) in periods of large fiscal adjustments ($FC_t \geq 1.5\%$ p. of GDP) and zero otherwise.[25] Table 12 reports the effect of budget consolidations on debt accumulation obtained from the following regression equation:

$$(D_t - D_{t-1}) = \beta_0 + \beta_1 (D_{t-1} - D_{t-2}) + \beta_2 FC_t + \beta_3 (y_t - y_{t-1}) + \beta_4 S_t + \upsilon_t. \quad (4)$$

We estimated both equations via GMM under the assumption that fiscal decisions are endogenous to the state of the economy, since cyclical correction cannot remove and time-to-build features impinge on the contemporaneous correlation between fiscal adjustment and growth (see, e.g., Jayadev and Konczal 2010; Hernández de Cos and Moral-Benito 2013; Holden and Midthjell 2013; Yang et al. 2015; Jordà and

[25] Following Alesina and Perotti (1995) and Alesina and Ardagna (2010), this complies with the measure of consolidation conventionally used in the literature.

Table 8 Crowding out (in) effect of FP in Italy, 1985–2019

OLS estimates of Eq. 1					
Variable	Dependent variable: $\Delta pk_t \equiv (pk_t - pk_{t-1})$				
Δpk_{t-1}	0.526 (3.248)	0.256 (1.572)	0.300 (1.829)	0.437 (2.782)	0.595 (3.505)
ΔPB_{t-1}	−1.566 (1.982)				
$\Delta CAPB\_EC_{t-1}$		−2.235 (2.482)			
$\Delta STPB_{t-1}$			−1.673 (2.025)		
$\Delta CAPB\_X0_{t-1}$				−1.831 (2.158)	
$\Delta CAPB\_X1_{t-1}$					−1.411 (1.905)
TR_{t-1}	−0.675 (1.586)	−0.507 (1.071)	−0.731 (1.582)	−0.637 (1.355)	−0.638 (1.666)
TPX_{t-1}	1.548 (2.122)	[a]1.190 (1.427)	[a]1.586 (1.960)	[a]1.459 (1.780)	[b]1.478 (2.329)
RER_{t-1}	−0.404 (2.262)	−0.324 (1.660)	−0.392 (2.024)	−0.380 (1.972)	−0.390 (2.399)
π_{t-1}	−0.261 (0.577)	−0.435 (0.957)	−0.418 (0.891)	−0.368 (0.796)	−0.192 (0.425)
$RLINT_{t-1}$	0.981 (1.702)	1.348 (2.231)	1.155 (1.909)	1.147 (1.925)	0.855 (1.505)
$\bar{R}^2$	0.295	0.317	0.275	0.287	0.290
$LM(1)$	0.114	0.088	0.283	0.152	0.081
$LM(4)$	0.595	0.459	0.745	0.652	0.495
$CUSUMSQ$	✓	✓	✓	✓	✓

Δpk= Annual percentage change of gross fixed private capital formation at 2010 prices, total economy; pk= log of PK≡K_total economy −K_general government. Results with the current account-to-GDP ratio (CA), the real short-term interest rate (RSINT), and SIZE replacing RER, RLINT, and TR & TPX are available upon request

For the definition of the other variables, refer to Table 5

Table 9 Capital accumulation and GDP growth in Italy, 1985–2019

Equation estimated: $\Delta y_t = \lambda_0 + \lambda_1 \Delta y_{t-1} + \lambda_2 \Delta k_t + \lambda_3 \Delta k_{t-1}$		
Variable	OLS	GMM
λ_0	0.507 (2.448)	0.529 (3.095)
Δy_{t-1}	0.333 (2.026)	0.300 (1.815)
Δk_t	0.362 (8.659)	0.360 (3.762)
Δk_{t-1}	−0.147 (2.076)	−0.140 (3.695)
$\bar{R}^2$	0.740	0.739
$LM(1)$	0.815	
$LM(4)$	0.138	
$CUSUMSQ$	✓	
J_s		0.498
WI_t		18.401*
IO_t		0.498
INS		$\alpha_0, \Delta y_{t-1}, \Delta k_{t-1}$, SIZE$_t$, SIZE$_{t-1}$

The HAC (Heteroskedasticity and Autocorrelation Consistent Covariance, or Newey–West) estimator is used in GMM estimates. J_s = J-statistic: Sargan test for identifying restrictions (p-value); WI_t = Weak Instruments test: Craig–Donald F-statistic, * denotes statistical significance >10%. IO_t = Instruments Orthogonality test: Eichenbaum–Hansen–Singleton (EHS) C-test of orthogonality conditions (p-value), (H_0: orthogonality conditions hold for SIZE); INS = Instruments

For variable definitions, refer to Tables 5, 6, and 7

Table 10 Short-run effect of FC on GDP growth in Italy, 1985–2019

GMM estimates of Eq. 3					
Variable	Dependent variable: $\Delta y_t \equiv (y_t - y_{t-1})$				
Δy_{t-1}	0.444 (3.341)	0.298 (3.025)	0.331 (3.033)	0.428 (3.239)	0.477 (3.561)
FC_B_t	−0.434 (2.897)				
FC_EU_t		−0.501 (3.469)			
FC_ST_t			−0.422 (3.152)		
FC_X0_t				−0.431 (3.096)	
FC_X1_t					−0.347 (2.105)
D_t	−0.023 (1.363)	−0.030 (2.044)	−0.027 (1.690)	−0.023 (1.425)	−0.017 (0.971)
$SIZE_t$	0.038 (1.722)	0.048 (2.513)	0.045 (2.093)	0.039 (1.796)	0.029 (1.316)
$\bar{R}^2$	0.179	0.203	0.168	0.177	0.165
J_s	0.632	0.676	0.641	0.638	0.230
WI_t	41.346**	25.195**	34.231**	37.245**	38.634**
IO_t	0.708	0.865	0.730	0.750	0.614
INS	$\alpha_0, \Delta y_{t-1}, \Delta PB_{t-1}, \Delta PB_{t-2}, SIZE_t, SIZE_{t-1}, D_t, D_{t-1}$, DummyFC				

FC_Z (Z={B, EU, ST, $X0$, $X1$})= fiscal consolidation based on PB, CAPB_EC, STB, CAPB_X0, CAPB_X1, respectively; D = General government consolidated gross debt-to-GDP ratio; DummyFC=1 if FC$\geqslant$1.5% p. of GDP and 0 otherwise. The HAC estimator is used in GMM estimates; J_s: Sargan test for identifying restrictions (p-value); WI_t: Craig–Donald F-statistic (Weak Instruments test), ** denotes statistical significance>5%; IO_t: EHS C-test of orthogonality conditions (p-value), (H_0: orthogonality conditions hold for D and SIZE); INS = Instruments
For the definition of the other variables, refer to Tables 5, 6, and 7

Table 11 Cumulative effect of FC on GDP growth in Italy, 1985–2019

GMM estimates of Eq. 3					
Variable	Dependent variable: $\Delta y_t \equiv (y_t - y_{t-3})$				
Δy_{t-1}	0.857 (21.523)	0.793 (17.709)	0.781 (16.260)	0.850 (21.314)	0.854 (22.384)
FC_B_t	−0.580 (2.107)				
FC_EU_t		−0.745 (3.710)			
FC_ST_t			−0.681 (4.142)		
FC_X0_t				−0.648 (2.607)	
FC_X1_t					−0.338 (1.230)
D_t	−0.012 (0.470)	−0.027 (1.339)	−0.022 (1.134)	−0.013 (0.551)	−0.005 (0.174)
$SIZE_t$	0.025 (0.796)	0.048 (1.791)	0.043 (1.605)	0.028 (0.906)	0.015 (0.453)
$\bar{R}^2$	0.713	0.758	0.731	0.716	0.712
J_s	0.543	0.760	0.746	0.576	0.465
WI_t	40.760**	32.118**	41.410**	39.108**	37.004**
IO_t	0.724	0.553	0.379	0.675	0.924
INS	$\alpha_0, \Delta y_{t-1}, \Delta PB_{t-1}, \Delta PB_{t-2}, SIZE_t, SIZE_{t-1}, D_t, D_{t-1}$, DummyFC				

For variable definitions, refer to Tables 9 and 10

Table 12 FC and government debt growth in Italy, 1985–2019

GMM estimates of Eq. 4					
Variable	Dependent variable: $\Delta D_t \equiv (D_t - D_{t-1})$				
β_0	40.570 (4.025)	45.761 (4.636)	42.190 (4.042)	40.558 (4.099)	41.007 (4.038)
ΔD_{t-1}	0.703 (9.386)	0.559 (8.126)	0.617 (8.551)	0.685 (9.557)	0.717 (9.003)
FC_B_t	0.546 (2.785)				
FC_EU_t		0.976 (4.000)			
FC_ST_t			0.660 (2.958)		
FC_X0_t				0.626 (3.191)	
FC_X1_t					0.452 (2.193)
Δy_t	−1.422 (10.451)	−1.147 (8.618)	−1.308 (10.083)	−1.396 (9.512)	−1.513 (11.314)
$SIZE_t$	−0.415 (3.902)	−0.476 (4.540)	−0.434 (3.926)	−0.416 (3.979)	−0.419 (3.907)
$\bar{R}^2$	0.648	0.728	0.681	0.664	0.627
J_s	0.452	0.319	0.344	0.418	0.469
WI_t	18.003*	18.843*	17.048*	17.910*	14.889*
IO_t	0.923	0.548	0.824	0.898	0.961
INS	β_0, Δy_{t-1}, ΔPB_{t-1}, ΔPB_{t-2}, $SIZE_t$, $SIZE_{t-1}$, ΔD_{t-1}, FC_t, π_t, CA_t, Δk_t, DummyFC				

EHS C-test of orthogonality conditions (p-value): (H_0: orthogonality conditions hold for SIZE, FC, π,CA, Δk)
For the definition of the other variables, see Tables 6, 7, 8, 9, and 10

Taylor 2016). This means that we cannot exclude that $E(\epsilon_t \mid FC_t) \neq 0$ in equation (3); similarly, we expect that $E(\upsilon_t \mid \Delta y_t) \neq 0$, $\Delta y_t \equiv (y_t - y_{t-1})$, in equation (4).

The empirical results strongly reject the "expansionary austerity" hypothesis, pointing to traditional Keynesian effects of budget consolidations. In particular:

- Tables 10 and 11 show that fiscal consolidation leads to an output growth contraction averaging 0.4 percent on impact and 0.7 percent after three years, while seriously questioning the negative relationship between public debt, government size, and growth predicted in the dominant narrative.
- Table 12 brings to light the perverse effect of large budget corrections on debt accumulation: they not only appear to miss the basic goal of reducing the debt but even to raise it, contrary to expectations.

The reason for this anti-austerity result is straightforward: fiscal changes move the two components of the debt-to-GDP ratio in the opposite directions, thus leading to a rise in DGR under budget consolidations.

The Issue of Sovereign Debt (Un)sustainability

As argued in the introduction, the belief that Italy has built up a huge and harmful (for economic and financial stability) sovereign debt over the past 3 decades is a leading pillar of the dominant storytelling. As a consequence, reducing the high level of debt through spending cuts and/or tax increases is a policy priority.

The critical point is that Italy's fiscal balance does not generate debt since 1992 (Fig. 3), casting serious doubts about the internal validity and reliability of the DGR indicator and raising the puzzling issue of how to measure and assess Italy's sovereign debt position (i.e., our point *b*).

The literature on debt sustainability has developed a battery of indicators and tests (see, e.g., Miller 1983; Buiter 1985; Blanchard 1990; Horne 1991; Croce and Juan-Ramon 2003, for empirical strategies based on indicators; Hamilton and Flavin 1986; Trehan and Walsh 1988; Bohn 1998, for strategies based on tests). A key feature of this research is that the most generally used synthetic indicator to gauge a country's fiscal discipline and debt sustainability builds around the evolution of DGR. Nevertheless, as argued by Piersanti et al. (2023, Chap. 3 of this volume), a number of theoretical and analytical pitfalls, involving the basics of both measurement theory and the intertemporal aspects of budget policy and dynamic optimization, flow from using the DGR as a measure of fiscal sustainability.

To address these critical issues, Piersanti et al. (2023) use an endogenous growth model to show that forward-looking agents' optimizing behavior typically gives rise to a wealth-based sustainability index of government policy of the form:

$$\mathfrak{F}_t = \frac{B_t}{W_t} + \frac{VP_t}{W_t}, \tag{5}$$

where $\mathfrak{F}_t$ denotes the sustainability index of fiscal policy, measuring the value of all policy adjustments (e.g., current and future tax increases and/or spending cuts) required to ensure the viability of the long-run budget balance as reflected by the two components in the right-hand side of (5), that is to warrant the long-run sustainability of government debt (B_t), $VP_t \equiv \int_t^{\infty} \left(G_v^P - R_v\right) e^{-(r-g)(v-t)} dv$ is the present value of primary budget deficits $\left(G_v^P - R_v\right)$ (G_v^P = total primary expenditure and R_v = total revenues), r and g the (real) interest rate and the GDP growth rate, respectively, and W_t the current size of national wealth.[26]

Equation (5) provides a model-based and consistently measured sustainability indicator by which the government's fiscal position can be assessed as follows: if $\mathfrak{F}_t \leq 0$, fiscal policy is rated as strongly sustainable; if $0 < \mathfrak{F}_t \leq (B_t/W_t)$, fiscal policy is rated as weakly sustainable; if $\mathfrak{F}_t \geq (B_t/W_t)$, fiscal policy is valued to be unsustainable.[27]

[26] Equation (5) builds in the interest-growth differential restriction $(r - g) > 0$, thus ensuring that the integral measuring VP_t is well defined.

[27] The manifold theoretical and empirical advantages flowing from using the above sustainability indicator, including the key role played by the wealth structure (i.e., the proportions of productive capital and of financial wealth), are deeply discussed in Piersanti et al. (2023, Chap. 3).

Table 13 After growth interest rate: average values, 1992–2018

Country	$r - g$
Germany	0.0106
Italy	0.0213
United States	0.0165
France	0.0098
United Kingdom	0.0082
Japan	0.0078
Aggregate	0.0124

The data in the table were computed by averaging 10 years $(r - g)$ MA starting from the time range [1992, 2001]

Table 14 Average values 2001–2018

Country	B/W	VP/W	$\mathfrak{F}$	B/Y
Germany	0.17	−0.05	0.12	0.69
Italy	0.24	−0.20	0.04	1.19
United States	0.16	0.36	0.52	0.85
France	0.18	0.45	0.63	0.80
United Kingdom	0.13	0.28	0.41	0.63
Japan	0.36	1.18	1.54	2.01
Aggregate	0.21	0.34	0.54	1.03

B/W = Government debt-to-wealth ratio; VP/W = present value of government primary balance-to-wealth ratio; $\mathfrak{F}$ =sustainability index of fiscal policy; B/Y = Government debt-to-GDP ratio

Using (5), we computed the values of $\mathfrak{F}_t$ for Italy over 2001–2018 and compared it with those obtained over the same period for the other advanced economies shown in Table 1. The main results are in Tables 13 and 14 and Fig. 5. Details on index calibration and data source are in Piersanti et al. (2023, Chap. 3, Sect. 3.3).

Table 13 reports the interest-rate-growth gap $(r - g)$. Table 14 shows the average value of $\mathfrak{F}_t$, along with its two basic components (B/W), and (VP/W), and the average value of the debt-to-GDP ratio (B/Y).

The following distinctive features are worthy of note from Table 14. First, when consistently measured relative to the current level of wealth, public debt levels appear much less threatening than the corresponding debt/GDP ratios, as they now amount to only one-fifth of total wealth on average in contrast to the more than 100% (103%) of total output. Obviously, this simply reflects the different scaling factors used to measure the level of indebtedness, but no doubt the picture in Table 14 is less gloomy and compelling than commonly supposed in most Fiscal Sustainability Reports released by national and international institutions or grades issued by rating

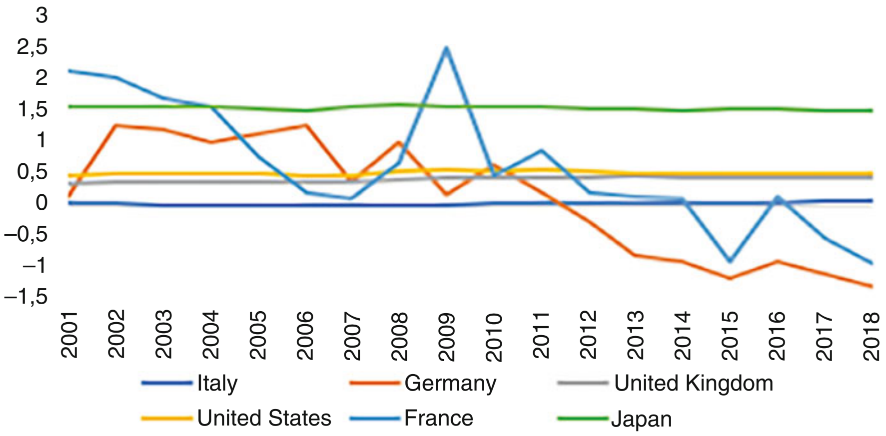

Fig. 5 The wealth-based sustainability indicator, 2001–2018

agencies.[28] Second, along with Germany, Italy ranks as the country with the most sustainable fiscal position, despite the higher interest-growth differential (Table 13), as the index shows an average value close to zero (0.04) and much lesser than the corresponding debt-wealth ratio (0.24). In view of the critical role played by the $r - g$ gap, this is quite remarkable and again brings to light the impressive effort of Italy's fiscal consolidation over the last decades, a feature that is hardly visible or even traceable in the DGR indicator. Finally, the US, France, the UK, and Japan show, on the contrary, an unsustainable debt position as $\mathfrak{F}_t > (B_t/W_t)$ on average.

More details about debt sustainability are given in Fig. 5, which displays the path of $\mathfrak{F}_t$ over the same period. According to Fig. 5, the path of $\mathfrak{F}_t$ for Italy proves to be in the neighborhood of strong sustainability since the index lingers in the range $(0, B_t/W_t)$ with a value well below the current level of debt and constantly close to zero. The same holds for Germany and France because the index converges to a value of $\mathfrak{F}_t < 0$ after 2012 and 2015, respectively. The path for Japan, the UK, and the US is unsustainable because the index systematically displays a value $\mathfrak{F}_t > (B_t/W_t)$.

The above results are very different from consolidated beliefs about public debt sustainability in these countries and suggest that indicators and tests of government solvency, used in the current fiscal policy literature and based on the dynamics of DGR, are strongly biased and misleading. Spelled out more clearly, the results show

[28] A "dangerous debt obsession" (Blot, 2018; Krugman, 2019) and a "single-minded focus on government liabilities" (Stiglitz, 2016) are also the side effects of DGR. Such an obsession is visible, in the economics literature, in Reinhart and Rogoff (2010), Ghosh et al. (2012), Reinhart et al. (2015), Cottarelli (2016, 2017), Bernardini et al. (2019), and Kose et al. (2021) to name only a few; in international policy institutions, in the Fiscal Compact of the European Union, and in the emphasis given to public debt thresholds in debt sustainability assessment made by the IMF, the World Bank, and the OECD.

that the fiscal position is sustainable for both Germany and Italy (and France after 2015) and strongly unsustainable for Japan, the UK, and the US once private wealth is taken into account for an empirical evaluation of the long-run fiscal balance. These findings are obscured if we focus on the dynamics of DGR and may lead to wrong and perverse policy strategies. The case of Italy to which unnecessary fiscal restrictions, and hence undue worsening off effects on output and growth, are imposed according to the DGR indicator and the Stability and Growth Pact's rules (SGP) in the EU, is markedly instructive.[29]

Conclusions

This chapter has investigated the role of Italy's fiscal policy on its poor growth performance over the last three decades. The econometric evidence on the links between changes in fiscal balance, capital accumulation, growth, and debt, described in endogenous growth models, points to a strong negative association, as the slowdown in growth over the period 1985–2019 in Italy is closely related to the long-lasting contractionary stance of its fiscal policy targeted primarily to meet EMU policy rules and hardly used countercyclically.

The chapter also finds that government spending does not crowd out, but crowds in private investment and that fiscal consolidations are typically contractionary, in both the short and medium terms with an average multiplier of 0.4 on impact and 0.7 after three years. Given that Italy's primary budget balance has been always in surplus since 1992 with an average surplus-to-GDP ratio of more than 2%, these results fully explain the less (>1.0% p., on average) GDP growth rate of Italy relative to other EZ countries with less restrictive budget measures.

Finally, the chapter shows that Italy's sovereign debt, when properly measured using a consistent, model-based sustainability indicator, turns out to be sustainable, meaning that the long-run budget policy requires no corrective action and thus signaling the fallacy and riskiness of the DGR indicator.

References

Afonso, A., L. Agnello, and D. Furceri (2010). Fiscal Policy Responsiveness, Persistence and Discretion. *Public Choice* 145 (3): 503–530.

Alesina A., and R. Perotti (1995). Fiscal Expansions and Adjustments in OECD Economies. *Economic Policy* 10 (21): 205–248.

[29] This is hardly understood, e.g., by Codogno and Galli (2017) and Bernardini et al. (2019), who using a standard Keynesian model where the intertemporal aspects of fiscal policy are simply ignored, still believe and want to show that running strong primary surpluses is the "only viable option" to reduce the public debt-to-GDP ratio.

Alesina, A., and R. Perotti (1997). Fiscal Adjustments in OECD Countries: Composition and Macroeconomic Effects. *International Monetary Fund Staff Papers* 44 (2): 210–248.

Alesina, A., and S. Ardagna (1998). Tales of Fiscal Adjustment. *Economic Policy* 13 (27): 488–545.

Alesina, A., and S. Ardagna (2010). Large Changes in Fiscal Policy: Taxes versus Spending. *Tax Policy and the Economy* 24 (1): 35–68.

Alesina, A., and S. Ardagna (2013). The Design of Fiscal Adjustments. In J.R. Brown (ed.). *Tax Policy and the Economy* 27 (1): 19–68.

Anzoategui, D., D. Comin, M. Gertler, and J. Martinez (2019). Endogenous Technology Adoption and R&D as Sources of Business Cycle Persistence. *American Economic Journal: Macroeconomics* vol. 11(3): 67–110.

Ardagna, A. (2004). Fiscal Stabilizations: When Do They Work and Why. *European Economic Review* 48 (5): 1047–1074.

Ardagna, A. (2009). Financial Markets' Behavior Around Episodes of Large Changes in the Fiscal Stance. *European Economic Review* 53 (1): 37–55.

Ball, L.M. (2014). Long-Term Damage from the Great Recession in OECD Countries. *European Journal of Economics and Economic Policies: Intervention* 11 (2): 149–160.

Barro, R.J. (1990). Government Spending in a Simple Model of Endogenous Growth. *Journal of Political Economy* 98 (1): S103–S125.

Bassanetti, A., M. Bugamelli, M. Momigliano, R. Sabbatini, and F. Zollino (2014). The Policy Response to Macroeconomic and Fiscal Imbalances in Italy in the Last Fifteen Years. *PSL Quarterly Review* 67 (268): 55–103.

Bergh, A., M. Henrekson (2011). Government Size and Growth: A Survey and Interpretation of the Evidence. *Journal of Economic Survey* 25 (5): 872–897.

Bernardini, S., C. Cottarelli, G. Galli, and C. Valdes (2019). Reducing Public Debt: The Experience of Advanced Economies over the Last 70 Years. Luiss School of European Political Economy, Policy Brief, July.

Blanchard, O. J. (1990). Suggestions for a New Set of Fiscal Indicators. OECD Economics Department Working Paper No. 79.

Blanchard, O., and D. Leigh (2013). Growth Forecast Errors and Fiscal Multipliers. *American Economic Review* 103 (3): 117–120.

Blanchard, O., E. Cerutti, and L. Summers (2015). Inflation and Activity - Two Explorations and their Monetary Policy Implications. IMF Working Paper No. 15/230.

Blot, C. (2018). Sustainability of Public Debt: A Dangerous Obsession?. In D.V. Malito, G. Umbach, and N. Bhuta (eds). *The Palgrave Handbook of Indicators in Global Governance*. Palgrave Macmillan, London.

Bohn, H. (1998). The Behavior of U.S. Public Debt and Deficits. *Quarterly Journal of Economics* 113 (3): 949–963.

Breuer, C. (2017). Expansionary Austerity and Reverse Causality. MPRA Paper No. 80412.

Bruce, N., and S.J. Turnovsky (1999). Budget Balance, Welfare, and the Growth Rate: Dynamic Scoring of the Long-Run Government Budget. *Journal of Money, Credit and Banking* 31 (2): 162–186.

Bugamelli, M., F. Lotti (eds.), M. Amici, E. Ciapanna, F. Colonna, F. D'Amuri, S. Giacomelli, A. Linarello,F. Manaresi, G. Palumbo, F. Scoccianti, and E. Sette (2018). Productivity Growth in Italy: A Tale of a Slow-Motion Change. Questioni di Economia e Finanza (Occasional Papers) No. 422, Bank of Italy.

Buiter, W.H. (1985). A Guide to Public Sector Debt and Deficits. *Economic Policy* 1 (1): 13–79.

Carrière-Swallow, Y., A.C. David, and D. Leigh (2021). Macroeconomic Effects of Fiscal Consolidation in Emerging Economies: New Narrative Evidence from Latin America and the Caribbean. *Journal of Money, Credit and Banking* 53 (6): 1313–1335.

Codogno, L., and G. Galli, (2017). Can Fiscal Discipline Be Counterproductive?. *Economia Italiana* 1–2–3.

Coricelli, F., and R. Fiorito (2013). Myths and Facts about Fiscal Discretion: A New Measure of Discretionary Expenditure. Luiss Lab of European Economics (LLEE) Working Paper No. 106.

Corsetti, G., A. Meier, and G.J. Müller (2012). What Determines Government Spending Multipliers?. *Economic Policy* 27 (10): 521–565.
Cottarelli, C. (2016). *Il macigno: Perché il debito pubblico ci schiaccia e come si fa a liberarsene*. Feltrinelli Editore, Milano.
Cottarelli, C. (2017). *What We Owe: Truths, Myths, and Lies About Public Debt*. Brookings Institution Press, Washington DC.
Croce, M.E., and M.V.H. Juan-Ramon (2003). Assessing Fiscal Sustainability: A Cross Country Comparison. IMF Working Paper No. 03/145.
Cugnasca, A., and P. Rother (2015). Fiscal Multipliers During Consolidation: Evidence from the European Union. ECB Working Papers No. 1863.
Çulha A.A. (2019). Asymmetric Government Expenditure: A Comparison of Advanced and Developing Countries. *Journal of Economic Policy Reform* 22 (2): 164–183.
Darby, J., and J. Melitz (2008). Social Spending and Automatic Stabilizers in the OECD. *Economic Policy* 56 (1): 715–756.
Del Granado, J.A., S. Gupta, and A. Hajdenberg (2013). Is Social Spending Procyclical? Evidence for Developing Countries. *World Development* 42 (1): 16–27.
Devries, P., J. Guajardo, D. Leigh, and A. Pescatori (2011). A New Action-Based Dataset of Fiscal Consolidation. IMF Working Paper No. 11/128.
Engler, P., and J. Tervala (2018). Hysteresis and Fiscal Policy. *Journal of Economic Dynamics and Control* 93 (C): 39–53.
European Commission (1999). Italy's Slow Growth in the 1990s: Facts, Explanation and Prospects. European Economy, Reports and Studies No. 5.
European Commission (2009). Impact of the Current Economic and Financial Crisis on Potential Output. European Economy, Occasional Paper No. 49.
European Commission (2014). Macroeconomic Imbalances. Italy 2014. European Economy, Occasional Paper No. 182.
Faini, R. (2004). Fu vero declino? L'Italia degli anni novanta. In G. Toniolo and V. Visco (eds.). *Il declino economico dell'Italia. Cause e rimedi*. Bruno Mondatori, Milan.
Faini, R., and A. Sapir (2009). An Obsolete Model? Growth and Specialisation in the Italian Economy. In M. Buti (ed.). *Italy in the EMU. The Challenges of Adjustment and Growth*. Palgrave Macmillan, Houndmills, UK.
Fatás, A., and I. Mihov (2003). The Case for Restricting Fiscal Policy Discretion. *Quarterly Journal of Economics* 118 (4): 1419–1447
Fatás, A., and L.H. Summers (2018). The Permanent Effects of Fiscal Consolidation. *Journal of International Economics* 112 (C): 238–250.
Fedelino, A., Ivanova, A., and M. Horton (2009). Computing Cyclically Adjusted Balances and Automatic Stabilizers. IMF Technical Notes and Manuals 09/05.
Furceri, D. (2009), Stabilization Effects of Social Spending: Empirical Evidence from a Panel of OECD Countries Overcoming the Financial Crisis in the United States. OECD Economics Department Working Papers No. 675.
Gechert, S., G. Horn, and C. Paetz (2018). Long-Term Effects of Fiscal Stimulus and Austerity in Europe. INFER (International Network For Economic Research) Working Paper No. 2018.04.
Ghosh, A., J.I. Kim, E. Mendoza, J. Ostry, and M. Qureshi (2012). Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies. *Economic Journal* 123 (566): F4–F30.
Giavazzi, F., and M. Pagano (1990). Can Severe Fiscal Contractions Be Expansionary? Tales of Two Small European Countries. In O. Blanchard, and S. Fischer (eds). *NBER Macroeconomics Annual 1990*. MIT Press, Cambridge, Mass.
Giordano, R., S. Lanau, P. Tommasino, and P. Topalova (2015). Does Public Sector Inefficiency Constrain Firm Productivity? Evidence from Italian Provinces. IMF Working Paper No. 15/168.
Girouard, N., and R. Price (2004). Asset Price Cycles, 'One-off' Factors and Structural Budget Balances. OECD Economics Department Working Papers No. 391.
Girouard, N., and C. André (2005). Measuring Cyclically Adjusted Budget Balances for OECD Countries. OECD Economics Department Working Papers No. 434.

Guajardo, J., D. Leigh, and A. Pescatori (2014). Expansionary Austerity: International Evidence. *Journal of the European Economic Association* 12 (4): 949–968.
Hamilton, J.D., and M.A. Flavin (1986). On the Limitations of Government Borrowing: A Framework for Empirical Testing. *American Economic Review* 76(4): 808–819.
Hernández de Cos, P., and E. Moral-Benito (2013). Fiscal Consolidations and Economic Growth. *Fiscal Studies* 34 (4): 491–515.
Hernández de Cos, P., and E. Moral-Benito (2016). On the Predictability of Narrative Fiscal Adjustments. *Economics Letters* 143 (6): 69–72
Holden, S., and N.L. Midthjell (2013). Successful Fiscal Adjustments – Does the Choice of Fiscal Instruments Matter?. CESifo Working Papers No. 4456.
Horne, J. (1991). Indicators of Fiscal Sustainability. IMF Working Paper No. 91/5.
International Monetary Fund (IMF) (2010). Will It Hurt? Macroeconomic Effects of Fiscal Consolidation. *World Economic Outlook,* Chap. 3, October.
International Monetary Fund (IMF) (2015). Where Are We Headed? Perspectives on Potential Output. *World Economic Outlook*, Chap. 3, April.
Ireland, P. (1994). Supply-Side Economics and Endogenous Growth. *Journal of Monetary Economics* 33 (3): 559–571.
Jayadev, A., and M. Konczal (2010). The Boom Not the Slump: The Right Time for Austerity. Economics Faculty Publication Series Paper 26, Roosevelt Institute, New York
Jones, L., R. Manuelli, and P. Rossi (1993). Optimal Taxation in Models of Endogenous Growth. *Journal of Political Economy* 101 (3) 485–519.
Jordà, Ò., and A. Taylor (2016). The Time for Austerity: Estimating the Average Treatment Effect of Fiscal Policy. *Economic Journal* 126 (590): 219–255
Joumard, I., M. Minegishi, C. Andre, C. Nicq, and R. Price (2008). Accounting for 'One-off' Operations when Assessing Underlying Fiscal Positions. OECD Economics Department Working Papers No. 642.
King, R., and S. Rebelo (1990). Public Policy and Economic Growth: Developing Neoclassical Implications. *Journal of Political Economy* 98 (1): S126–S151.
Kose, M.A., F.L. Ohnsorge, C.M. Reinhart, and K.S. Rogoff (2021). The Aftermath of Debt Surges. NBER Working Paper No. 29266.
Krugman, P. (2019). The World Has a Germany Problem. The Debt Obsession that Ate the Economy. *The New York Times*, August 20.
Larch, M. (2004). Relegated to the League of Laggards? Roots of Italy's Slow Potential Growth. ECFIN Country Focus No. 1 (8).
Lucas, R. (1990). Supply-Side Economics: An Analytical Review. *Oxford Economic Papers* 42 (2): 293–316.
Mendoza, E., G. Milesi-Ferretti, and P. Asea (1997). On the Effectiveness of Tax Policy in Altering Long-Run Growth: Harberger's Superneutrality Conjecture. *Journal of Public Economics* 66 (1): 99–126.
Miller, M. (1983). Inflation Adjusting the Public Sector Financial Deficit. In J. Kay (ed.). *The 1982 Budget*. Basil Blackwell, London.
Momigliano, S., and P. Rizza (2007). Temporary Measures in Italy: Buying or Losing Time?. MNB Conference Volume, Magyar Nemzeti Bank (Central Bank of Hungary) 1 (1): pp. 61–71.
Morris, R., and L. Schuknecht (2007). Structural Balances and Revenue Windfalls: The Role of Asset Prices. European Central Bank Working Paper No. 737.
Mourre, G., I. George-Marian, D. Paternoster, and M. Salto (2013). The Cyclically-Adjusted Budget Balance Used in the EU Fiscal Framework: An Update. European Economy Discussion Paper No. 478.
Pagano, P., and M. Sbracia (2014). The Secular Stagnation Hypothesis: A Review of the Debate and Some Insights. Questioni di Economia e Finanza (Occasional Papers) No. 231, Bank of Italy.
Pecorino, P. (1993). Tax Structure and Growth in a Model with Human Capital. *Journal of Public Economics* 52 (2): 251–271.
Perotti, R. (2013). The Austerity Myth: Gain Without Pain?. In A. Alesina and F. Giavazzi (eds). *Fiscal Policy after the Financial Crisis*". NBER Books, University of Chicago Press, Chicago.

Piersanti, G., P. Canofari, A. Piergallini, and A. De Dominicis. (2023). Fiscal Policy and Sovereign Debt Dynamics: (Re-) Assessing the Intertemporal Viability of the Government Budget Using a Model-Based and Consistently Measured Sustainability Indicator. In C. Imbriani and P. Scaramozzino (eds.), *Economic Policy Framework Revisited*. Springer Nature Switzerland AG, Zurig.

Pinelli, D., I.P. Székely, and J. Varga (2016). Exploring Italy's Growth Challenge. A Model-Based Exercise. European Economy Discussion Paper No. 41.

Price, R.W., T. Dang, and Y. Guillemette (2014). New Tax and Expenditure Elasticity Estimates for EU Budget Surveillance. OECD Economics Department Working Papers No. 1174.

Price, R.W., T. Dang, and J. Botev (2015). Adjusting Fiscal Balances for the Business Cycle: New Tax and Expenditure Elasticity Estimates for OECD Countries. OECD Economics Department Working Papers No. 1275.

Rebelo, S. (1991). Long-Run Policy Analysis and Long-Run Growth. *Journal of Political Economy* 99 (3): 500–521.

Reifschneider, D., W. Wascher, and D. Wilcox (2015). Aggregate Supply in the United States: Recent Developments and Implications for the Conduct of Monetary Policy. *IMF Economic Review* 63 (1): 71–109.

Reinhart, C.M., and K.S. Rogoff (2010). Growth in a Time of Debt. *American Economic Review: Papers & Proceedings* 100 (2): 573–578.

Reinhart, C.M., V. Reinhart, and K.S. Rogoff (2015). Dealing with Debt. *Journal of International Economics* 96 (S1): S43–S55.

Romer, P.M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy* 94 (5): 1002–1037

Romer, C.D., and D.H. Romer (2010). The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. *American Economic Review* 100 (3): 763–801.

Rossi, N., and G. Toniolo (1996). Italy. In N. Crafts and G. Toniolo (eds.). *Economic Growth in Europe since 1945*. Cambridge University Press, Cambridge, UK.

Rossi, N. (2011). Aspetti della politica economica italiana dalla crisi del 1992–93 a quella del 2008–09. In M. Ciaschini and G. M. Romagnoli (eds.). *L'economia italiana: metodi di analisi, misurazione e nodi struttrali*. Franco Angeli, Milan.

Stiglitz, J.E. (2016). The Measurement of Wealth: Recessions, Sustainability and Inequality. In J.E. Stiglitz and M. Guzman (eds.). *Contemporary Issues in Macroeconomics. Lessons from the Crisis and Beyond*. IEA Conference Vol. 155-II, Palgrave Macmillan, Houndmills, UK and New York: 63–76.

Stokey, N., and S. Rebelo (1995). Growth Effects of Flat-Rate Taxes. *Journal of Political Economy* 103 (3): 510–550.

Tervala, J. (2021). Hysteresis and the Welfare Costs of Business Cycles. *Economic Modelling* 95 (C): 136–144.

Teulings, C., and R. Baldwin (2014). *Secular Stagnation: Facts, Causes, and Cures*. CEPR Press, London.

Toniolo, G., and V. Visco (2004). *Il declino economico dell'Italia. Cause e rimedi*. Bruno Mondadori, Milan.

Trehan, B., and C. Walsh (1988). Common Trends, the Government Budget Constraint, and Revenue Smoothing. *Journal of Economics Dynamics and Control* 12 (2–3): 425–444.

Turner, D. (2006). Should Measures of Fiscal Stance Be Adjusted for Terms of Trade Effects?. OECD Economics Department Working Papers No. 519.

Turnovsky, S.J. (1996). Optimal Tax, Debt, and Expenditure Policies in a Growing Economy. *Journal of Public Economics* 60 (1): 21–44.

Turnovsky, S.J. (2000). Fiscal Policy, Elastic Labor Supply, and Endogenous Growth. *Journal of Monetary Economics* 45 (1): 185–210.

Turnovsky, S.J. (2004). The Transitional Dynamics of Fiscal Policy: Long-Run Capital Accumulation, and Growth. *Journal of Money, Credit and Banking* 36 (5): 883–910.

Yang, W., J. Fidrmuc, and S. Ghosh (2015). Macroeconomic Effects of Fiscal Adjustments: A Tale of Two Approaches. *Journal of International Money and Finance* 57 (C) 31–60.

Parameter Heterogeneity and Convergence Clubs: Shedding Light on the Human Capital Puzzle

Leonardo Becchetti and Giovanni Trovato

Introduction

Cross-country regressions on the determinants of levels and growth of per capita GDP generally suffer from omitted variables bias since many factors contributing to economic development are either missing or non-recordable. The widespread use of random or fixed -effect panel estimates only partially solves this problem as it captures time-invariant (in the fixed-effect case), country -specific hidden factors but is not capable of measuring how these factors affect magnitudes of the available regressor coefficients. Three further serious problems in this literature are departures from normality, misspecification of the production function, and the restrictive assumption of homogeneity in the effect of inputs on per capita GDP. With regard to the latter, the interplay of human capital with other country fundamentals (economic freedom, quality of institutions,[1] quality of education systems (see, for example,

[1] Quality of institutions is widely acknowledged as a crucial determinant of economic growth (Knack and Keefer 1995; Temple 1999; Rodrik 1999; Barro and Sala-I-Martin 1992). Frankel (2002) considers that the success of market-based economies crucially depends on good institutions and, more specifically, institutions that are crucial in protecting property rights, fighting corruption, supporting macroeconomic stabilization, and promoting social cohesion. Jerzmanowski (2006) finds that the role of institutions is that of making growth episodes persistent rather than ruling out growth take-offs, on the same line (Bucci et al. 2021)

The authors thank M. Alfó, S. Di Giacomo, F. Mattesini, H. Meta, J. Temple, R. J. Waldmann and R. Rocci for their useful comments and suggestions. The usual disclaimer applies.

L. Becchetti · G. Trovato (✉)
Dipartimento di Economia e Istituzioni, Università di Roma "Tor Vergata", Rome, Italy
e-mail: giovanni.trovato@uniroma2.it

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_9

Barro 2001), culture, religion, and social norms) makes it difficult to believe that this variable may have the same effect on the dependent variable in markedly different economic environments. In other words, private and social returns to education are highly heterogeneous across countries, and it is hardly reasonable to adopt the standard restriction that requires human capital investment to have the same effects on per capita GDP in Sub-Saharan Africa and in high -income OECD countries. This should suggest extreme care when drawing policy conclusions from heterogeneous groups of countries on the basis of a common estimated coefficient (Temple 2001a,b).[2]

Following, among others, Alfó et al. (2008), (hereafter ATW), we provide an original contribution to the empirical growth literature, developing an approach that deals parsimoniously with the four above-mentioned problems (departure from the normality assumption, misspecification of the production function, omitted variables bias, and parameter heterogeneity). Our mixed random coefficients model (estimated according to a finite mixture) identifies subgroups of countries with homogeneous production functions. It also assumes that intergroup differences are captured by the latent structures in country-specific socio-political environments and quality of human capital formation (Lindsay 1983a,b; Alfó et al. 2008). The estimated model, when compared to a panel fixed-effect approach, has the advantage of restricting the individual effects to a small discrete set of possible values and of accommodating extreme and/or strongly asymmetric departures from the normality assumptions of most parametric estimators (Lindsay 1983a,b; Lindsay and Lesperance 1995; McLachlan and Peel 2000; Alfó and Trovato 2004) since locations and associated probabilities are completely free to vary over the corresponding supports.

To justify the technical complexity required to implement our approach, we document throughout the paper that semi-parametric models present some methodological advantages and provide additional insights with respect to more standard estimating techniques (such as those of homogeneous parameter and linear-with-interaction models). In essence, we use the finite mixture to account for heterogeneity in the intercept and human capital effects on levels and rates of growth of per capita GDP in a Solow augmented specification, controlling for sources of variability arising from omitted institutional and socio-cultural factors. As in ATW, we follow the intuition of Bernanke and Gürkaynak (2001), here after BG, who stressed that, under the conditional convergence hypothesis, levels of per capita income and growth rates (and therefore residuals of their respective equations) are determined by the same data generation process (DGP) and then have to be studied in a simultaneous way.[3] Our results are in line with the theoretic framework of multiple equilibria and convergence clubs (Azariadis and Drazen 1990, Durlauf

[2] Durlauf (2001) emphasizes this point in his survey on the empirical growth literature by arguing that the development of proper methodologies tackling the heterogeneity issue is one of the main goals of current research in this field.

[3] In this contest, BG states that if convergence occurs, poorer countries grow faster than richer ones. ATW find as results of their estimation that residuals of the finite mixture bivariate model are negative correlated, confirming the Bernanke and Gürkaynak's theoretical intuition.

and Johnson 1995; Bernard and Durlauf 1996 and Galor 1996). To date, some empirical papers have tested convergence clubs (among others Di Vaio 2011; Owen et al. 2009 and Alfó et al. 2008) using finite mixture since failure to allow for unobservable heterogeneity in country steady states may lead to spurious rejection of the above assumption. An additional original contribution of our paper is the development of a mixture model in which the country probability of belonging to a cluster depends on the initial level of human capital. We aim to contribute in this way to the debate on the effects of human capital on growth by testing the hypothesis that its initial level affects country position in the space of characteristics. Within this theoretical and empirical framework, our paper faces two challenges: (i) on the methodological point of view, it aims to develop an approach that, as explained above, deals originally and parsimoniously with crucial problems in the empirical literature; (ii) with regard to the empirical findings, it aims to show that the additional complexity of the model is compensated by the advantage of providing new insights on the interpretation of the determinants of economic development. Choosing a model implies selecting an optimal degree of abstraction that isolates the most relevant regularities of a given phenomenon. Between the two extremes of a homogeneous parameter approach (which is simple but too restrictive in its assumptions) and a description of the reality where each country is a cluster with its own production function (which fails to identify any law or regularity of the phenomenon), the latent class approach is a good compromise that provides more insights with respect to both.

Summing up, our main empirical objective is to identify the determinants of economic growth using as benchmark the Solowian model relaxing the homogeneity assumptions used by “traditional” OLS-based regressions. In this respect, Harberger (1987) highlights that countries with different stories and economic or social development cannot be included in the same regression analysis. Our model also addresses the typical endogeneity problem of growth estimates. As stressed by Durlauf et al. (2005), heterogeneity has been dealt with in traditional convergence models by treating stocks of initial human and physical capital as initial conditions, while interactions and additional variables have been used to tackle heterogeneity. The problem is that both the Solowian model variables and the control variables that appear in the standard growth regressions are themselves endogenously determined by initial conditions. This is why we handle heterogeneity directly inside the data generation process. Our main findings show that, once heterogeneity is taken into account, countries show different growth paths leading to different steady states. Moreover, once the model has been conditioned on the initial level of human capital, we show that such variable strongly affects growth dynamics of different countries. These results are consistent with theoretical growth models with multiple equilibria (see among others Azariadis and Drazen 1990).

The paper is divided into seven sections (including introduction and conclusions). The second section compares our paper to the closest contributions in the empirical growth literature in order to clarify our original points. The third section illustrates the random coefficient model taking special care to explain why such a model is preferred to the alternative of linear-with-interaction-term or fixed-effect models and why the selected Cobb–Douglas specification is preferred to the CES or translog specifications. The fourth section discusses the choice of variables used in the empirical analysis. The fifth section presents econometric findings of the latent class approach and compares them to those of a homogeneous parameter benchmark. The sixth section identifies and comments on the characteristics of the endogenously determined clusters of countries (before and after conditioning on the initial level of human capital) and discusses estimates of a multinomial logit model in which cluster affiliation (or heterogeneity in the contribution of human capital and the TFP to per capita GDP) is regressed on latent factors such as measures of the quality of the educational system, institutional quality, and country fundamentals. The seventh section concludes.

Our Paper and the Empirical Growth Literature

Consensus on the existence and relevance of parameter heterogeneity in cross-country level and growth regressions has significantly grown in the last decades. Valuable approaches that try to address this problem—and are closer to our own—Alfó et al. (2008), Owen et al. (2009), Ng and McLachlan (2014), Pittau et al. (2010), and Bucci et al. (2021).

The underlying assumption of our empirical model is that countries share some common and unobserved economic structures (e.g., public debt sustainability, reliability and fairness of the legal system, quality of public schools, etc.) whose effects are proxied by country-specific parameters. These are, in turn, considered as random variables with an unspecified distribution function, which can be estimated by a discrete distribution. In this way, countries can be considered as belonging to a set of *hidden* homogeneous clusters (components), sharing some common economic features represented by cluster-specific parameters. Following this approach, we restrict the country-specific effect to take values in a small, discrete set accommodating extreme and/or strongly asymmetric departures from usual parametric assumptions.[4] The first contribution of the paper is, then, to define a model describing the impact of schooling on growth, by allowing parameter heterogeneity among countries.

In conclusion, the originality of our study with respect to the closest examples in the literature is derived from the concurring adoption of the simultaneous modeling of both human capital and labor augmenting component unobserved heterogeneity. In addition to it, we try to explain the unobserved heterogeneity in the contribution of the two factors with a multinomial logit approach and document that the puzzle of the weakly significant effect of human capital on growth may be solved if we tackle the problem of multicollinearity by making the probability of belonging to a cluster dependent on the initial level of human capital. Our novel

[4] See, e.g., Alfó and Trovato 2004.

methodological approach is applied to a crucial topic in development economics. As it is well-known, reforms in many low-income countries have made (at least primary) schooling compulsory, thereby significantly increasing human capital investment. However, making schooling compulsory with limited public financial resources often generates a quantity/quality trade-off in public schools (absenteeism of inadequately paid teachers, excessively a high number of students per class), while weak institutional rules may discourage educated talents from creating value in their home country. When and under what side conditions the investment in human capital may produce positive effect in terms of economic development is therefore a very important issue in the development literature.

The Model

As evidenced in the introduction, country-specific heterogeneity in growth dynamics contrasts with the standard homogeneity assumption adopted when estimating the augmented Solow model. Furthermore, it is well-known that empirical findings from the Solowian model can be affected by omitted variable and error-in-variable biases (Durlauf 2000). The standard approach followed to solve these problems is to introduce additional factors generally incorporated into the TFP. In this way, though, parameter heterogeneity (and the role of latent variables on it) is not addressed, and it is highly likely that not all relevant explanatory variables are included.[5]

An alternative approach to solve jointly the omitted bias and the parameter heterogeneity problem is to handle random effects within a mixture model. In such a model, the random component captures the impact of the unobserved variables limiting the effects of the omitted variable bias, while the endogenous clustering of the mixture identifies subgroups of countries with homogeneous parameters. This gives the possibility of explaining parameter heterogeneity across subgroups by taking into account the role of measurable latent variables.

To perform this task, we conventionally define $\{\mathbf{y}_1, \ldots, \mathbf{y}_n\}$ as the realized random vectors of n conditional independent and identically distributed (*i.i.d*) levels of per capita GDP $\{(\mathbf{Y}/\mathbf{L})_1, \ldots, (\mathbf{Y}/\mathbf{L})_n\}$, where $(\mathbf{Y}/\mathbf{L})_i$ is a $T - dimensional$ random vector with probability density function $f(\mathbf{y}_i)$ on $\mathbf{R}^T$; i.e., $\mathbf{y}_i$ contains the

[5] If the problem is solely parameter heterogeneity, the linear-with-interaction model could solve the problem avoiding unnecessary complexity. More specifically, we might ignore the rich information we get from the latent class model (endogenous identification of homogenous clusters and attribution to each of them of an additional random effect on intercept and human capital coefficients), take the factors which we a priori consider more relevant for their impact on the intercept and human capital coefficients, and create intercept and slope dummies. Limits to this methodology include exogenous subsampling, multicollinearity problems, and difficulties in parameters interpretation. Beyond goodness of fit, the advantage of our approach lies in the fact that we can handle, at the same time, nonlinearity of the log transformed production function, parameter variability across countries, and omitted variable bias.

realized random variables corresponding to the year t ($t = 1, \dots, T$) measurement made for the $i-th$ country in the sample. The $i-th$ country's output per worker in a Solow model augmented for the role of human capital (Mankiw et al. 1992) is typically

$$f(y_{it}|A_{it}, k_{it}, h_{it}) = A_{it}^{(1-\alpha_H-\alpha_K)} k_{it}^{\alpha_K} h_{it}^{\alpha_H}, \tag{1}$$

where $\alpha_K, \alpha_H \in (0, 1)$ represent the shares of physical and human capital, respectively.[6] The corresponding canonical parameters are modeled in the balanced growth path as a log-linear function of an outcome-specific set of predictors, as follows:

$$\ln(y_{it}) = \ln(A) + g + \frac{\alpha_K}{(1-\alpha_K-\alpha_H)} \ln\left[\frac{sk_{it}}{(n_{it}+g+\delta)}\right] + \tag{2}$$
$$+ \frac{\alpha_H}{(1-\alpha_K-\alpha_H)} \ln\left[\frac{sh_{it}}{(n_{it}+g+\delta)}\right] + \varepsilon_{it},$$

where $\ln(y_{it})$ is the log of output per worker, A captures the labor augmenting component, $\ln(sk_{it})$ and $\ln(sh_{it})$ are the fractions of income invested in physical and human capital, respectively, and $ln(n_{it}+g+\delta)$ is the sum of population growth, rate of technological progress, and capital depreciation. In other words, equation (2) tells us that the steady-state value of GDP per effective labor depends on the shares of capital inputs, the growth of labor force, and the depreciation rate. Following MRW, Durlauf et al. (2001) show that, from equation (2), it is possible to obtain the following estimable equation for growth dynamic once defining the specification

[6] Alternatively, we could estimate a random coefficient CES function, but our focus on heterogeneity in human capital in such specification leads (by considering all linear and nonlinear arguments of the production function containing human capital) to four (instead of two) random components in the level equation for a degree of complexity that is hard to interpret. We could opt for a homogeneous parameter CES estimate, but we believe that the estimate of random components in a CD model is a more proper way to capture such nonlinearity. This is because models are imperfect, synthetic views of the reality and are falsifiable by later and more updated versions. This is also true for production functions. More complex functional forms such as translog and CES can capture some nonlinearities better than the standard Cobb–Douglas approach but are not so flexible to rule out any form of misspecification. The latent class approach is, in our opinion, the most suitable solution to the problem of models' inadequacy since it does not neglect the problem and allows proper treatment through the mixture components (McLachlan and Peel 2000).

$ln(A_{i,t}) = ln(A_0) + \varepsilon_i$ for the unobservable technological progress[7] and subtracting from both sides of (2) the initial income $ln(y_{i,0})$ and taking logs

$$\gamma_{it} = g_i + \beta ln(A_0) - \beta \left[\frac{\alpha_K}{1-\alpha_K-\alpha_H} ln(sk_{it}) + \right. \quad (3)$$

$$\left. + \frac{\alpha_H}{1-\alpha_K-\alpha_H} ln(sh_{it}) - \frac{\alpha_K+\alpha_H}{1-\alpha_K-\alpha_H} ln(n_i + g + \delta) - ln(y_{i,0}) \right] + \varepsilon_{it},$$

where $\gamma_{i,t} = t^{-1}(ln(y_{i,t}) - ln(y_{i,0}))$ is the rate of growth of the output per labor input and $\beta = -t^{-1}(1 - e^{-\lambda_i t})$ (with $\lambda_i > 0$) measures the convergence rate of the output per labor force to its steady-state value. Finally, technology (A_{it}) and labor force (L_{it}) are assumed to grow at exogenous and constant rates, respectively, identified by the rate of growth of the labor augmenting technological progress (g_i) and population (n_i).

The standard specification illustrated in (3) has been criticized on several grounds. Brock and Durlauf (2000), Durlauf (2001), Durlauf et al. (2001), Durlauf and Johnson (1995), Liu and Stengos (1999), Kalaitzidakis et al. (2001), and Masanjala and Papageorgiou (2004), under different approaches, reject the parameter homogeneity assumption implied by (3) due to the above-mentioned problems of nonlinearity of the log transformed production function, parameter variability across countries, and omitted variable bias. A further problem is that saving rates are highly likely to be correlated with initial conditions. Goetz and Hu (1996) argue that the convergence results based on (3) are biased since physical and human capital accumulation are functions of per capita (or per worker) income. On the same line, Cohen-Cole et al. (2012) shows that this specification fails to consider the feedback effect between human capital and income level. Moreover, Durlauf et al. (2005) emphasize that these regressions are difficult to define since the model uncertainty is a problem that is only partially solved by nonlinear specifications (Kalaitzidakis et al., 2001).

For all these reasons, level and growth rates are likely to be correlated thus biasing univariate estimates for level and growth rates (Bernanke and Gürkaynak 2001 and Alfó et al. 2008). Following Alfó et al. (2008), we perform a factor analysis to check for multicollinearity among variables in the MRW Solowian growth model. Under the fundamental statistical assumption that regressors have to be orthogonal, extracted factors should explain not more than 20%–25% of the total variance in the augmented Solowian framework. As shown in Tables 6 and 7, results of factor analysis confirm previous findings from Alfó et al. (2008) and, specifically, lack of independence among regressors, given that all the model variability can be

[7] MRW stress that $ln(A_{it})$ reflects not only the technological progress but also all the "not directly" estimable country-specific conditions as like as climate or institutions or resources endowments. MRW assume that these differences vary across countries following the relationship: $ln(A_{i,t}) = ln(A_0) + \upsilon_i$ in which the random term ε_i is normally distributed and independent from the n_i, $s_{K,i}$, and $s_{H,i}$ distributions, with $ln(A_0)$ being constant across time periods and countries

expressed by a single factor. These results could support Cohen-Cole et al. (2012) hypothesis of a feedback between initial conditions and human capital effects.

For this reason, in what follows, we model the growth path also with a bivariate model, thereby avoiding the risk of correlation between regressors and the error terms.[8] In this way, we can study the effects of human capital allowing for conditional convergence analysis. In the growth literature, $\beta-$convergence occurs if poorer countries grow faster than richer ones. In the bivariate process with equations of level and growth rates of per capita income, we can test for convergence by examining correlations of their respective residuals. If the model identifies a negative and significant correlation among residuals, this indicates the presence of a convergence path. Following ATW, the proposed model assumes that unobserved heterogeneity, via the random coefficients of the intercept and human capital variable, impacts on both level and growth rates in the steady state. This means that, if poorer countries catch up with the levels of per capita income of richer countries, the corresponding latent structures should be negatively correlated once dependence between the two responses has been accounted for Davidson and MacKinnon (1993).

The Specification of the Unconditioned Bivariate Growth Model

To illustrate the bivariate process analytically,[9] we denote with y_{1it} and y_{2it} per capita levels and growth rates of domestic output at time $t = 1, \ldots, T$, respectively. Assuming that p_{jt} covariates have been recorded for each country, we denote by $\mathbf{x}_{1it}$ and $\mathbf{x}_{2it}$ the design matrix including them alongside the vectors of the two intercepts. To simplify the discussion, consider the case where covariates are the same in the two equations and, respectively, equal to $x_{1it} = \ln[sk_{it}/(n_i + g + \delta)]$ and $x_{2it} = \ln[sh_{it}/(n_i + g + \delta)]$. Following the usual notation for multivariate data, let $\mathbf{y}_i = (\mathbf{y}_{i1}, \mathbf{y}_{i2})$ denote respectively the vector of observed per capita and growth rate of output for the i-th country $(i = 1, \ldots, n)$ in the analyzed time window. In the MRW framework, differentiation along the balanced growth path equation shows that only time-related changes in technology affect country-specific growth rates. As a result, growth rates are independent of capital accumulation. MRW assume that technology may differ across countries reflecting more country-specific characteristics unrelated to industrial decisions. In that contest, following BG and ATW, we can define the technology path in standard notation as

$$\ln(A_{it}) = \bar{a}_t + \varepsilon_{it} \tag{4}$$

[8] Even though in a semi-parametric model, this risk would be lower.

[9] See Alfó and Trovato (2004) and Alfó et al. (2008) for the univariate specification of the finite mixture.

and obtain the following system:

$$E(\mathbf{y}_i) = \begin{cases} y_{1it} = \ln(y_{it}^*) + \varepsilon_{it} + \xi_{it} = \bar{a}_t + \frac{\alpha}{(1-\alpha-\beta)} \ln\left[\frac{sk_{it}}{(n_i+g+\delta)}\right] \\ \qquad + \frac{\beta}{(1-\alpha-\beta)} \ln\left[\frac{sh_{it}}{(n_i+g+\delta)}\right] + \varepsilon_{it} + \xi_{it} \\ \\ y_{2it} = gw_{it} = \ln(y_{it})^* - \ln(y_{i0}^*) = \ln(A_{it}) - \ln(A_{i0}) \\ \qquad = tg(\cdot) + \xi_{it} - \xi_{i0}, \end{cases} \tag{5}$$

where the balanced growth equilibrium output per worker, $\ln(y_{it}^*)$, differs from the current observed value of the same variable $\ln(y_{it})$ only for a random component, ε_{it}, plus a stochastic and stationary term, ξ_{it}, which represents the cyclical deviation from that path. The second equation specifies that, according to the Solow model, the growth rate of per capita GDP (gw_{it}) is not affected by saving rates. Indeed, by differentiating the output per worker along the balanced growth path, we obtain the second expression of the system. Looking at the possibility that countries converge overall, it can be noted that multiple steady -state regimes are possible in a Solowian contest (Azariadis and Drazen, 1990; Durlauf and Johnson 1995 and Bernard and Durlauf 1996). As shown in ATW, starting from the model of Bernanke and Gürkaynak (2001), we admit the possibility of multiple balanced growth paths entailing heterogenous groups of countries. More specifically, we use a multivariate expansion of the univariate model since the error terms in system (5) are correlated, allowing for correlated latent effects. Given such modeling assumptions, the bivariate regression model may be written as follows:

$$E[y_{ijt}] = (\gamma_0 + u_{0ij}) + x_{1it}\gamma_{1j} + x_{2it}(\gamma_{2j} + u_{1ij}), \quad j = 1, 2 \quad i = 1, \ldots, n, \tag{6}$$

where u_{0ij} and u_{1ij} represent, respectively, the vectors of heterogeneity in the intercept and human capital investment coefficient.[10]

As a consequence, we can rewrite (6) as

$$E[y_{ijt}] = \gamma_{0ij} + x_{1it}\gamma_{1j} + x_{2it}\gamma_{2ij}, \quad j = 1, 2 \quad i = 1, \ldots, n. \tag{7}$$

As demonstrated by Alfó and Trovato (2004), the estimated correlation structure between the nonparametric latent terms takes into account both sources of heterogeneity (i.e., from level and growth equations, respectively). Given model assumptions, the corresponding likelihood function of (6) can be rewritten as

[10] We model only the random component of the intercept and the human capital parameter to have a more parsimonious model and to make it analytically tractable.

follows:

$$L(\cdot) = \prod_{i=1}^{n} \left\{ \int_{\mathcal{U}} f(\mathbf{y}_i \,|\mathbf{X}_i, \mathbf{u}_i)\, \mathrm{d}G(\mathbf{U}_i) \right\}$$
$$= \prod_{i=1}^{n} \left\{ \int_{\mathcal{U}} \left[\prod_{j} \prod_{t=1}^{T} f\left(y_{jit} \,|\mathbf{x}_{it}, u_{ij} \right) \right] \mathrm{d}G(\mathbf{U}_i) \right\}. \tag{8}$$

This multiple integral cannot be solved in closed form, even though some simplifications are possible. We therefore provide a nonparametric ML estimation of the mixing distribution $G(\cdot)$ (for a detailed discussion, see Alfó and Trovato 2004). In this case, the likelihood function becomes

$$L(\cdot) = \prod_{i=1}^{n} \left\{ \sum_{k=1}^{K} f_{ik}\pi_k \right\} = \prod_{i=1}^{n} \left\{ \sum_{k=1}^{K} \left[\prod_{j} \prod_{t=1}^{T} f\left(y_{jit} \mid \mathbf{x}_{it}, u_{jk} \right) \right] \pi_k \right\}, \tag{9}$$

where $\pi_k = \Pr(\mathbf{U}_k) = \Pr(u_{k01}, u_{k02}, u_{k21}, u_{k22})$, $k = 1, \ldots, K$ represents the joint probability of locations $\mathbf{u}_k$.

In this model then, locations $\mathbf{U}_k$ and corresponding masses π_k have to be estimated by introducing into the linear predictor the interaction between a K-level factor and the indicator variables d_{jit}, where $d_{jit} = 1\ \forall i = 1, \ldots, n,\ j = 1, 2$ and $t = 1, \ldots, T$, if the $j-th$ outcome is modeled, and 0 otherwise. By taking derivatives of the vector of model parameters, $\boldsymbol{\gamma}$, we have

$$\frac{\partial \log[L(\boldsymbol{\gamma})]}{\partial \boldsymbol{\gamma}} = \frac{\partial \ell(\boldsymbol{\gamma})}{\partial \boldsymbol{\gamma}} = \sum_{i=1}^{n} \sum_{k=1}^{K} \left(\frac{\pi_k f_{ik}}{\sum_{k=1}^{K} \pi_k f_{ik}} \right) \frac{\partial \log f_{ik}}{\partial \boldsymbol{\gamma}} = \sum_{i=1}^{n} \sum_{k=1}^{K} w_{ik} \frac{\partial \log f_{ik}}{\partial \boldsymbol{\gamma}}, \tag{10}$$

where

$$f_{ik} = f(\mathbf{y}_i \mid \mathbf{x}_i, \mathbf{u}_k) = \prod_{j=1}^{2} \prod_{t=1}^{T} f\left(y_{jit} \mid \mathbf{x}_{it}, u_{kj} \right) = \prod_{j=1}^{2} \prod_{t=1}^{T} f_{jik} \tag{11}$$

and w_{ik} represents the posterior probability that the $i-th$ unit belongs to the $k-th$ mixture component. The corresponding likelihood equations are weighted sums of those from an ordinary multivariate regression model with weights w_{ik}.

The description of the model should have clarified that we use a semi-parametric model. We do so because it allows us: (i) to take into account country heterogeneity in physical and economic characteristics (climate, geographical environments, political systems, but also differences in technologies, factors endowment, markets structures, etc.); (ii) to accommodate extreme and/or strongly asymmetric departures from normality; (iii) to cluster regions according to homogeneous values of mixture components; (iv) to consider directly a Solowian standard model of growth. In fact, all the social and political variables enter into our empirical estimation process only as explanatory of the latent structures of countries. This will allow us to benefit from the explanatory power of homogeneous clusters of economic spaces, without losing empirical and theoretical contribution of additional factors that explain economic development. In the next section, we discuss our mixture model more in detail in order to understand how the initial stock of human capital affects the growth path of countries.

The Mixture Model with Concomitant Variables

In the previous paragraph, we have shown that finite mixture models could be a proper tool to model unobserved heterogeneity in a semi-parametric approach. Moreover, the side result of mixture models is the classification of units in clusters with homogeneous unobserved characteristics, based on the the posterior probability estimates $\widehat{w}_{ik}$. According to a simple mapping rule, in fact, the i-th country can be classified into the l-th component if $\widehat{w}_{il} = \max(\widehat{w}_{i1}, \ldots, \widehat{w}_{iK})$. It is worth noticing that each component is characterized by homogeneous values of the estimated latent effects, i.e., conditionally on the observed covariates, countries from that group show a similar structure, at least in the steady state. In equation (11), the w_{ik} weights are estimated in an unconditional way. In the following, we specify that the weights could depend on different factors. Strictly speaking, we allow each component of the mixture to have an assigned weight depending on further variables (i.e., concomitant variables). As stressed by Grün and Leisch (2008) and Dayton and Macready (1988), the concomitant variables (i.e., those that could model the probability weight) are to be simultaneously estimated in the EM process. In our specification, the relationships between the standard growth and the socio-demographic variables is then modeled through concomitant variable models where group sizes (i.e., the weights of the mixture) depend on the socio-demographic variables. In particular, by assuming that $\pi = f(\alpha, c)$ where c is the concomitant variable and α its parameter, we can modify the likelihood in equation 9 obtaining

$$L(\cdot) = \prod_{i=1}^{n} \left\{ \sum_{k=1}^{K} f_{ik} \pi_k(\alpha, c) \right\} = \prod_{i=1}^{n} \left\{ \sum_{k=1}^{K} \left[\prod_{j} \prod_{t=1}^{T} f\left(y_{jit} \mid \mathbf{x}_{it}, u_{jk} \right) \right] \pi_k(\alpha, c) \right\}, \tag{12}$$

where

$$\forall c \sum_{k=1}^{K} \pi(\alpha, c) = 1 \; \pi(\alpha, c) > 0. \tag{13}$$

Following Dayton and Macready (1988), we use the following multinomial logit model to estimate the posterior probability

$$\pi(\alpha, c) = \frac{e^{c^{\mathsf{T}}} \alpha_k}{\sum_1^K e^{c^{\mathsf{T}}} \alpha_k}. \tag{14}$$

As a consequence, the estimated posterior probability is

$$\hat{\pi}_{ik} = \frac{\pi(c_k, \alpha) f_{ik}}{\sum_1^K \pi_k(c_k, \alpha) f_{ik}}. \tag{15}$$

Summing up, the above model allows us to account more properly for the role of human capital on growth inequality among countries and to test whether the initial level of human capital affects the probability of belonging to a specific cluster. In other words, the estimated country's probability to belong to a specific cluster has been modeled as a function of the different levels of human capital measured in 1960, and our aim is to test if countries with higher initial condition grow faster or not.

The Dataset

We estimate the model for non-overlapping 5-year periods between 1960 and 2005 for the subset of non-oil countries, with regressors being lagged four years with respect to the dependent variable. Five-year periods are standard in the panel growth literature, given the trade-off between having sufficient degrees of freedom and avoiding the negative effects of the strong autocorrelation of dependent variables (Bond et al. 2001). Data are drawn from the Summers–Heston Penn World Tables (PWT 6.3) and World Bank economic indicators. In estimating (5), we use as dependent variable the logarithm of the real gross domestic product (real GDP) per total labor force ($ln(Y/L)$) and its growth rate (measured as a one-period log difference). Among regressors, $ln(sk)$ is the log of gross domestic investment over GDP, $ln(sh)$ is the log of the percentage of population over 15 years old who completed secondary school over the working population, and $ln(ngd)$ is the log of the sum of population growth, the rate of technological progress, and capital depreciation.[11] The GDP per working population, the stock of physical capital, and the population are retrieved from the Penn World Tables (PWT) 6.3 database, while the sources for the schooling variable are either the World Bank 2010 series or the Barro and Lee database.

Results

In the sections that follow, we present results for both unconditioned and conditioned probability mixture models. In the next subsection, we display findings for the univariate specification using two different (Barro and Lee and World Bank) human capital measures. Our findings document in this case that the results obtained with both parametric and semi-parametric models, under both measures of human capital, are biased because of the presence of multicollinearity among regressors and the consequent impossibility of discriminating between initial conditions (measured by initial levels of GDP per worker and by intercept) and structural differences (measured by physical and human capital). This is why we propose in section "The Bivariate Specification and the Convergence's Clubs" the unconditioned bivariate mixture model approach. In that section, we comment on results obtained with this methodology by emphasizing that it allows to understand more about the dynamics of economic growth paths. Our findings document the presence of unobserved heterogeneity leading to the selection of six groups of countries sharing the same "environmental" conditions. After this step, we perform a multinomial logit model in which we document the role of quality of human capital and other structural variables in explaining the differences in countries growth rates. At this step of the analysis, however, the human capital puzzle seems not yet resolved. Finally, in section "Does Human Capital Initial Level Affect Growth Dynamics?," we show that, once prior probabilities are conditioned on the concomitant variable (the initial stock of human capital), countries are clustered into four groups and the initial human capital stock has an important role in explaining differences in growth regimes.

The Univariate Specification and the Factor Analysis

We estimate models from equations (3) and (5) using finite mixture and parametric specifications. As reported in Table 1, we use as parametric benchmarks the feasible generalized least square (FGLS) and the OLS fixed-effect model. Results displayed

[11] We follow the standard convention of using a common value of .05 for g+d and summing it to the rate of population growth. In any case, our findings are in line with those discussed by Lee et al. (1997) using a stochastic Solow model and allowing for country-specific depreciation and technological progress.

Table 1 Comparison between the univariate parametric models and finite mixture models

	Finite Mixture Model		Feasible GLS		OLS Fixed Effect	
gavgF5	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
lnyL	−0.015**	0.002	−0.009**	0.001	−0.036**	0.004
lnsh	−0.002	0.004	−0.001	0.001	0.001	0.002
lnsk	0.028**	0.003	0.026**	0.002	0.025**	0.004
lngd	−0.046**	0.016	−0.033**	0.009	0.064**	0.018
const	0.062	0.048	0.050†	0.027	0.208**	0.064
ℓ	1458.494		376.364			
Number of observations	711		711		711	
Number of countries	90		90		90	
K	3					
Romano test ($H_0 : K = 3$)	0.040	$\simeq$ 0.345				
σ^2	.00086765	(.00004966)				

Significance levels : † : 10% * : 5% **: 1%
gavgF5: 5'Ys per worker GDP growth; lnyL: initial level of log of per worker GDP; ln(sh): log of schooling years of the working population; ln(sk): log of the Summers–Heston corrected investment to GDP ratio; lngd: log of the sum of the rates of change in population and in technological progress plus depreciation ; K: the number of mixture components that are selected by the BIC criteria; ℓ: log-likelihood; σ^2: within-countries (residual) variance. Time intervals in panel estimates: non-overlapping 5-year periods between 1960 and 2000, with regressors being lagged four years with respect to the dependent variable

provide evidence consistent with the human capital's puzzle: i.e., spending in human capital seems not to be the right choice for driving economic growth.[12]

The literature (see, for example, the Temple's discussion (1999) on the topic) identifies error in measurement of (quality of) human capital (see, for example, Cohen-Cole et al. 2012) or brain drain effects as possible causes for this well-known puzzle. Since finite mixture models impose a latent structure for the covariates, they can accommodate for error-in-variables bias or for some unobserved heterogeneity effects (Aitkin and Rocci 2002, Alfó and Trovato 2004). The problem is also that, when we estimate the model by mixtures, the human capital accumulation variable still remains not significant. Moreover, our results do not change when we use the alternative human capital measure from Barro and Lee (2001) dataset (see Table 2, the estimates for locations and probabilities are not presented here for reasons of space but are available upon request).[13] (Table 3). As derived from equations (10) and (11)[14] the secondary product of finite mixtures is that they allow for

[12] The models have been estimated using GLLAMM package for STATA 17 or FlexMix package for R-plus.

[13] Since using Barro and Lee's measure does not change our results, we continue in what follows by using the traditional World Bank measure of the log of the percentage of population over 15 years old who completed secondary school over the working population.

[14] In the case of univariate model equation, (11) becomes

Table 2 Univariate parametric models and finite mixture models. Barro & Lee measure of human capital

	Finite Mixture Model		Feasible GLS		OLS Fixed Effect	
gavgF5	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
lnyL	−0.015**	0.002	−0.009**	0.001	−0.035**	0.004
lnsk	0.029**	0.002	0.026**	0.002	0.025**	0.005
lnsh	0.0005	0.003	−0.002	0.002	0.0001	0.004
lngd	−0.045**	0.016	−0.031†	0.009	−0.060**	0.019
const	0.071	0.049	0.058	0.027	0.203**	0.064
ℓ	1455.06		1433.6			
Number of observations	711		711		711	
Number of countries	90		90		90	
K	4					
Romano Test ($H_0 : K = 4$)	$0.033 \simeq 0.789$					
σ^2	8.80E-04	4.96E-05				

Significance levels : † : 10% * : 5% **: 1%
lnsh: Barro & Lee measure of Human Capital see Table 1

Table 3 Matrix of variances and covariances of random terms for univariate finite mixture models

	σ_{u_1}	σ_{u_2}
σ_{u1}	0.0099	
σ_{u_2}	0.0033	0.0011

σ_{u_1} Std. dev. for intercept
σ_{u_2} Std. dev. for sh

Table 4 Locations and probabilities for univariate finite mixture models

Clusters	$\hat{\gamma}0k$	$\hat{\gamma}_{3k}$	$\hat{\pi}_k$
$k = 1$	−0.92774	−0.31006	0.0111
$k = 2$	0.01777	0.00447	0.7753
$k = 3$	0.00462	−0.00846	0.0321
$k = 4$	−0.01996	0.00139	0.181

$\hat{\gamma}_{0k}$ estimated locations for intercept
$\hat{\gamma}_{3k}$ estimated locations for sh
$\hat{\pi}_k$ estimated posterior probability

posterior classification of units in clusters (Tables 4 and 5). As specified in equation (11), posterior probability and locations (Table 4) define clusters within which countries share the same space of characteristics identified by the latent structure.

$$\frac{\partial \log[L(\boldsymbol{\delta})]}{\partial \boldsymbol{\delta}} = \frac{\partial \ell(\boldsymbol{\delta})}{\partial \boldsymbol{\delta}} = \sum_{i=1}^{n} \sum_{k=1}^{K} \left(\frac{\pi_k f_{ik}}{\sum_{k=1}^{K} \pi_k f_{ik}} \right) \frac{\partial \log f_{ik}}{\partial \boldsymbol{\delta}} = \sum_{i=1}^{n} \sum_{k=1}^{K} w_{ik} \frac{\partial \log f_{ik}}{\partial \boldsymbol{\delta}}, \tag{16}$$

where w_{ik} represents the posterior probability that the $i-th$ unit comes from the $k-th$ component of the mixture.

Table 5 Penalized criteria for univariate finite mixture models

K	2	3	4	5	6	7
ℓ	1443.0096	1457.2013	1458.494	1459.5507	1459.5507	1459.5507
BIC	−2840.052	−2842.17	−2818.49	−2794.33	−2768.07	−2741.80
AIC	−2872.02	−2892.40	−2886.99	−2881.10	−2873.10	−2865.11
CAIC	−2833.05	−2831.17	−2803.49	−2775.33	−2745.07	−2714.80

K: locations; ℓ: log-likelihood; $BIC = -2\ell(\cdot) + d\log n$; $AIC = -2\ell(\cdot) + d$; $CAIC = -2\ell(\cdot) + d(\log n + 1)$
where d is the number of parameters and n is the sample size

Table 6 Factor analysis: principal components, rotate

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.861	1.383	0.905	0.905
Factor2	0.477	.	0.232	1.137

Model $lny_{i,t-1}, lnsh_{i,t}, lnsk_{i,t}, lnsk_{i,t}$
LR test of independence: $\chi^2(6) = 977.04$

Results of country classification under this approach are highly unsatisfactory.[15] As specified in paragraphs and , we believe that this is due to the extremely high feedback effect between human capital and initial conditions. If this feedback effect exists, then we have (at least) multicollinearity in the empirical specification. Moreover, Durlauf et al. (2005) remark that initial conditions and proxy variables for structural heterogeneity, as well as for schooling rates among countries, could be endogenously self-determined, thereby leading to failure in testing convergence. For this reason, we perform a factor analysis to check for multicollinearity between variables in the MRW Solovian growth model. Should the four regressors be orthogonal, we would find factors explaining no more than 20%–25% of the total variance. Looking at Tables 6 and 7 and Fig. 1,
however, we find that the first factor accounts for approximately 90% of the total variance. The collinearity among regressors is further evidenced by looking at the factor scoring plot (Fig. 2) where we can clearly see that initial conditions (measured

[15] Country classification using log of the percentage of population over 15 years old completed secondary school over the working population for the univariate model is:

1. Liberia Algeria Benin Central African Congo, Dem. Rep. Honduras Jamaica Malawi Mauritania Nicaragua Niger Papua New Guinea Peru Sierra Leone Tanzania Togo Zambia Zimbabwe
2. Botswana
3. Argentina Australia Austria Bangladesh Belgium Bolivia Brazil Burundi Cameroon Canada Chile China Colombia Congo, Rep. Costa Rica Cote d'Ivoire Denmark Dominican Republ Ecuador Egypt, Arab Rep. El Salvador Finland France Germany Ghana Greece Guatemala Haiti Hong Kong SAR, C India Indonesia Ireland Israel Italy Japan Jordan Kenya Korea, Rep. Malaysia Mali Mauritius Mexico Morocco Mozambique Nepal Netherlands New Zealand Norway Pakistan Panama Paraguay Philippines Portugal Rwanda Senegal Singapore South Africa Spain Sri Lanka Sudan Sweden Switzerland Syrian Arab Repu Thailand Trinidad and Tob Tunisia Turkey Uganda United Kingdom United States Uruguay

Table 7 Rotate factor loadings

Variable	Factor1	Factor2	(1-Uniqueness)
lnyL	0.8274	−0.1234	0.3002
lnsh	0.8053	0.0636	0.3474
lnsk	0.6908	−0.0228	0.5223
lngd	0.2554	0.261	0.8667

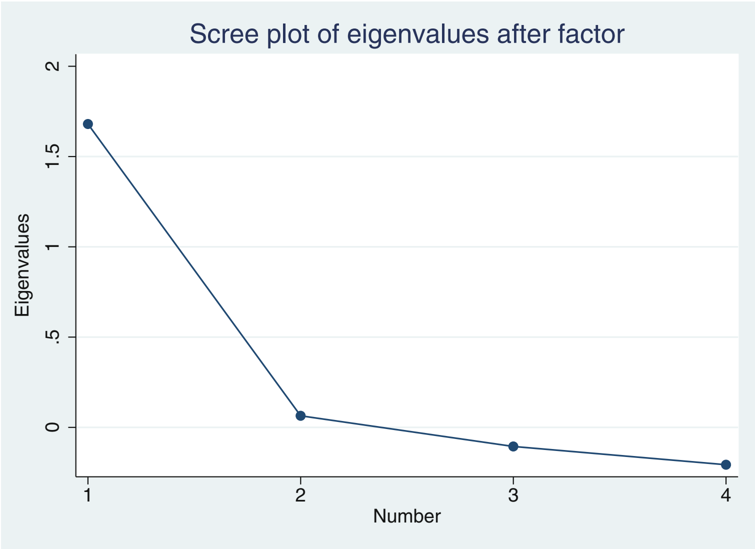

Fig. 1 Eigenvalues Plot after PCM. Model $lny_{i,t-1}, lnsh_{i,t}, lnsk_{i,t}, lnsk_{i,t}$

by the initial level of GDP per worker), human, and physical capital are so highly correlated to identify just the same factor, with only population going into a second one.

These results confirm what observed by Durlauf et al. (2005) and Alfó et al. (2008). Cross-section tests on convergence are inflated by collinearity, and since initial per capita GDP is a good predictor for capital saving rates, additional covariates effects are likely not to be estimated properly.

The fact that both mixtures and parametric standard models give unexpected results in terms of parameters' magnitude and significance in the standard conditional convergence equation seems to confirm that level variables and initial levels of log GDP per capita are inter-related, so that it is likely that the variance of the log difference of GDP per capita is almost entirely covered by that of the initial conditions (see, among others, Temple 1999). This implies that the significance of the lagged level of GDP in convergence estimates is upward biased since this variable captures heterogeneity in level variables. This may also contribute to explain the puzzle of the insignificant effect of human capital in panel growth estimates (most of which is a *between* rather than a *within* effect, the *between* effect being captured by the lagged income level). In what follows we show

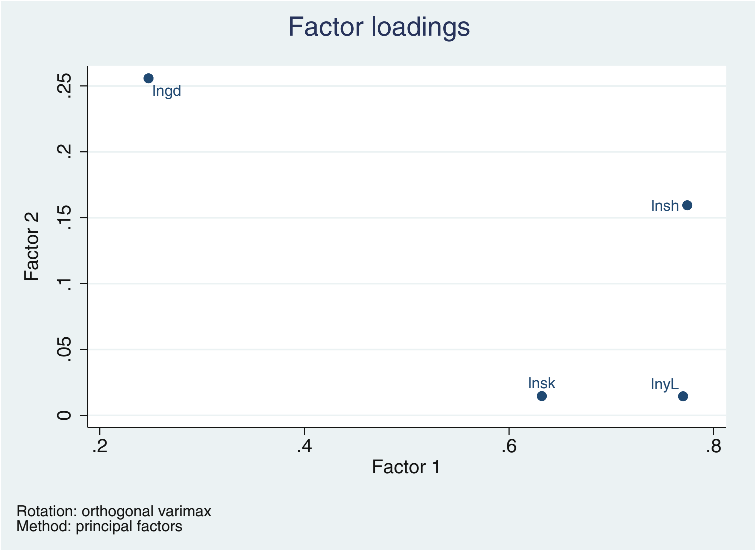

Fig. 2 Factor Loading Plot. Model $lny_{i,t-1}, lnsh_{i,t}, lnsk_{i,t}, lnsk_{i,t}$

that, by accounting for unobserved heterogeneity and tacking into account for multicollinearity, we find that convergence exists for clubs of countries and that human capital contribution to output is different for different groups of countries.

The Bivariate Specification and the Convergence's Clubs

Following Alfó et al. (2008), we employ the bivariate mixture model trying to solve the above described shortcoming in the standard specification approach. For the two-equation system, we apply the SUR estimate of BG (2001) that assumes that the two dependent variables are the outcomes of a unique density function (Tables 3 and 8) in our bivariate finite mixture model (Table 8, columns 3 and 4). Criteria for evaluating the optimal number of clusters are provided in Table 9, while Tables 10 and 11 provide locations as well as probabilities of the six identified clusters and the matrix of correlation effects, respectively.

In Table 8, the estimated within-country variance is 0.021 and its standard error 0.0009. The hypothesis of parameter homogeneity is therefore rejected. The variances of the random terms are high and significant (Table 11).

Table 8 Comparison between the bivariate SUR and finite mixture models

	Seemingly Unrelated Model		Bivariate FMM	
ln(y)	Coef.	Std. Err.	Coef.	Std.Err.
const	4.778**	0.748	8.932**	0.384
ln(sh)	0.437**	0.064	0.239**	0.015
ln(sk)	0.444**	0.084	0.301**	0.016
lngd	−2.351**	0.259	−0.573**	0.131
gw				
const	0.011**	0.004	0.001	0.020
sk	0.075**	0.014	0.101	0.089
sh	−0.068*	0.036	−0.009	0.106
glf	−0.380**	0.126	−0.967	1.839
ℓ	−428.91		68.2515	
Number of observations	1012		1012	
Number of countries	90		90	
Breusch–Pagan test	χ^2=8.245			
K			6	
Romano Test ($H_0 : K = 6$)			0.070	$\simeq$ 0.545
σ^2			.0210 (0.0009)	

Significance levels : † : 10% * : 5% **: 1%

ln(y): log of per capita GDP; ln(sh): log of schooling years of the working population; ln(sk): log of the Summers–Heston corrected investment to GDP ratio; lngd: log of the sum of the rates of change in population and in technological progress plus depreciation; K: the number of mixture components that are selected by the BIC criteria; ℓ: log-likelihood; σ^2: within-countries (residual) variance. Time intervals in panel estimates: non-overlapping 5-year periods between 1960 and 2000, with regressors being lagged four years with respect to the dependent variable

Table 9 Penalized criteria for bivariate finite mixture models

k	2	3	4	5	6	7
ℓ	−242.936	−100.852	100.085	175.364	216.1021	214.3335
BIC	592.5936	351.113	−8.071	−115.941	−154.728	−108.502
AIC	515.8718	243.703	−146.1695	−284.728	−354.204	−338.667
CAIC	586.435	369.308	34.477	−49.039	−63.473	7.106

K: locations; ℓ: log-likelihood; $BIC = -2\ell(\cdot) + d \log n$; $AIC = -2\ell(\cdot) + d$; $CAIC = -2\ell(\cdot) + d(\log n + 1)$
where d is the number of parameters and n is the sample size

The likelihood ratio test (LRT) shows that the effect of human capital varies significantly among countries with p-values equal to 0.001 (Table 8).[16] The hypothesis of homogeneity in the impact of per capita GDP on levels is therefore rejected,

[16] The p-values are obtained by comparing the maximum likelihood of the full and constrained model. The latter is obtained by estimating the model without the random coefficient of the schooling variable.

Table 10 Location and probabilities of 5-year BFME

k	1	2	3	4	5	6
u_{01}:	−1.800	−0.993	0.938	0.553	−0.489	1.062
u_{21}:	−0.145	−0.089	0.099	0.130	−0.105	−0.029
u_{02}:	−0.012	0.001	0.001	0.006	−0.006	0.005
u_{22}:	0.122	0.028	−0.022	−0.007	−0.051	−0.041
prob	0.108	0.193	0.230	0.216	0.142	0.112

u_{01}: intercept latent effect in the level equation; u_{21}: human capital latent effect in the level equation; u_{02}: intercept latent effect in the growth equation;u_{22}: human capital latent effect in the growth equation

Table 11 Correlation matrix of the latent effects

	$\sigma_{u_{01}}$	$\sigma_{u_{21}}$	$\sigma_{u_{02}}$	$\sigma_{u_{22}}$
$\sigma_{u_{01}}$	0.954**			
$\sigma_{u_{21}}$	0.004**	0.00003**		
$\sigma_{u_{02}}$	0.0845*	0.0004*	0.0110497*	
$\sigma_{u_{22}}$	−0.128†	−0.020*	−0.002†	0.1313†

Significance levels : † : 10% * : 5% **: 1%.
$\sigma_{u_{01}}$: standard deviation of the intercept latent effect in the level equation; $\sigma_{u_{21}}$: standard deviation of human capital latent effect in the level equation; $\sigma_{u_{02}}$: standard deviation of the intercept latent effect in the growth equation;$\sigma_{u_{22}}$: standard deviation of the human capital latent effect in the growth equation

confirming the Solowian theoretical framework. Strictly speaking, the Solow model predicts that in the long-run steady state the level of real output per worker is a function of the saving rate and of the labor force growth rate. Since saving and growth rates vary across countries, each country has a specific steady state; if country steady state correctly describes the distribution of output per worker, the Solow model assumes that the long-run growth rate is independent of saving rates and capital accumulation. For this reason, results from Alfó et al. (2008), Azariadis and Drazen (1990), Durlauf and Johnson (1995), Bernard and Durlauf (1996), and Galor (1996) may also be consistent with the presence of convergence clubs and multiple equilibria within the Solow model. In our approach, the unobserved heterogeneity produces clusters of countries: i.e., we can assign countries to clusters since each country belongs to a given space of characteristics on the log-likelihood with a proper posterior probability $\widehat{z}_{ik}$. The i-th country can be classified in the l-th group (component of the estimated mixture) if $\widehat{z}_{il} = \max(\widehat{z}_{i1}, \ldots, \widehat{z}_{iK})$. It is worth noting that each group is characterized by homogeneous values of the estimated random effects, i.e., countries assigned to that group have a similar structure conditional on the observed covariates. In identifying locations and prior probabilities of the mixture, we find that the Bayesian Information Criterion is maximized when considering the optimal number of six mass points (Table 9). We also perform a test for the null hypothesis that data are drawn from exactly a 6-component finite mixture following the Romano (1988) bootstrap-based procedure. The observed value of the (scaled) D statistic is equal to 0.070 with the corresponding (approximate) p-value $\simeq$ 0.545 (B=1000 resamples). With the same approach, we test the null hypothesis that data are drawn from the homogeneous OLS model, obtaining an approximate p-value < 0.001 (B=1000 resamples). As a result, the null hypothesis is clearly rejected in this second case and not rejected in the first.

Signs and magnitudes of the estimated coefficients of the production function with the mixture approach are as expected in the level equation (Table 8). Physical and human capital are positive and significant in the level equation, and the term capturing the sum of capital depreciation, population growth, and technological progress is negative and significant. Mean response coefficients of the independent variables under the mixture model are different from those obtained under the SUR (homogeneous parameter) approach. In the SUR level equation, the three regressor coefficients are larger, while the intercept is smaller. A closer look at coefficient magnitudes in the level equation provides additional points in favor of the finite mixture approach. First, it is evident that the standard Cobb–Douglas restriction that assumes that the sum of the physical and human capital coefficients must equal, in absolute value, the third variable coefficient is not rejected in the mixture model, while it is rejected in the benchmark homogeneous parameter model. Second, implied factor shares (α and β) under the RC approach are around 22 percent for physical capital and (as sample average) 35 percent for human capital. While such values are in line with those assumed in the literature,[17] those implied by the SUR model coefficients are much less reasonable.

By looking at growth equations, the SUR approach exhibits a positive and significant physical capital, as well as a surprisingly negative and weakly significant human capital coefficient. Our SUR results are similar to those of BG. The significance of parameters in the growth equation leads to a rejection of the Solow model. Moreover, the correlation of the system residuals is 0.122 with p-value = 0.0049, indicating lack of convergence. In any case, the human capital result requires further inquiry.

The growth equation of the finite mixture approach shows all insignificant coefficients implying the non-rejection of the Solow model. Moreover, by looking at Table 11, we can see that the correlation among residuals is always positive and significant, with the exception of that of human capital effects in the growth equation (u_{22}), which are negatively correlated with those of the level equation. These findings suggest that, even though differences in factors underlying human capital investment are diminishing between countries, differences in country-specific characteristics are growing (the random terms of the intercepts). Finally, random components of the intercepts of the level and growth equations are positively correlated revealing lack of convergence across groups (Table 11). As a result, our evidence supports the hypothesis of persisting divergences across countries and is therefore not at odds with the idea of convergence clubs (groups with different levels

[17] MRW calculate by comparing average and minimum manufacturing wage that the human capital share should be between one half and one third.

of per capita GDP with their own specific growth paths) at least with regard to our estimation period.

Based on the interpretation of these results, the policy claim of the paper is that convergence in schooling years is not enough to produce economic convergence if differences in quality of institutions and education persist.

Even though many of the factors mentioned above indicate that our parsimonious hypothesis on the number of heterogeneous parameters improves significantly upon the homogeneous benchmark, the difference may be considered somewhat implicit in the characteristics of the two models. The real point is therefore the trade-off between model abstraction of reality and the capacity to capture the most important regularities of economic development. In principle, a model with a number of clusters equal to the number of country years would perfectly reproduce the observed reality but would not help us to identify any regularity of the phenomenon. By contrast, an over-simplification, such as homogeneous parameter estimates, is too far from reality and prevents us from identifying important aspects of it (existence of convergence clubs, estimation of out-of-the-model possible factors affecting the impact of inputs on the production function, etc.). With the aim to shed light on this point and by following Aitkin (1997) and McLachlan and Peel (2000), we plot cdfs (see Fig. 3) from the latent class model, the observed values, and the homogeneous parameter SUR benchmark. We show that with a slightly lower level of abstraction (only four heterogeneous parameters and far fewer clusters than the number of country years) we get very close to the observed values of the dependent

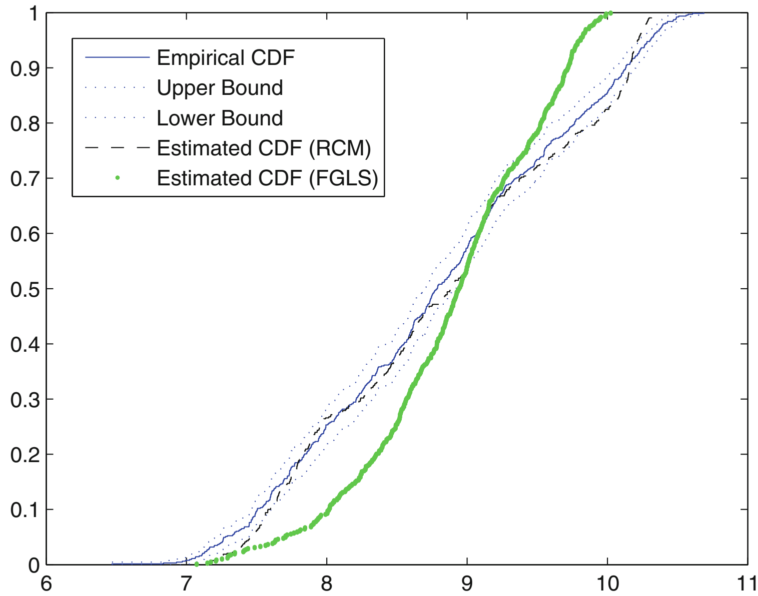

Fig. 3 Cumulative density function (CDF) limits and RCM and SUR CDFs

variable and within its 95 percent cdf bands, while the cdf of the SUR estimate is outside the same bands for relevant tracts of the function.

Interpretation of Clusters

Examining our data-driven classification, we find two groups with positive (intercept and the human capital investment) random components (see Table 10) in the level equation. The first (group 3) includes some of high-income OECD as well as some emerging countries. Subsequently, we note that group 4 has a positive intercept human capital random component, but this group also contains mainly emerging countries. Surprisingly, the group six (clearly an ample subset of high -income OECD countries containing no emerging or less developed countries) has the random term for the schooling effect negative and the magnitude of the latent parameter for the intercept higher compared with the others. This fact seems to suggest that initial conditions (measured by the random part of the intercept, see Durlauf et al. 2005) determine the dynamic of growth and contributes to the human capital puzzle which we further address in the next section when considering the feedback effect between human capital and initial conditions. The three remaining groups with both negative random components include all other low-income countries (all African sub-Saharan countries, with the exception of South Africa, are in these three groups). As with any econometric approximation of an observed phenomenon, our results make sense even though they cannot be "perfect" by definition.[18] The reader must remember that we consider only four random components (two in the level and two in the growth equation), while unobserved differences between countries are innumerable and multi-dimensional. This approach cannot capture everything, and, furthermore, it has the limitation of representing a multi-dimensional phenomenon on a reduced dimensional scale. This is proven by the fact that the variance of the latent effects is high with respect to both the variance in the growth equation and the covariance between the two latent effects.

We estimate a multinomial logit model in order to examine what countries have in common in terms of potential explanatory variables of random components. In our six equation model, group 1 (containing all low-income countries and having both negative intercept and human capital random components) is the omitted benchmark. What we therefore observe is that legal structure, enforcement of property rights, and quality of education significantly raise the likelihood of belonging to the two "virtuous" groups (6 and 3) relative to that of belonging to the benchmark group 1 (Table 12). The same coefficients are not significant (at 1

[18] In interpreting our findings, we must always remember the estimation period to which they refer and consider that the last decade of convergence of many emerging countries falls outside of our time interval.

Table 12 Countries' groups

Benin	Bangladesh	Argentina	Algeria	Bolivia	Belgium
Burundi	Haiti	Australia	Botswana	Cameroon	Canada
Central African	India	Austria	Chile	Cote d'Ivoire	France
China	Indonesia	Brazil	Colombia	Ecuador	Germany
Congo, D. Rep.	Mali	Costa Rica	Congo, Rep.	Honduras	Italy
Ghana	Mauritania	Denmark	Dominican R.	Nicaragua	Netherlands
Liberia	Mozambique	Finland	Egypt	Panama	Norway
Malawi	Nepal	Greece	El Salvador	Paraguay	Spain
Tanzania	Niger	Hong Kong	Guatemala	Peru	United Kingdom
Togo	Pakistan	Ireland	Jamaica	Philippines	United States
	P. New Guinea	Israel	Kenya	Senegal	
	Rwanda	Japan	Korea, Rep.	Zimbabwe	
	Sri Lanka	Jordan	Malaysia		
	Sudan	Mexico	Mauritius		
	Thailand	New Zealand	Morocco		
	Uganda	Portugal	Sierra Leone		
	Zambia	Singapore	Syria		
		South Africa	Tunisia		
		Sweden	Turkey		
		Switzerland	Uruguay		
		Trinidad and Tob			

percent) in equations estimating the determinants of affiliation to groups 2, 4, and 5, which are in fact also characterized by negative random components (with the exception of a mildly positive human capital component in group 4) and composed mainly of low-income countries. None of the Sub-Saharan countries is in group 4 where the human capital component is mildly positive. Another interesting result is that, among institutional variables, the "freedom to exchange with foreigners" variable (capturing barriers to capital movement and to trade exchanges) seems to play a less important role than the legal structure and property right variable in terms of effects on the probability of affiliation to the "virtuous clusters" (above all if we consider clusters 3 and 6). Summing up our results, as like as Barro's (2001) ones, emphasizes the importance of quality more than quantity of schooling (Table 13).

Does Human Capital Initial Level Affect Growth Dynamics?

In the previous sections, we have documented that the stock of human capital is fundamental to understand why countries lie on different points of the space of characteristics. Low-income countries have a negative impact on human capital,

Table 13 Estimation results: mlogit

Variable	Coefficient	Std. Err.
Group 1		
legal	0.275	(0.349)
freedomexc	−0.310	(0.414)
regulation	−0.954	(0.709)
pr	0.080	(0.436)
cl	−0.033	(0.708)
CultProx	0.102*	(0.042)
frac_rel	2.673	(4.146)
tyr	0.443	(1.358)
high	−90.372	(118.365)
noschool	4.083	(8.827)
Intercept	−0.718	(9.113)
Group 3		
legal	1.067**	(0.334)
freedomexc	−0.390	(0.401)
a5_	−1.022†	(0.620)
pr	0.452	(0.424)
cl	−0.687	(0.591)
CultProx	0.042	(0.030)
frac_rel	5.876†	(3.010)
ty25	−0.822	(0.779)
high25	102.801**	(31.250)
noscho25	−3.537	(5.003)
Intercept	0.490	(4.983)
Group 4		
legal	−0.069	(0.338)
freedomexc	0.093	(0.327)
a5_	−0.087	(0.519)
pr	0.468	(0.364)
cl	−0.297	(0.543)
CultProx	0.048†	(0.028)
frac_rel	−1.439	(2.595)
ty25	0.444	(0.803)
high25	−0.358	(35.804)
noscho25	1.427	(4.693)
Intercept	−2.728	(5.658)

(continued)

Table 13 (continued)

Group 5		
legal	−0.085	(0.411)
freedomexc	0.453	(0.470)
a5_	−2.028**	(0.541)
pr	0.620†	(0.368)
cl	−1.156	(0.729)
CultProx	0.026	(0.030)
frac_rel	7.483**	(2.331)
ty25	−0.639	(0.800)
high25	104.240**	(30.350)
noscho25	0.826	(5.863)
Intercept	5.160	(5.522)
Group 6		
legal	0.699†	(0.423)
freedomexc	0.545	(0.388)
regulation	−2.928**	(0.818)
pr	−0.738	(0.653)
cl	−0.699	(0.729)
CultProx	0.085**	(0.031)
frac_rel	11.258**	(2.861)
ty25	−1.023	(0.782)
high25	107.745**	(31.354)
noscho25	1.864	(4.662)
Intercept	5.500	(5.483)

Significance levels : † : 10% $*$: 5% $**$: 1 base category 2^{th} group $high$ Percentage of "higher school complete" in the total pop. (Barro & Lee 2001) tyr Average schooling years in the total population $noschool$ Percentage of "no schooling" in the total population $Cultprox$ from Keefer and Vlaicu (2008) (McDonalds, Ikea and Booktrade) $legal$ legal rights and property rights $fredoomexc$ freedom to exchange with abroad $regulation$ financial and banking regulation pr political rights cl civil liberties $frac\_rel$ fractional religion

while high-income countries exhibit a higher estimated parameter for the quality and the level of human capital investment. But this is not all the story. The next step is to understand if differences among economic paths may or may not be due to the different starting points in the level of human capital. To understand that we employ the mixture model applying the equations in 14 and 15 that allow to model the prior probabilities as a function of the initial country-specific level of human capital

Table 14 Concomitant variable, finite mixture models

	Bivariate ConcFMM	
ln(y)	Coef.	Std.Err.
const	7.191**	14.77
ln(sh)	0.167**	8.25
ln(sk)	0.295**	13.92
lngd	−0.846**	−5.61
gw		
const	−0.009	−0.41
sk	0.05	0.25
sh	0.093	0.87
glf	−0.499	−0.22

Table 15 Class probabilities, log odds parameters for the concomitant model

	Coef.	Std.Err.
$class_1$		
totcompl1960	−.973**	.273
cons	2.434	.622
$class_2$		
totcompl1960	−.237**	.084
cons	1.380	.526
$class_3$		
totcompl1960	−.335**	.116
cons	1.367	.580

The class probability depends on the percentage of population total, completed secondary school $\hat{\pi}_{ik} = \frac{\pi(c_k,\alpha) f_{ik}}{\sum_1^K \pi_k(c_k,\alpha) f_{ik}}$

measured in 1960. To estimate the conditioned probability modes, we use as starting values the parameters resulting from the model estimated in the previous paragraph. As it is shown in Tables 14 and 15, our results do not change dramatically.

The most remarkable change is in the clustering process. Indeed, by looking at the clustering outcome, we note that only four groups remain for which the initial level of human capital dramatically affects results. In particular, the high-income OECD countries are in cluster 4, while the rest of the world is divided into three clusters. It has to be stressed that China, India, and Brazil in our sample period are not in cluster 4 both for the heterogeneity of their level and growth patterns and for sample period considered that includes only part of their recent growth performance. Our findings document that starting conditions explain a significant part of country heterogeneity in long run. Table 15 shows us that if countries in groups 1, 2, or 3 had a higher initial level of schooling, their probability of belonging to the high-income group would have been much higher. Moreover, by looking at correlations among random terms (see Table 16), we can see that also in the concomitant model the results are the same of the bivariate mixture model (see Table 11). Summing

Table 16 Correlation matrix of the latent effects

	σ_{u_1}	σ_{u_2}	σ_{u_3}	σ_{u_4}
σ_{u_1}	1.508			
σ_{u_2}	0.005	0.00004		
σ_{u_3}	0.072	0.0004	0.007	
σ_{u_4}	−0.067	−0.00035	−0.0043	0.00479

Significance levels: † : 10% * : 5% **: 1%
$\sigma_{u_{01}}$: standard deviation of the intercept latent effect in the level equation; $\sigma_{u_{21}}$: standard deviation of human capital latent effect in the level equation; $\sigma_{u_{02}}$: standard deviation of the intercept latent effect in the growth equation; $\sigma_{u_{22}}$: standard deviation of the human capital latent effect in the growth equation

up, the concomitant model allows us to detect the effect of initial level of schooling on the dynamic of country-specific growth path, helping to shed light to the puzzle of the insignificance of human capital in standard growth estimates. If the human capital is, above all, a between effect, it is already incorporated into initial conditions and therefore absorbed by the lagged dependent variable. In this respect, using the mixture model and conditioning the probability of belonging to obtained clusters to concomitant variables such as human capital help us to manage this type of problem (Table 17).

Conclusions

Production functions, as any other model, are imperfect synthetic views of reality and are falsifiable by later and more updated versions. More complex functional forms such as translog and CES can capture some nonlinearities better than the standard Cobb–Douglas approach but still contain rigidities and may hide some misspecification. The latent class approach is, in our opinion, a possible solution to the problem of model inadequacy. First, it does not neglect the problem. Second, it allows us to deal with misspecification properly through the semi-parametric specification of the mixture (McLachlan and Peel 2000). More specifically, and with reference to our case, measurement errors, omitted variable bias, and departures from normality are three typical phenomena that are unavoidable in econometric estimates. They all generate biases that affect residuals. Standard approaches, such as OLS, assume that the problem does not exist, while the latent class techniques try to tackle it by working on the residual and isolating in it a systematic element that can be related to different latent factors (not all of them identifiable with available controls).

We therefore choose the latent class approach to investigate determinants of economic development. We apply the approach to the BG two-equation system that consists of a joint estimate of a level and a growth equation. Results from our human capital augmented Solow model, in which heterogeneity in the intercept and

Table 17 Countries groups: probability conditioned to initial stock of human capital

Bangladesh	Algeria	Bolivia	Argentina
Benin	Botswana	Cameroon	Australia
Burundi	Brazil	Cote d'Ivoire	Austria
CentralAfr.Rep.	Chile	Honduras	Belgium
China	Colombia	India	Canada
CongoD.Rep.	CongoRep.	Indonesia	Denmark
Ghana	CostaRica	Kenya	Finland
Haiti	DominicanR.	Mali	France
Liberia	Ecuador	Mauritania	Germany
Malawi	Egypt	Mozambique	Greece
Nepal	El Salvador	Nicaragua	Hong Kong
Niger	Guatemala	Pakistan	Ireland
P.NewGuinea	Jamaica	Peru	Israel
Rwanda	Jordan	Philippines	Italy
Sudan	Korea Rep.	Senegal	Japan
Tanzania	Malaysia	Sri Lanka	Mexico
Togo	Mauritius	Thailand	Netherlands
Uganda	Morocco	Zimbabwe	New Zealand
Zambia	Panama		Norway
	Paraguay		Portugal
	Sierra Leone		Singapore
	Syria		South Africa
	Tunisia		Spain
	Turkey		Sweden
	Uruguay		Switzerland
			United Kingdom
			United States

human capital component is accounted for, show that human and physical capital investment regressors are significant in the level, but not in the growth equation. The mixture approach identifies six different clusters and finds that correlations between country-specific latent structures (captured by the latent terms in intercepts) are positive, while those related to human capital are negative. When we further take into account the feedback effect between human capital and initial conditions, the number of clusters becomes four and the impact of human capital on them is enhanced, giving a partial solution to the puzzle of the insignificant human capital effect on growth. Our findings therefore support the hypothesis of lack of convergence across clusters, even in the presence of convergence in human capital investment. The multinomial logit analysis that follows documents that group affiliation is crucially determined by two variables: legal structure and property right rules, and the quality of education. Differences in these two main latent factors are responsible for the heterogeneity in the labor augmenting component and in the impact of human capital investment on per capita GDP. Our findings may be interpreted also in terms of relationship with the literature testing the Solow model. As in Durlauf et al. (2005), we find that the explanatory power of the Solow growth model is enhanced when cross-country heterogeneity is allowed for. In addition to it, when unobserved heterogeneity is considered, growth rates are not significantly associated with investment rates. More specifically, even though Bernanke and Gürkaynak (2001) reject the Solow growth model when analyzing cross-country data on GDP, growth, and investment, the evidence against the Solow model becomes statistically insignificant when a pooled-cross-section model is applied to Bernanke and Gurkaynak's data allowing for unobserved heterogeneity across countries.

As a consequence of the above findings, the main policy claim of the paper is that convergence clubs do, indeed, exist (at least in our sample period) and that long-lasting characteristics (such as quality of education, legal structure, and the enforcement of property rights) determine inclusion in a low- or high-growth cluster. A related claim is that convergence in schooling years does not produce economic convergence if differences in quality of institutions and education persist (the brain drain may be a reason why). Our findings are also consistent with the paradox of high private and low social returns from education in less developed countries (that is, high returns to schooling at micro -level but low contribution of human capital to economic growth) (Psacharopoulos and Patrinos 2004). A likely interpretation of this is that, in the presence of a poor quality of rules and institutions, the opportunities for rents-seeking are widespread, leading higher educated individuals away from value creating activities.

Appendix A

To estimate our RC model, we adopt the following maximum likelihood (ML) approach. Consider that, conditionally upon the parameters $\theta_i = [\gamma_{0i}, \gamma_1, \gamma_{2i}, \gamma_3]^{\mathsf{T}}$, the probability density function of $\ln(y)_{it}$ is (we avoid the index j to simplify the notation)

$$f(y_{it}|\theta_i) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{-\frac{1}{2\sigma^2}\left[y_{it} - \gamma_{0i} - \gamma_1 x_{1it} - \gamma_{2i} x_{2it} - \gamma_3 x_{3it}\right]^2\right\}, \tag{17}$$

while that of $\mathbf{y}_i = [y_{i1}, \ldots, y_{iT}]^{\mathsf{T}}$ is

$$f(\mathbf{y}_i|\theta_i) = \prod_{t=1}^{T} f(y_{it}|\theta_i). \tag{18}$$

We assume that θ_i is a random variable with probability function g. The marginal (unconditional) distribution of $\mathbf{y}_i$ is then given by the following integral:

$$f(\mathbf{y}_i) = \int f(\mathbf{y}_i|\theta_i)g(\theta_i)d\theta_i. \tag{19}$$

Treating the $\mathbf{U}_i$'s as nuisance parameters and integrating them out, we obtain for the likelihood function the following expression:

$$L(\cdot) = \prod_{i=1}^{n}\left\{\int_{\mathcal{U}} f(\mathbf{y}_i|\mathbf{X}_i, \mathbf{U}_i)\mathrm{d}G(\mathbf{U}_i)\right\}, \tag{20}$$

where $\mathcal{U}$ represents the support for $G(\mathbf{U}_i)$, the distribution function of $\mathbf{U}_i$. Due to the assumption of conditional independence among outcomes, we have

$$f_i = f\,(\mathbf{y}_i\,|\mathbf{X}_i, \mathbf{u}_i)) = \prod_{t=1}^{T} f(y_{it}|\mathbf{X}_i, \mathbf{u}_i) = \prod_{t}^{T} f_{it}. \tag{21}$$

Model parameters are estimated by adopting a non-parametric maximum likelihood (NPML) approach (Laird 1978).[19]

We do not assume a particular specification for the p.d.f. g, but we estimate it together with the other parameters. As demonstrated by Lindsay (1983a,b), since the NPML estimate of a mixing distribution is a discrete distribution on a finite number of K locations, the likelihood function can be expressed as

$$L(\cdot) = \prod_{i=1}^{n}\left\{\sum_{k=1}^{K} f\,(y_i\,|\mathbf{X}_i, \mathbf{u}_k)\pi_k\right\} = \prod_{i=1}^{n}\left\{\sum_{k=1}^{K}[f_{ik}\pi_k]\right\}, \tag{22}$$

where $f\,(y_i\,|\mathbf{X}_i, \mathbf{U}_k) = f_{ik}$ denotes the response distribution in the k-th component of the finite mixture (which is assumed to be normal). Locations $\mathbf{u}_k$ and corresponding masses π_k represent unknown parameters, as well as the number of locations K, which is treated as fixed and estimated via formal model selection techniques.

The maximum likelihood estimates of model parameters are computed by using an EM algorithm (Dempster et al. 1977 and McLachlan and Krishnan 1997), which consists of two (expectation and maximization) steps. As it is well-known (see,

[19] On the consistency of the NPML estimators, Kiefer and Wolfovitz (1956) show that, by letting the probability density function of $\mathbf{u}_i = (u_{1i}, u_{2i})$ undetermined, we can correctly estimate the correlation between the two random effects. Furthermore, Lindsay (1983a,b) stresses that the NPML approach generates clusters characterized by homogeneous values of the random components, avoiding an exogenous subsampling process such as that used in threshold regression models. It has to be noted that this kind of classification is possible and successful only if country heterogeneity exists (Lindsay 1983a and Lindsay 1983b).

among others, Aitkin 1997 and Wang et al. 1996), the univariate EM algorithm maximizes the complete likelihood of (20) in the M-step. The EM algorithm starts by denoting with $\mathbf{z}_i = (z_{i1}, \ldots, z_{iK})$ the unobservable vector of components, where $z_{ik} = 1$, if the observation has been sampled from the component of the mixture, and 0 otherwise. Since the vector of components $\mathbf{z}$ is unobservable, it has to be treated as missing data. We therefore denote as incomplete the observed random sample $\mathbf{y} = (\mathbf{y}_1^\top, \ldots, \mathbf{y}_n^\top)^\top$, while the complete-data vector is $\mathbf{y}_c = (\mathbf{y}\top, \mathbf{z}^\top)^\top$. On this basis in the M-step, we maximize the complete likelihood

$$L(\cdot) = \prod_{i=1}^{n} \prod_{k=1}^{K} \{\pi_k f(\mathbf{y}_i | \mathbf{X}_i, \mathbf{u}_i)\}^{z_{ik}} . \tag{23}$$

Since the z_{ik} components are treated as missing data, in the E-step they are estimated by their expectations

$$\hat{z}_{ik} = w_{ik} = \frac{\pi_k f_{ik}}{\sum_{k=1}^{K} \pi_k f_{ik}}, \tag{24}$$

where $\hat{z}_{ik} = w_{ik}$ is the posterior probability that the i-th unit belongs to the $k - th$ component of the mixture. It can be shown that, at each step (E or M), the likelihood (11) increases. The complete likelihood is maximized with respect to a subset of parameters given the current values of the others. Hence, the log of the complete likelihood

$$\ell_c(\cdot) = \sum_{i=1}^{n} \sum_{k=1}^{K} \hat{z}_{ik} \left(\log(\pi_k) + \sum_i \log(f(y_i | \mathbf{u}_k)) \right) \tag{25}$$

is maximized with respect to the π's, and it reaches a maximum when

$$\pi_k = \frac{1}{n} \sum_i \hat{z}_{ik}, \tag{26}$$

which represents a well-known result of maximum likelihood in finite mixtures. Since closed-form solutions of maximization of complete likelihoods are unavailable, we use a standard Newton–Raphson algorithm. The E- and M-steps are alternatively repeated until the following relative difference

$$\frac{|\ell^{(r+1)} - \ell^{(r)}|}{|\ell^{(r)}|} < \epsilon, \qquad \epsilon > 0 \tag{27}$$

changes by an arbitrarily small amount if the adopted criterium is based on the sequence of likelihood values $\ell^{(r)}$, $r = 1, \ldots$. Since $\ell^{(r+1)} \geq \ell^{(r)}$, convergence is obtained with a sequence of likelihood values that are upward bounded. Penalized likelihood criteria (such as AIC, CAIC, or BIC) have been used to choose the exact number of mixture components.

References

Aitkin, M.A.(1997) Contribution to the discussion paper by S. Richardson and P.J. Green, *Journal of The Royal Statistical Society*, **B**, 59, 764–768.

Aitkin, M.A., Rocci, R. (2002). A general maximum likelihood analysis of measurement error in generalized linear models. Statistics and Computing, **12**,163–174.

Alfó, M., Trovato G. (2004) "Semiparametric mixture models for multivariate count data, with application", *Econometrics Journal*, 7, 1–29.

Alfó, M., Trovato G. and R.J. Waldmann (2008) "Testing for country heterogeneity in growth models using a finite mixture approach", *Journal of Applied Econometrics*, 23, 487–514.

Azariadis, C. and Drazen, A. (1990). "Threshold Externalities in Economic Development", *Quarterly Journal of Economics* ,501–526.

Barro, R. J. (2001) "Human Capital and Growth", *American Economic Review*, 91, 12–17.

Barro, R. J. and Lee, JW. (2001) "International Data on Educational Attainment Updates and Implications." *Oxford Economic Papers*, 53, 541–63

Barro R. and Sala-I-Martin, X. (1992), "Convergence", *Journal of Political Economy*, 100, 223–251.

Bernanke, B.S. and Gürkaynak, R.S. (2001). "Is Growth Exogenous? Taking Mankiw, Romer and Weil Seriously." *NBER Working Papers*, 8365.

Bernard, A.B. and Durlauf, S.N (1996) "Interpreting Tests of the Convergence Hypothesis", *Journal of Econometrics*, 71, 161–73

Bond, S.R., Hoeffler, A. and Temple, J. (2001). *"Estimation of Empirical Growth Models"*, Discussion Paper No. 2048, Centre for Economic Policy Research.

Brock, W.A. and Durlauf, S.N., (2000), "Growth Empirics and Reality", *World Bank Economic Review*, 15, 2, 229–72

Bucci, Alberto, Lorenzo Carbonari and Giovanni Trovato (2021) Variety, Competition, and Population in Economic Growth: Theory and Empirics. *Macroeconomic Dynamics* 25(5), 1303–1330.

Cohen-Cole, Ethan B., Steven N. Durlauf and Giacomo Rondina (2012) Nonlinearities in growth: From evidence to policy. *Journal of Macroeconomics* 34,42–58.

Dayton, C.M. and Macready, G.B. (1988). "Concomitant-Variable Latent-Class Models". *Journal of the American Statistical Association*, 83, 173–178.

Davidson, R. and MacKinnon, J.G., (1993), *"Estimation and Inference in Econometrics"*, New York, Oxford University Press, 1993. ISBN 0-19-506011-3.

Dempster, A.P., Laird, N.M. and Rubin, D.A. (1977), "Maximum Likelihood Estimation from Incomplete Data via the EM Algorithm (with Discussion)." *Journal of Royal Statistical Society, B*, 39, 1–38.

Di Vaio, G. (2011) "Did globalization drive convergence? Identifying cross-country growth regimes in the long run." *European Economic Review*, 55,832–844

Durlauf S.N. (2000) "*Econometric Analysis and the Study of Economic growth: A Skeptical Perspective*", in: Macroeconomics and the real world. Volume 1. Econometric techniques and macroeconomics, Oxford University Press, 249–61.

Durlauf, S.N. (2001), "Manifesto for a Growth Econometrics" *Journal of Econometrics*, 100, 1, 65–69.

Durlauf, S., Kourtellos, A. and Minkin A. (2001), "The local Solow Growth model." *European Economic Review*, 45, 928–940.

Durlauf, S.N., Johnson P.A. and Jonathan R. W. Temple, (2005) "*Growth Econometrics*" in Handbook of Economic Growth, Volume A, Aghion P. and Durlauf S.N. ed., North-Holland.

Durlauf, S. and Johnson, P.A. (1995), "Multiple regimes and cross-country growth behaviour." *Journal of Applied Econometrics*, 10, 365–384.

Galor, O. (1996) "Convergence? Inferences from Theoretical Models" *Economic Journal*, 106, 1056–69

Goetz, S.J. and Hu, D. (1996). "Economic Growth and Human Capital Accumulation: Simultaneity and Expanded Convergence Tests". *Economics Letters*, 51, 355–362.

Grün B, Leisch F (2008). "FlexMix Version 2: Finite Mixtures with Concomitant Variables and Varying and Constant Parameters." *Journal of Statistical Software*, 28(4), 1–35.

Harberger, A., (1987), "*The Macroeconomics of Successful Development: What Are the Lessons? Comment,*" in Macroeconomics Annual, S. Fischer, ed., Cambridge: MIT Press. pp. 255–58.

Jerzmanowski, Michal (2006), "Empirics of Hills, Plateaus, Mountains and Plains: A Markov-Switching Approach to Growth". *Journal of Development Economics*, 81, 357–385

Kalaitzidakis, T., Mamuneas,T.A., Savvides, A. and Stengos, T. (2001), "Measures of Human Capital and Nonlinearities in Economic Growth." *Journal of Economic Growth*, 6, 229–254.

Keefer, P. and Vlaicu, R., (2008), Democracy, credibility, and clientelism. *The Journal of Law, Economics, & Organization*, 24(2), 371–406.

Kiefer, J. and Wolfovitz, J.,(1956) "Consistency of the maximum likelihood estimation of a mixing distribution", *Journal of the American Statistical Association*,73, 805–811

Knack, S. and P. Keefer (1995), "Institutions and economic performance: cross-country tests using alternative institutional measures", *Economics and Politics*, 7, 207–227

Frankel, J.A. (2002), *Promoting Better National Institutions: The Role of the IMF*, presented at the Third Annual IMF Research Conference, Washington, November 7–8.

Laird, N.M. (1978), "Nonparametric Maximum Likelihood Estimation of a Mixing Distribution." *Journal of American Statistical Association*, 73, 805–811.

Lee, K., M.H. Pesaran and R. Smith (1997). "Growth and convergence in a stochastic Solow model." *Journal of Applied Econometrics*, 12, 357–392.

Lindsay, B.G. and Lesperance, M.L. (1995). "A review of semiparametric mixture models", *Journal of Statistical Planning and Inference*, 47, 29–39

Lindsay, B.G. (1983a). "The geometry of mixture likelihoods: a general theory", *Annals of Statistics*, 11, 86–94,

Lindsay, B.G. (1983b). " The geometry of mixture likelihoods, part II: the exponential family", *Annals of Statistics*, 11, 783–792,

Liu, Z. and Stengos, T. (1999), "Non-linearities in Cross-Country Growth Regressions: A Semiparametric Approach." *Journal of Applied Econometrics*, 14, 527–538.

Mankiw, N.G. and Romer, D. and Weil, D.N. (1992), "A contribution to the empirics of economic growth." *Quarterly Journal of Economics*, 107, 407–37.

Masanjala, W.H. and Papageorgiou, C. (2004), "The Solow model with CES Technology: nonlinearities and parameter heterogeneity." *Journal of Applied Econometrics*, 19, 171–201.

McLachlan, G. and Krishnan, T. (1997), *"The EM Algorithm and Extensions*." John Wiley & Sons Inc.

McLachlan, G. and Peel, D. (2000), *"Finite Mixture Models*." John Wiley & Sons Inc.

Ng, S.K. and McLachlan G.J. (2014). "Mixture models for clustering multilevel growth trajectories", *Computational Statistics & Data Analysis*, 71, 43–51.

Owen, A.L., Videras J and Davis L. (2009) "Do all Countries follow the same Growth Process?", *Journal of Economic Growth*, 14, 265–286.

Pittau, M.G., Zelli, R. and Johnson P.A. (2010), "Mixture Models, Convergence Clubs and Polarization", *Review of Income and Wealth*, 56, 101–122

Psacharopoulos G. Patrinos H.A. (2004), " Returns to investment in education: a further update", *Education Economics*,12, 111–134.

Rodrik, D. (1999), " Where Did All the Growth Go? External Shocks, Social Conflict and Growth Collapses", *Journal of Economic Growth*, 4, 385–412

Romano, J. (1988), “A Bootstrap Revival of Some Nonparametric Distance Tests”, *Journal of the American Statistical Association*, 83, 698–708

Temple J. (1999), “The new growth evidence”, *Journal of Economic Literature*, 37, 112–156.

Temple J. (2001a), “Generalizations That Aren’t? Evidence on Education and Growth”, *European Economic Review*, 37, 112–156.

Temple J. (2001b), “Growth Effects of Education and Social Capital in the OECD Countries”, *OECD Economic Studies*, 33, 2001/II

P. Wang, M.L. Puterman, I. Cockburn, and N. Le, (1996) Mixed Poisson regression models with covariate dependent rates. *Biometrics*, 52:381–400.

Time Use in Macroeconomics: European Integration and Marketization of Domestic Work

Rama Dasi Mariani and Furio Camillo Rosati

Introduction

Several of the works of Giancarlo Marini (e.g. Marini 1990; Marini et al. 2004) have focused on the role of public debt and on the impact of European integration on the economic system. One of the remarkable effects of the process of European integration has been the commitment to guarantee and promote the actual possibility of free movement for individuals and workers within the Union. This, coupled with the expansion of the Union with the inclusion of several countries from Eastern Europe, has generated large migration flows. Such flows have been characterized by relatively large movements of workers, mainly low-skilled, from lower to higher income countries, as well as by more disperse movements of high-skilled workers across the Union.

In this chapter, we focus on a specific aspect linked to the migration flows generated by the process of creating a unified labour market: the increase in the supply of services that substitute or complement for the time devoted by households to non-market activities.

The role of non-market (domestic) work has seldom been considered in macroeconomic analysis even if it absorbs a large part of the time endowment of individuals and families. The decision about the allocation of time to non-market work affects, of course, market activities and, in this way, labour supply, production, and the demand for market goods. Beyond the effects on labour market participation,

R. D. Mariani
Dipartimento di Giurisprudenza, Università degli Studi Roma Tre, Rome, Italy

F. C. Rosati (✉)
Dipartimento di Economia e Finanza, Università degli Studi di Roma Tor Vergata, Rome, Italy
e-mail: f.rosati@economia.uniroma2.it

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_10

non-market work affects other important dimensions relevant to the evolution of economic systems like fertility and human capital.

There is evidence that marketization of domestic work has substantially altered the pattern of labour force participation especially for women, and that differential taxation and subsidy structures can explain the different patterns of specialization observed in different countries, affecting their growth and business cycles.

In this chapter, we first discuss some of the analyses that have focused on the role of non-market work in relationship with the business cycle and the structure of the economy. Subsequently, we present a theoretical framework that rationalizes the relationship between time use and the marketization of domestic services. We equip the theoretical model with some suggestive evidence on marketization trends in Italy. We then focus on one particular form of marketization: that relative to the care of children. With the help of a very simple illustrative model, we discuss the implications for the quality and quantity of children. Finally, we summarize the results of an empirical analysis of the impact of immigrants specializing in domestic services on children's human capital accumulation. This analysis exploits the "natural experiment" of 2007 when there was a substantial and unexpected inflow of workers from Romania and Bulgaria, specializing to a large extent in the provision of domestic services.

Domestic Work and the Business Cycle

In their 1991 paper, Benhabib et al. focus on the role in the real business cycle models of the substitutability between time spent on market work and domestic work. They start from the observation that a substantial amount of time is devoted to domestic work and that the negative correlation between the two forms of time use indicates a degree of substitutability. On this basis, they build a simple model that considers individuals obtaining utility both from market goods and from home-produced goods. In their model, home goods are produced with time as the only input.

They show that for any model that includes home production there exists a mapping into a model without home production, but that such a mapping requires assuming a change in the structure of the underlying preferences. In other words, models without home production can reproduce the same results as models with home production, but for this to happen it is necessary to assume a shift in preferences. They further illustrate the role of non-market work by looking at the effects of changes in the relative productivity of labour in the market and non-market sector. When there is an increase in the productivity of market work (relative to non-market work), individuals will reallocate time away from non-market to work towards the market sector and there will be an increase in employment (hours worked) and real wage. On the other hand, when it is the non-market productivity to increase, the flow of work will be in the opposite direction and there will be a decrease in employment in the market sector coupled with an increase in real wages.

Therefore, the association between real wages and employment (working hours) might depend on the origin of the productivity shock. If one does not consider the role of the domestic production, one would observe an indiscernible pattern in the relationship between real wages and employment.

The role of the domestic production in affecting the macroeconomic outcomes rests on the hypothesis that the allocation of time between market and non-market activities is affected by the relative returns in the two activities. Ngai and Pissarides (2011) look into the effects of taxation and subsidies on the allocation of time across the two activities. They build a model that includes three sectors characterized by different levels of substitutability between market and home-produced goods. In particular, the three different goods are substitutes in the utility function of the consumer and are produced with different mixes of market and non-market goods. They show that taxation and subsidies are relevant to the allocation of time across market and non-market work along two different ways. On the one hand, taxes and subsidies alter the composition of the demand of the consumption goods and in this way the derived demand for market and non-market work, as consumption goods are characterized by different intensity in the use of the two inputs. On the other hand, taxation can alter the relative return to work in the two sectors and, in this way, the labour supply for the two types of work. Ngai and Pissarides show, using time series data from OECD countries, that differences in taxes and subsidies across countries can contribute to explain the observed cross-country differences in the mix of the goods consumed and in the allocation of time across the market and non-market sector.

Whilst changes in taxation might affect the allocation of time across economies and time, technological changes have been an important driver of more long-term trends in the allocation of time. Especially the so-called marketization of domestic services has generated substantial changes in the allocation of time between market and non-market work especially for women. Not only the absolute amount of time devoted to non-market work but also the composition of the use of time in non-market activities has been profoundly affected. Greenwood et al. (2005) develop a dynamic general equilibrium overlapping generations model that includes a domestic production function à la Becker to analyse how technological changes and, in particular, the adoption of time saving technologies like household appliances affect women's time allocation.

The adoption of new technologies that improve labour productivity in the domestic sector is embodied in new durable goods. Over time the price of these goods has been substantially falling and this has increased their demand. As these new technologies become available and affordable, the household decides how much to invest in them and how to allocate (women) time between market and non-market activities. The authors show that such a model is able to explain a substantial fraction of the increase in women labour force participation.

Marketization of Domestic Services and Time Use

To fix our ideas about the possible effects of the increase of supply of domestic services, before looking at some descriptive evidence, we present a simple model of time allocation.

We consider a unitary household whose utility (U) is defined over a consumption good available in the market (C), a domestically produced good (Z), the number of children (n), their quality (Q), and leisure (L):

$$U\,(C, Z, n, Q, L) \tag{1}$$

Z, Q, and n can be produced using own time, respectively t_Z, t_Q, and t_n. n can also be produced by employing someone to provide care t_b for a salary w_b according to a well-behaved production function:

$$n = f\,(t_n, t_b) \tag{2}$$

For simplicity, we assume that domestically produced goods do not use market goods as inputs; therefore, we can write the domestic production function as:

$$Z = g\,(t_Z)\,,\; Q = h\left(t_Q\right) \tag{3}$$

with all production functions showing the usual properties.

Normalizing the amount of time available to the household to 1 and indicating with w the market wage rate and with w_b wage rate for the domestic services, the quantity of market good consumed C is given by:

$$C = w\ \left(1 - L - t_Z - t_Q - t_n\right) - t_b\ w_b + A \tag{4}$$

Substituting in the utility function, the value function to be maximized with respect to the different use of times becomes:

$$U\left(w\ \left(1 - L - t_Z - t_Q - t_n\right) - t_b\ w_b, g\,(t_Z)\,, h\left(t_Q\right), f\,(t_n, t_b)\,, L\right) \tag{5}$$

Differentiating with respect to the various uses of time and to the demand for market domestic services, we get the usual arbitrage conditions allowing us to write the Marshallian demand for time as:

$$t_i = t_i\ \ (w, w_b, A)\ \ i = Z, Q, n \tag{6}$$

$$L = L\ \ (w, w_b, A) \tag{7}$$

An increase in the marketization of domestic services—that in our simple model can be modelled as a decrease in w_b—can have, therefore, a complex impact on time allocation that cannot be predicted *a priori* without additional restrictions on the utility function. For example, if children are a normal good, then a reduction in w_b should lead to an increase in fertility, whilst the effects on the other uses of time and on the demand for domestic services cannot be signed without additional restrictions on the utility function as they depend on the patterns of complementarity/substitutability.

We now proceed to present some descriptive evidence based on a time-use survey carried out by the Italian National Statistical Office (Istat) at regular intervals. Every five years, Istat collects data on the time allocation by households through a survey containing a daily diary where households' members note down every activity carried out during the day. Data are available from 2003 till 2013. Although we cannot infer causality from this analysis, the evidence is suggestive of changes in time allocation that are also consistent with the increased availability of marketable domestic services induced by the large inflows of immigrant women from the new EU-member states. Of course, other factors have also been at play during the period considered, for example, changes in the market wage rate and also in the relative market wage of men and women (not modelled here). The discussion, therefore, is only suggestive of the possible links between availability of market services and time use: a discussion of a more causal analysis will be presented in the following section.

In particular, we group the self-reported activities performed during an entire day into six broad categories: leisure, market work, homework (including all the activities related to the house and to the household, but childcare), childcare, education, and other activities.[1] More specifically, leisure encompasses grooming and recreational activities. Market work refers to income-generating and related activities, like commuting. Some examples of activities included in the category of childcare are physical care and supervision (*i.e.* basic care), but also playing or talking with children and assisting them in schoolwork (*i.e.* interactive childcare). We also show the result for an additional category of time use: time spent with children. This is not an alternative use of time, as it does not refer to the main activity performed, but it is the time during which the child is present in the same place where the parent is.

In Fig. 1, we show the amount of time (measured in minutes) devoted on an average day to the different activities by the population aged 15–64. The figure also shows the trends in time use separately for women and for men in the same age group.

During this period, we observe relatively large changes in the use of time. Time spent in market and non-market work (excluding childcare) decreases—the former only for women—and leisure time increases. At the same time, time devoted to rearing children increases, especially, in relative terms, in interactive childcare.

[1] In what follows we are not presenting figures about the last two listed activities (*i.e.* education and other activities), as a very limited amount of time is devoted on average to them. Nonetheless, results are available upon request.

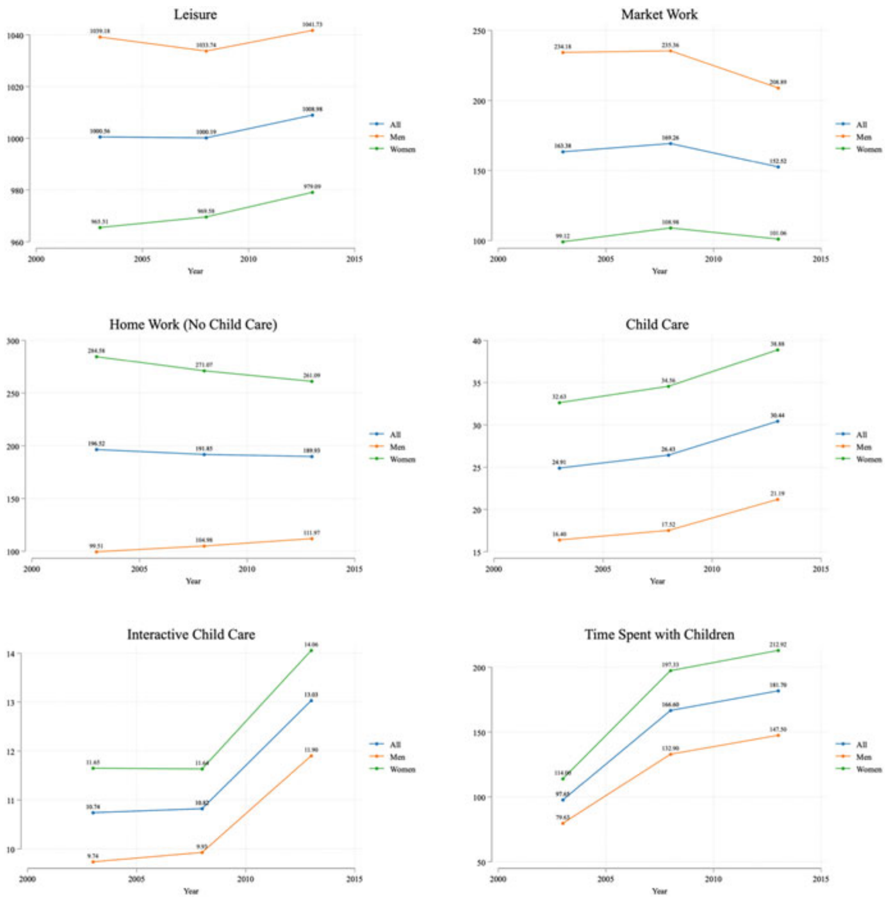

Fig. 1 General trends in time use. Notes: Authors' elaboration. Data are from the survey "Indagine Multiscopo sulle Famiglie: Uso del Tempo" (https://www.istat.it/it/archivio/216733)

Whilst also other forces have been at play, the observed changes in time allocation are compatible with an increased availability of marketable domestic services.

To better understand these dynamics, we disaggregate the female population, firstly, in high- and low-skilled women and, secondly, in women with and without children. The trends for the entire female population are also shown. Therefore, Fig. 2 shows the time devoted to the different activities during an average day by high- and low-skilled women. It is easy to grasp that leisure activities have expanded mainly for low-skilled women who, at the same time, have reduced their homework. High-skilled women, by contrast, have increased the time dedicated to childcare, both in general and in interactive childcare specifically.

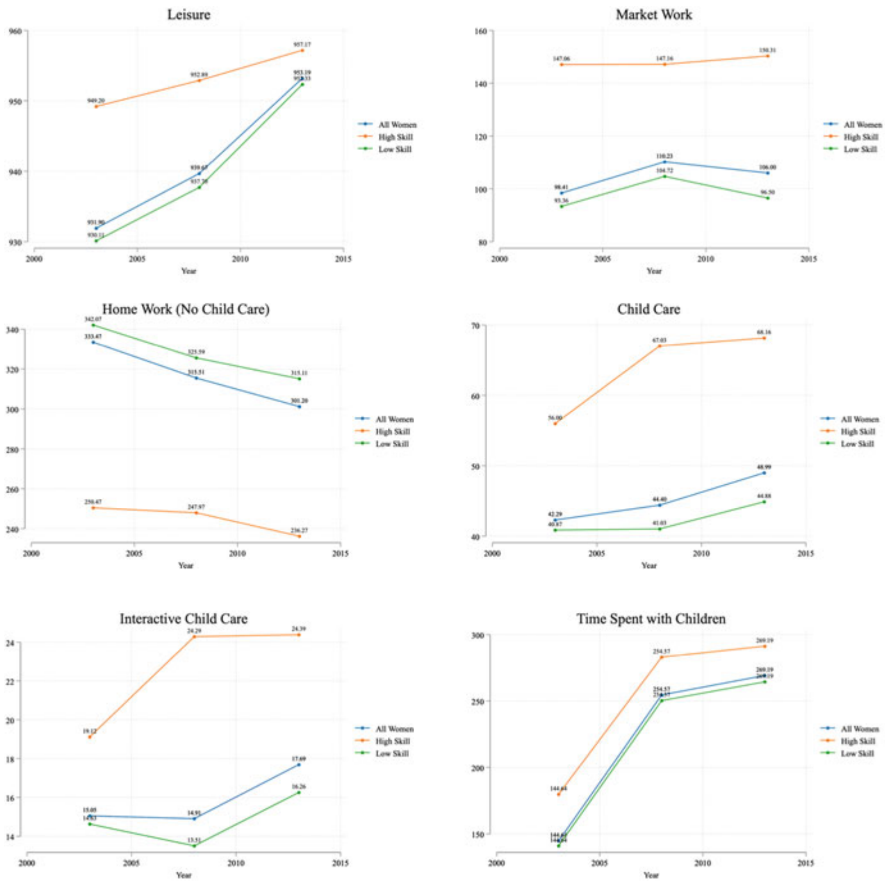

Fig. 2 Trends in time use for high- and low-skilled women. Notes: Authors' elaboration. Data are from the "Indagine Multiscopo sulle Famiglie: Uso del Tempo" (https://www.istat.it/it/archivio/216733). High-skilled women are defined as having a college degree or more

Again, the hypothesis of complementarity between market and non-market work appears to be supported by the figures, especially for low-skilled women. Nonetheless, the time saved to market work seems to be devoted to leisure for low-skilled women and to childcare for high-skilled ones (Fig. 3).

When we consider separately women with and without children, we observe that during the period of analysis, the time devoted to the market work decreases only for women with children. This seems to suggest that the marketization hypothesis and the complementarity between domestic services provided by household members and non-household members are valid only for women with children.

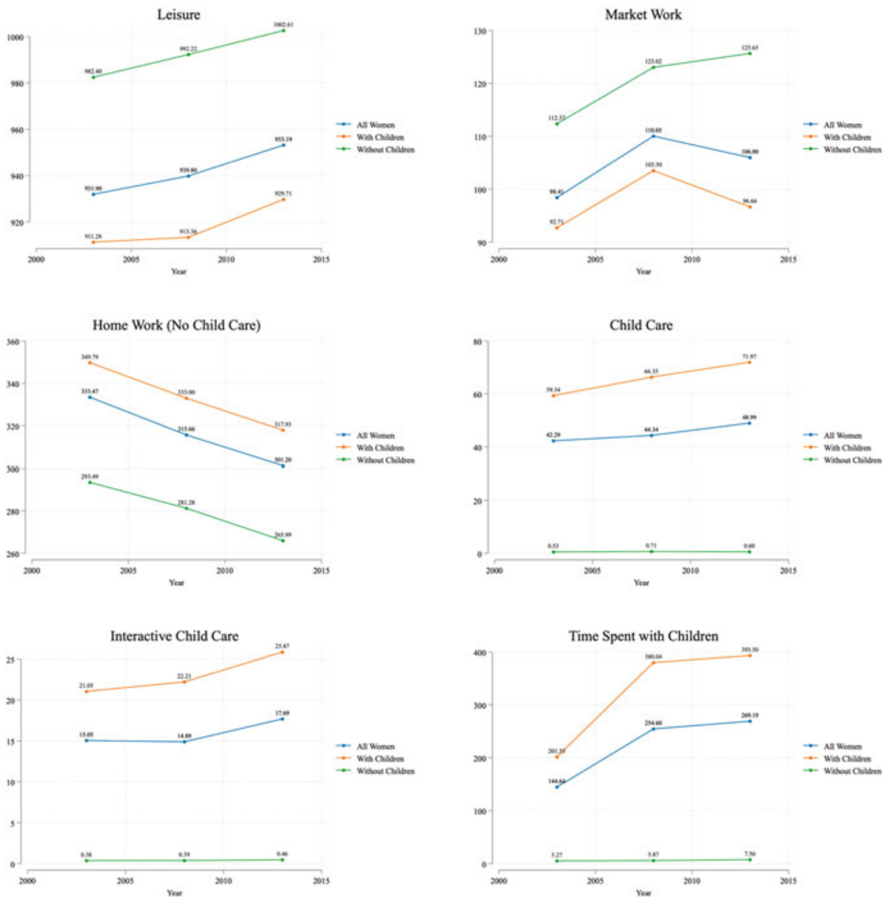

Fig. 3 Time trends for women with and without children. Notes: Authors' elaboration. Data are from the "Indagine Multiscopo sulle Famiglie: Uso del Tempo" (https://www.istat.it/it/archivio/216733)

A Closer Look at the Impact of Migrants on the Quantity and Quality of Children

A Theoretical Framework

At the cost of some simplifying assumptions, we can use a version of the model presented above that helps us fix the ideas about the impact of an increase in the supply of domestic services on the quantity and quality of children. Here we follow the approach of Doepke et al. (2022).

We make the following assumptions, in particular: domestic services can substitute only for time devoted to child rearing (what is called basic time with children) and do not contribute to human capital accumulation. Domestic services and mother time are perfect substitute (up to a constant) in providing basic childcare. Human capital is accumulated only through education expenditures. Of course, we lose in this way some of the complexities due to complementarity or substitutability amongst the different inputs, but we gain in clarity of exposition.

In particular, we assume that the unitary household maximizes the following utility function:

$$U = \log(C) + \delta \log(n, Q) \tag{8}$$

$$C = (1 - (\varphi - b)\, n)\, w - n\ \ (p\, e + p_b\, b) \tag{9}$$

and

$$h = (\theta + e)^{\gamma} \tag{10}$$

where C is current consumption, n the number of children, h the quality of each child, and $0 < \gamma < 1$. The utility of the household, hence, depends on current consumption and on the number and quality of the children defined over their human capital. The human capital depends, through a decreasing return production function, on the investment in education e that has a price p and on the innate ability of the children θ.

Each child has rearing cost in terms of time of φ unit of parent time, having normalized total time to 1. Parents, however, can also hire babysitters from the market: each unit b of babysitter time has a cost f. By making use of marketable domestic services parents can reduce the time they need to allocate to child rearing and, therefore, its opportunity cost is given by the market wage rate w. We assume for simplicity that parents and babysitter times are perfect substitutes (up to a constant set to 1 for simplicity of notation). This rules out complementarity between parents and babysitter times and other complex relationships between the two.

Substituting the budget constraint and the human capital production function into the utility function we have:

$$U = \log\left((1 - (\varphi - b)\, n)\, w - pen - np_b b\right) + \delta \log(n) + \delta\gamma \log(\theta + e) \tag{11}$$

to be maximized with respect to n and e, taking into consideration the non-negativity constraints for all the variables.

First of all, we have to note that because of the assumed perfect substitutability between parents and helpers time we have two possible regimes. If the cost of marketable services f is higher than the opportunity cost of parent time w, then households will only use their own time for child rearing.

In the opposite case, parents would only use babysitter time for child rearing. We would have, therefore, two different regimes to consider. To simplify our presentation, we assume that $f < w$, but also that the quantity of domestic services available, b, is rationed and less than φ. In other words, we assume that the market for domestic services does not clear through price, but through rationing of the excess demand. The results obtained would not change in any substantial way if we would analyse separately the two regimes.

Maximization of the utility function with respect to n and e, under the hypotheses just described, leads to the following optimal solutions:

$$n = \frac{w\,(1-\gamma)\,\delta}{(\delta+1)\,(w\varphi - p\theta - bw + b\;p_b)} \tag{12}$$

$$e = \frac{w\gamma\,(\varphi - b) - p\theta + bp_b\gamma}{p\,(1-\gamma)} \tag{13}$$

It is easy to see that an increase in the availability of domestic services generates an increase in the optimal number of children and reduces the investment in human capital.

$$\frac{d\,n}{d\,b} = \frac{w\,(w - p_b)\,(1-\gamma)\,\delta}{(\delta+1)\,(w\varphi - p\theta - bw + b\;p_b)^2} > 0 \tag{14}$$

$$\frac{d\,e}{d\,b} = -\frac{(w - p_b)\,\gamma}{p\,(1-\gamma)} < 0 \tag{15}$$

Of course, such a sharp result depends on the assumption that domestic services cannot be used to support human capital investments. Therefore, the increase in b represents a reduction in the (relative) price of the quantity of children and the household reacts accordingly.

We have seen how marketization of domestic services has been an important factor in changing the allocation of time across market and non-market sectors. In what follows we present some empirical evidence summarizing the work of Mariani and Rosati (2021) relative to the specific case of marketization previously mentioned, namely the increase in the supply of domestic services provided by low skilled, especially female, immigrants.

A Natural Experiment

Italy has experienced a large inflow of migrants specializing in domestic services since 2007. In 2007, Bulgaria and Romania joined the European Union and entered the Schengen Area of free movement of people: starting from 1 January 2007,

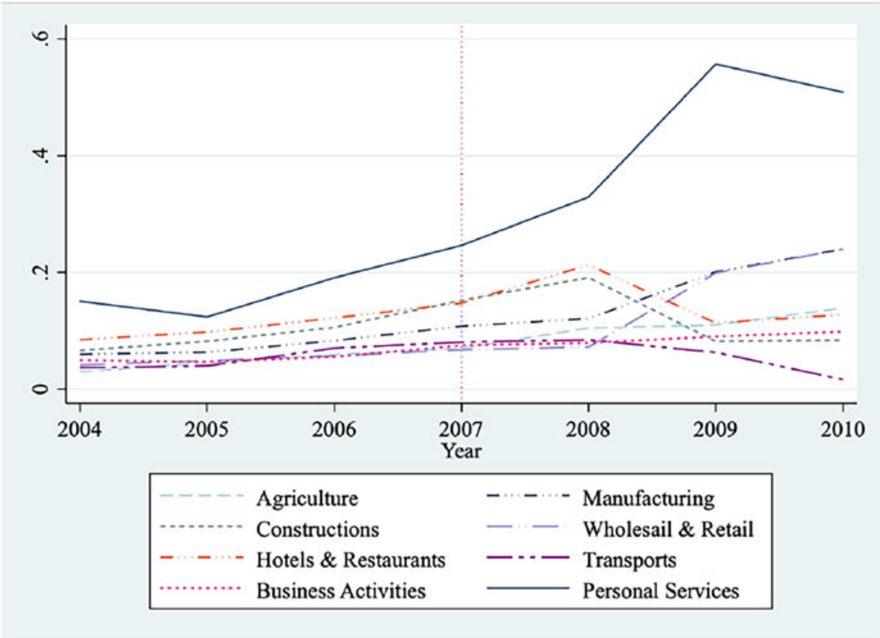

Fig. 4 Immigrants workers by sector. Notes: authors' elaboration on LFS data. Sectors above the average immigration rate in Italy are plotted. On the vertical axis is measured the immigrant rate with respect to native workers. For more details, see Mariani and Rosati (2021)

Bulgarians and Romanians became EU citizens and were allowed to travel and live in all EU-member states without any restriction.[2]

The free access of Bulgarians and Romanians to the Italian labour market was supposed to start on 1 January 2012. On 28 December 2006, however, the new Italian government decided to grant access to workers in agriculture, hotels and restaurants, constructions, manufacture of basic metals and fabricated metal products, and personal service activities[3] from the very beginning of the enlargement—*i.e.* 1 January 2007, 3 days after the decision was made.

The result was an unprecedented increase of immigrant workers from Bulgaria and Romania employed in the authorized sectors during 2007. Figure 4 shows the ratio of immigrant to native workers in the sectors where immigrants were

[2] Already before 2007 Romanians and Bulgarians did not need a travel visa to move within the European Union. Nevertheless, they were allowed to stay in a single member country for a maximum of 90 days. After that period, they had to move to another country. In any case, they were not allowed to work without a permit (Council Regulation N. 539/2001).

[3] According to NACE rev.2 (or equivalently ISIC rev.4) those sectors are classified as 01/03 (Agriculture), 24/25 (Manufacture of basic metals), 41/43 (Construction), 55/56 (Accommodation and food service activities), and 96 (Personal and household goods and a variety of personal service activities not elsewhere classified).

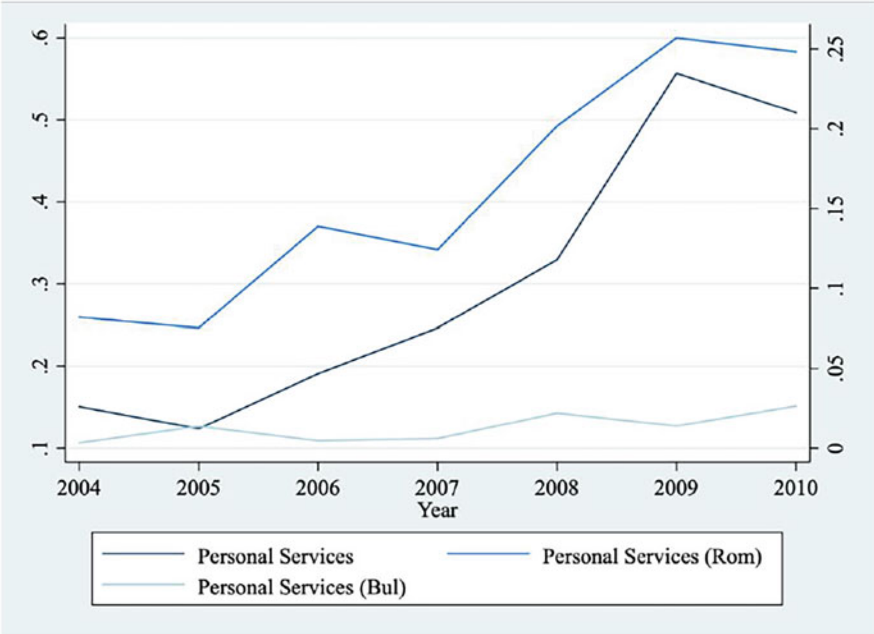

Fig. 5 Shares of immigrant workers in personal service activities. Notes: authors' elaboration on LFS data. On the left-hand-side vertical axis is measured the ratio of immigrant over native workers in the sector of personal service activities. On the right-hand-side vertical axis is measured the share of immigrant workers from Romania and Bulgaria employed in the same sector. For more details, see Mariani and Rosati (2021)

relatively more present.[4] As it is easy to see, the largest increase is observed in the personal service activities (NACE code 96 "Personal and household goods and a variety of personal service activities not elsewhere classified"), making the episode particularly suitable for our study.

The large increase in the employment of immigrants in personal service activities observed in 2007—with the share of immigrant workers employed in the sector increasing from 0.19 in 2006 to 0.55 in 2009—was associated with a redoubling of the share of Romanians employed in the sector—increasing from about 0.12 to 0.25—whilst the share of Bulgarians in the sector remained fairly constant around the low level of 2006 (see Fig. 5). Also, the other ethnic groups specialized in personal services—*i.e.* Ukrainian, Moroccan, Moldavian, and Filipino—did not change their supply in a relevant way in the period analysed.

Therefore, in the period considered the supply shock in the sector of personal service activities appears to be mainly due to the arrival of workers from Romania.

[4] We show the data for sectors where the ratio of immigrants exceeded the national average in 2006.

In fact, there was an overall increase in the employment in the personal service activities of about 20 per cent coupled with an increase of 200 per cent in the number of immigrants, of 400 per cent of Romanians, and a reduction of about 20 per cent of native employment. Moreover, women represented by far the majority[5] of immigrant workers employed in personal service activities. For all these reasons, Mariani and Rosati (2021) concentrated on the impact of the sudden increase of Romanian female workers in the personal service sector on the native household fertility and childcare choices.

Mariani and Rosati (2021) have looked at the impact of immigration on fertility and human capital investment and presented novel evidence of the impact on native fertility and on children's quality of large flow of immigrants providing household services. They exploit the "natural experiment" described above and utilize a DID approach to estimate this impact. Because of the possible non-random allocation of migrants across the country different versions of an instrument à la Card (2001) have been employed, all leading to consistent results. The analysis, carried out at the level of local labour market (LMA) areas, indicates that in LMAs which received relatively more immigrants specializing in personal services the number of births increased by about 2–4 per cent, an economically meaningful impact. All the areas, independently from the population density, experienced such a positive increase in fertility. At the same time, the effect has been larger in the areas of the country where immigrants concentrated the most and right after the mass arrival in 2007.

As mentioned above, a change in the cost and/or availability of childcare can affect both the number and the "quality" of children. To approximate children's human-capital accumulation, Mariani and Rosati (2021) have used data on test scores provided by the National Institute for the Evaluation of the Education and Training System (INVALSI). Each year, INVALSI runs a nationwide standardized learning test. The test, relative both to mathematics and to reading, is submitted to children enrolled in the second and fifth grade of primary school, the third grade of lower secondary school, and the second grade of upper secondary school. They use the test results for the second year of primary school, which corresponds to the second grade (the earliest grade for which tests are available). The test scores were corrected to take into account the possible cheating.[6] The data on test scores are available only at provincial level and, therefore, the analysis was carried out at this level of aggregation.

Mariani and Rosati (2021), in particular, used the data for the school years from 2012/2013—the first year a 7-year-old child born in 2005 might be enrolled in the second grade[7]—to 2017/2018—the last year for which data were available at the time of analysis—and included in the analysis only native children, following the DiD approach discussed above to assess if the same cohort of children experienced

[5] More than 80 per cent in 2006 according to Mariani and Rosati (2021).

[6] The correction factor is calculated directly by INVALSI following Quintiano et al. (2009).

[7] In INVALSI dataset, children enrolled in advance with respect to the regular starting age are not distinguished from those who are "on time".

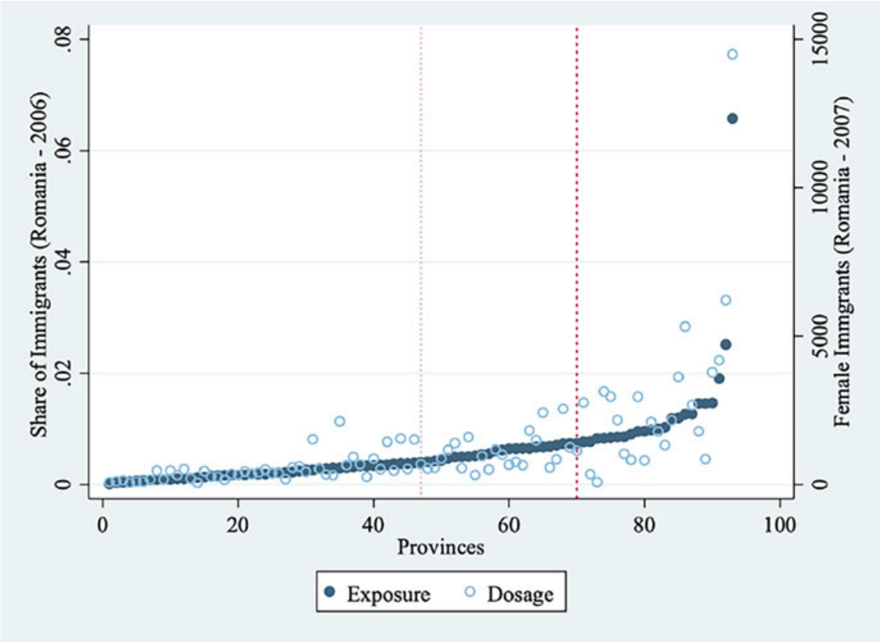

Fig. 6 Exposure to treatment and dosage. Notes: authors' elaboration on Istat data. Provinces are ordered on the basis of the 2006 share of immigrants from Romania. The exposure to the treatment is the share of immigrants from Romania in 2006, and it is measured on the left-hand vertical axis. The dosage of the treatment is the flow of female immigrants from Romania in 2007, and it is measured on the right-hand vertical axis. The two most exposed provinces are excluded from the graph. The dotted line represents the median and the dashed line represents the 75th percentile of the share distribution

different levels of human-capital accumulation depending on their exposure to large immigration flows. Below we are going to describe their empirical strategy in some detail.

To estimate the effect of immigration on children's human capital, Mariani and Rosati (2021) exploit the fact that the distribution of new arrivals across the country is influenced, especially for low-skilled workers, by the existing networks of immigrants of the same origin.[8] Therefore, the share of immigrants from a specific country living in an area is a very good predictor of the likelihood of the area receiving additional immigrants from the same country. As shown in Fig. 6, the areas where the share of immigrants from Romania was relatively high in 2006—the year before the enlargement—are also the areas that experienced relatively larger inflows in 2007.

[8] For a detailed analysis of immigrant location choice, see Bartel (1989). For a description of the geographical distribution of immigrants in Italy, see Mariani et al. (2021).

On this basis, their use of a difference-in-differences (DiD) approach to estimate the impact of immigration appears to be straightforward, even though the selection of a threshold to separate treated and untreated units remains somehow arbitrary. Therefore, they estimate a DiD with a continuous treatment where the dosage is given by the number of immigrant women from Romania living in the same area.

In particular, the equation they estimate is the following:

$$Y_{i,t} = \beta_0 + \beta_1 Post_t * Imm_{i,t-1} + \beta_2 \boldsymbol{X}_i + \lambda_i + \tau_t + \varepsilon_{i,t} \quad (16)$$

where $Y_{i,\,t}$ is the outcome of interest observed in province i at year t, $Post_t$ is a dummy variable equal to 1 for the years after 2007 and $Imm_{i,\,t-1}$ is the number of immigrant women from Romania expressed as share of the province i female population aged 15–49 at year $t-1$,[9] $\boldsymbol{X}_i$ is a vector of controls, λ_i and τ_t are province and year fixed effects, and $\varepsilon_{i,\,t}$ is the idiosyncratic error term.

The equation has been estimated by OLS because it is hardly reasonable to imagine a demand-pull effect on immigrants due to the demand for human capital investment, once controlled for a large set of parents' background characteristics that can be considered as predetermined with respect to investment in children human capital.

The regressions also include in the vector of controls some students and mothers' characteristics that are shown by the existing literature to have an influence on the test scores, such as student's gender and age (in months), kindergarten and pre-primary school attendance, and mother's education level and working status. The use of the inverse hyperbolic sine transformation to the test scores and immigrant ratio allows us to interpret the estimated coefficients as elasticities.[10]

The estimates of the coefficient of the share of immigrant women from Romania are reported in Table 1 (reproduced from Mariani and Rosati 2021). The dependent variable in Panel A is children's test score in reading (Italian); the dependent variable in Panel B is children's score in mathematics. To investigate whether the different trends in time use across macro areas in Italy are also reflected in the effect of immigrant supply of domestic services on children's human capital, separate regressions were estimated for each macro area.

At the national level, there appears to be a negative impact on reading, but not on mathematics test scores. The effects, moreover, are differentiated according to the area of the country. Indeed, the number of female immigrants from Romania appears to exert a positive effect on both reading and mathematics test scores in the Northwest. In the South, on the contrary, we find a negative impact on reading scores, whilst the other areas of the country appear to be unaffected.

[9] Given the duration of gestation, it is reasonable to suppose that most of the births observed in year t are from women observed in year $t-1$.

[10] Regression coefficients on variables transformed with the inverse sine transformation can be interpreted identically to those obtained using the standard log transformation since $\frac{d}{dx} asinhx = \frac{1}{\sqrt{1+x^2}} \approx \frac{1}{x} = \frac{d}{dx} lnx, \forall x \geq 2$

Table 1 Estimation results of the DiD on human capital accumulation of young children

	(1)	(2)	(3)	(4)	(5)	(6)
	Italy	North West	North East	Centre	South	Islands
Panel A: Reading test scores						
Female immigrants (Rom) * Post	−0.0221**	0.0836***	0.0873*	0.0408	−0.0602***	0.0179
	(0.0106)	(0.0288)	(0.0474)	(0.0419)	(0.0178)	(0.0480)
Observations	1,299,028	161,351	166,151	118,732	253,072	67,857
R-squared	0.041	0.056	0.055	0.036	0.029	0.028
Student controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Mathematics test scores						
Female immigrants (Rom) * Post	0.0188	0.0527***	0.0118	0.00283	−0.00783	0.00493
	(0.0283)	(0.00995)	(0.0103)	(0.00764)	(0.00651)	(0.0237)
Observations	1,288,552	162,518	169,786	120,835	254,198	69,026
R-squared	0.038	0.067	0.061	0.039	0.027	0.027
Student controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: authors' elaboration on INVALSI and Istat dataset. We use the inverse hyperbolic sine transformation for the number of female workers from Romania and standardized test scores. Test scores refer to children born between 2005 and 2010 and enrolled in grade 2 in the school years 2012/2013–2017/2018. Children born before 2007 (31st December) are in the pre-treatment period. Individual controls include gender, age (in months), kindergarten and pre-primary school attendance, mother's education level and working status. Robust standard errors are clustered at the province level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

In conclusion, it is possible to identify some impact of the presence of migrants specializing on domestic services on human capital accumulation. These effects appear to be differentiated by area with opposite signs between North and South. On the basis of the data available it is not possible to test for the possible causes of such a heterogeneous effect. It could be due to difference in the skills of the individuals hired, to different pattern of complementarity/substitutability between parents and domestic helper's time, etc. Further research is necessary to address this issue.

Whilst the trends in time allocations discussed above are somehow suggestive of possible channels through which this effect might have taken place, further research to be carried when data will become available will be necessary for an actual identification of the possible channels.

Conclusions

The free movement of people is one of the cornerstones of the vision underlying the European Union. Its progressive implementation has generated large movements of population, especially from the "new" and relatively poor member states towards the "old" and richer ones.

One of the aspects of these migration flows, seldom discussed or analysed, has been the increase of the supply of domestic services that potentially substitutes or complements the time allocated to non-market activities by the households.

In fact, in the recent past relevant changes in the time allocation of the native households have taken place in Italy as well as in other European countries. From a theoretical point of view, such changes in the allocation of time between market and non-market activities could affect the characteristics of the business cycles and lead to change in the observed wage-employment patterns. To what extent this might have actually happened is a question open for further research.

We have presented some descriptive evidence of the change in time allocation in Italy and discussed in more detail the effects of the increase of the supply of domestic services on fertility and human capital. The results of the studies mentioned indicate that native fertility has increased in response to the large inflow of immigrants specializing in domestic services, whilst the impact on human capital has been heterogenous across the country.

Finally, it is worth mentioning that the flow of migrants might have altered the sustainability of public debt, as even under the most stringent assumptions, Ricardian equivalence fails if new generations enter the economy (see, e.g., Blanchard 1985; Buiter 1988).

Therefore, effects of the right of the free movement of people within the European Union go beyond the labour market potentially affecting several important dimensions of the economic system. There has been surprisingly little attention to this aspect, and substantial additional research is necessary in this area.

References

Bartel, A. P. (1989). Where do the new US immigrants live?. *Journal of Labor Economics*, *7*(4), 371–391.

Benhabib, J., Rogerson, R., & Wright, R. (1991). Homework in Macroeconomics: Household Production and Aggregate Fluctuations. *Journal of Political Economy*, *99*(6), 1166–1187. http://www.jstor.org/stable/2937726

Blanchard, Olivier Jean (1985), "Debt, Deficits and Finite Horizons", Journal of Political Economy, Vol. 93, No, 2, April, pp. 223–247.

Buiter, Willem H. (1988), "Death, Birth, Productivity Growth and Debt Neutrality", *Economic Journal*, Vol. 98, No. 391, June, pp. 279–293.

Card, D. (2001). Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. Journal of Labor Economics, 19(1), 22–64.

Doepke, M. and Hannusch, A and Kindermann, F and Tertilt, M (2022). The Economics of Fertility: A New Era. NBER WP 29948

Greenwood, J., Seshadri, A., & Yorukoglu, M. (2005). Engines of Liberation. The Review of Economic Studies, 72(1), 109–133. http://www.jstor.org/stable/3700686

Mariani, R. D., Pasquini, A., & Rosati, F. C. (2021). The immigration puzzle in Italy: A survey of evidence and facts. *Italian Economic Journal*, 1–32.

Mariani, R., & Rosati, F. (2021). Immigrant supply of marketable child care and native fertility in Italy. Journal of Demographic Economics, 1–31. doi:https://doi.org/10.1017/dem.2021.28

Marini, Giancarlo (1990), "Teoria economica e debito pubblico", *Giornale degli Economisti e Annali di Economia*, Nuova Serie, Anno 49, No. 5/6 (Maggio-Giugno 1990), pp. 153–174.

Marini, Giancarlo, Alessandro Piergallini and Pasquale Scaramozzino (2004), "The Changeover to the Euro and the Behaviour of Inflation", *Review of Economic Conditions in Italy*, No. 1, January–April, pp. 139–153.

Ngai, L. Rachel, and Christopher A. Pissarides. 2011. "Taxes, Social Subsidies, and the Allocation of Work Time." American Economic Journal: Macroeconomics, 3 (4): 1–26.

Quintiano, C., Longobardi, S., & Castellano, R. (2009). L'influenza dei fattori socio economici sulle competenze degli studenti italiani: un'analisi multilevel dei dati PISA 2006. *Rivista di economia e statistica del territorio*, 2, 1–41.

Bank Financing and Start-Up Survival in the Italian Economy

Angelo Castaldo, Rosanna Pittiglio, Filippo Reganati, and Domenico Sarno

Introduction

Firms' access to bank credit has always played a crucial role in understanding the environmental factors that are capable of affecting the consolidation and growth productive structure of modern economies. Exogenous global shocks like the 2007–08 financial and economic crisis severely reduced overall economic operators' access to credit, determining a substantial reduction in the volume of bank credit (i.e. the credit crunch). In particular, due to the greater fragility of small and medium-sized enterprises (SMEs) and start-ups compared to large and more structured firms, SMEs are the first entities to be negatively affected. For these reasons, this field of analysis is central to the debate on the strategic industrial policy choices of national and international policy makers. Looking ahead, the current 2020 COVID-19 pandemic crisis also involves a similar risk.

The in-depth theoretical analysis of the frictions in the bank/start-up relationship is based on incomplete contract and asymmetric information theories (Stiglitz and Weiss 1981). In the debt-equity financing decision, start-ups are hindered in their access to external finance by a narrower range of factors than large, well-structured, and mature firms (Ang 1992; Scherr et al. 1993; Cressy 1996; Berger and Udell 1998; Cassar 2004; Colombo and Grilli 2007; Nofsinger and Wang 2011). This standpoint is consistent with literature findings (Diamond 1984; Ramakrishnan and Thakor 1984) that explain the greater difficulty start-ups encounter in gaining

A. Castaldo · F. Reganati (✉)
Dipartimento di Studi Giuridici, Filosofici ed Economici, Università degli Studi di Roma La Sapienza, Rome, Italy
e-mail: filippo.reganati@uniroma1.it

R. Pittiglio · D. Sarno
Dipartimento di Scienze Politiche, Università degli Studi della Campania Luigi Vanvitelli, Caserta, Italy

C. Imbriani, P. Scaramozzino (eds.), *Economic Policy Frameworks Revisited*, Contributions to Economics, https://doi.org/10.1007/978-3-031-36518-8_11

access to financing with higher risks and uncertainty linked to the opacity of new entrepreneurial initiatives. From a macroeconomic perspective, given the effects on the real economy of the 2007–2008 financial economic crisis, this market equilibrium sub-optimality might also be reinforced by an increase in the inefficiencies arising from the credit channel hypothesis (Bernanke 1983; Bernanke and Blinder 1988; Bernanke et al. 1996).

There is a consistent stream of empirical literature that aims to analyse the drivers of new firms' success and resilience (Aghion et al. 2007; Astebro and Bernhardt 2003; Audretsch 1995; Bastié et al. 2011, 2013; Calvino et al. 2015; Carter and Van Auken 2006; Cooper and Gimeno-Gascon 1992; Deloof et al. 2019; Franco and Haase 2010; Geroski et al. 2010; Hogarth and Karelaia 2012; Honjo and Kato 2016; Ogane 2016; Van Praag 2003; Resende et al. 2016). Amongst the most effective factors, the initial ability of start-ups to access external finance, especially bank loans, has been considered prevalent.

The main aim of this chapter is to investigate whether access to bank loans in the early stage (seed) of a start-up's lifecycle is an effective predictor of a firm's default over time, when controlling for a consistent number of other firm- and industry-related characteristics. In particular, we attempt to answer the following research questions: What is the relationship between bank loan financing and start-up firm survival rates? Are there some differences between short- and long-term bank loan financing? To what extent is the impact of bank financing related to sector specificity?

Finding an answer to these questions is particularly important for both researchers and policymakers. From the theoretical point of view if, on the one hand, extensive literature has emphasised the function of debt-equity financing decisions on the success of start-ups, on the other, the specific issue of a link between access to bank credit and the probability of default for start-ups has so far received scant attention, especially in countries, such as Italy, where banks are the main source of new external finance. From the policy perspective, the importance of access to credit for investments and/or liquidity has induced national governments to implement a set of loan measures such as direct lending, co-funding, interest rate subsidies, and public credit guarantee (PCG) schemes (Holmstrom and Tirole 1997; Minelli and Modica 2009; Arping et al. 2010; Castaldo 2020). However, policymaker's awareness of the potential effects arising from the implementation of such instruments needs to be enhanced (Besanko and Thakor 1987; D'Ignazio and Menon 2013; De Blasio et al. 2017; Lelarge et al. 2010; Stelletto et al. 2017).

In order to carry out this analysis, we use three different cohorts of firms that were established between 1 January 2004 and 31 December 2006 and examine their likelihood of surviving up to 31 December 2014. The period covered by the analysis (2004–2014) includes the effects of the global financial crisis (2007–09) and the sovereign debt crisis (2011–2012). The econometric analysis is based on a discrete-time proportional hazard model where we control for several firm- and industry-specific covariates. For the empirical analysis, the manufacturing and service sectors are considered separately; in addition, in order to control for some sector-specific characteristics, more comprehensive tests are conducted for disaggregated level of industry by breaking down the data according to the degree of technological/knowledge intensity of the sector in which start-ups are involved.

In our opinion, the chapter contributes to the existing literature as follows. With regard to recent studies on the impact of bank debt on firm survival (Castaldo et al. 2020; Deloof and Vanacker 2018; Wamba et al. 2017), on the one hand, we expand the econometric strategy by employing a more robust discrete-time proportional hazard model; on the other hand, we deepen the analysis of observed differences in start-ups' resilience by considering the heterogeneity of business models related to belonging to either manufacturing or service sectors. Secondly, with regard to other similar empirical studies (Musso and Schiavo 2008; Cole and Sokolyk 2018; Deloof and Vanacker 2018), our analysis investigates the impact of the financial crises of 2007–2008 and 2011 on bank–firm relationships, enabling us to more widely assess the way in which exogenous shocks so harm small and new Italian enterprises (Cowling et al. 2016). Finally, differently from other papers (Castaldo et al. 2020; Deloof et al. 2019) that investigate the relationship between the survival of Italian start-ups and the debt financing market, we conduct a sensitivity analysis of our baseline models by sub-sampling according to the degree of technological intensity of the sector in which start-ups operate.

The chapter is organised as follows. In Section "How Relevant Is Access to Bank Loans for Start-Up Success?", the main literature (review) is outlined, whilst in Section "Data and Descriptive Analysis", data and some descriptive statistics are provided, which are related to start-up firms disaggregated by manufacturing and services. The theoretical model and empirical results are presented in Section "The Econometric Methodology". Finally, Section "Econometric Results" summarises and concludes.

How Relevant Is Access to Bank Loans for Start-Up Success?

Our research question lies within the wider theoretical framework of optimal financial structure. When specifically considering start-ups, several studies (Ang 1992; de Bettignies and Brander 2007; Robb and Robinson 2014) refer explicitly to access to bank credit as a relevant channel for new businesses to acquire capital resources.

Since the seminal paper by Cressy (1996), a wide stream of literature (Cooper and Gimeno-Gascon 1992; Cooper et al. 1994; Gimeno-Gascon and Woo 1994; Storey 1994; Vos and Forlong 1996; Huyghebaert 2001; Carter and Van Auken 2006; Deloof et al. 2019) has, amongst other strategic determinants, empirically investigated the role of bank credit issuance and availability in the survival of start-ups. However, the conclusions of this literature are erratic (Briozzo et al. 2016).

Indeed, in the transition stages of new businesses' entrepreneurial activities (seed, early stage, and growth), banks play a crucial role in providing financial resources (Stulz 2001). Particularly in countries like Italy, where other forms of external financing are not effective (i.e. provision of external finance is almost entirely offered by banks), the greater difficulty encountered by start-ups in order to access banking loans hampers their potential for innovative development (less knowledge-intensive), such as the creation of new highly profitable market opportunities (knowledge-intensive). Does heterogeneity in the intensity of access to bank credit (Diamond 1991) displace an effect on start-up resilience?

Several studies undermine the role of access to bank loans in the survival of start-ups. Applying a probit regression model to a sample of 738 US start-ups for the years 1982, 1987, and 1992, Astebro and Bernhardt (2003) observe a negative correlation between having a bank loan and business survival after controlling for labour, capital structure, and other firm characteristics. However, we deem these results to be feeble given the absence of in-depth robustness check analysis.

With similar findings, relying on a more robust methodology, Cosh et al. (2009) implement a multivariate tobit and probit estimation on a sample of 2520 UK firms. They provide evidence of the greater difficulties encountered by start-ups in gaining access to banks to explain their operational outcomes. In other words, start-ups are able to acquire the desired level of external financing under any circumstances. In our view, this result seems sound for the UK, where alternative external finance sources can be exploited, but cannot be generalised to include other countries like Italy, where bank credit is by far the most important financing source.

When investigating the ability of start-ups to succeed in turnaround strategies, Collett et al. (2014) underline that the firms with lower access to long-term financing are less resilient compared to the firms with shortages debt. Boyer and Blazy (2014) ground their analysis on heterogeneous survival rates across innovative and non-innovative micro-start-ups in France. In doing so, they test the 'pecking order' hypothesis, verifying that banks ensure a negative impact on default when compared to the exploitation of personal resources.

Closer to our work are the studies by Wamba et al. (2017) and Castaldo et al. (2020), due to the similarity of the results and their robustness, as well as the analysis by Cole and Sokolyk (2018) with regard to econometric strategy. Both these contributions empirically assess bank loans as a key determinant for the probability of start-up survival. In particular, quantitative analysis (logistic regression) and qualitative analysis by Wamba et al. (2017) reveal that both access to bank loans and the level of such loans improve the survival probability of a start-up, although this effect vanishes over time. Relying on a two-stage least squares (2SLS) regression analysis, Castaldo et al. (2020) show that, after controlling for firm characteristics and performance, the initial debt structure of Italian start-ups (i.e. total, short-term, and long-term debt) negatively influences the probability of default. As with our approach, this contribution relies on a very similar definition of a start-up and on a unique dataset of observations representative of the total population of new companies for the cohorts used in the panel.

Finally, Cole and Sokolyk (2018), on the other hand, adopt a closer econometric methodology applying a Cox proportional hazard model on data retrieved from the Kauffman Firm Survey (4928 start-ups in 2004). Their estimations give evidence that new companies which have a higher banking debt in the start-up phase face a lower probability of failure. A strong point in their approach is that, by applying a two-step Heckman model, they provide a sound robustness check with regard to the risk of selection bias.

A notable conclusion arising from this analysis states that innovation is a crucial factor for the survival of SMEs. Therefore, following Rosenbusch et al. (2011), we further investigate this issue by conducting a sensitivity analysis according to the sector and its technological intensity.

Data and Descriptive Analysis

The data used for this analysis are drawn yearly from Analisi Informatizzata delle Aziende (AIDA), a commercial dataset provided by Bureau Van Dijk containing information on Italian companies which have to deposit their balance sheet. This database, which has been used in an increasing number of empirical studies for Italian case (see among others, Ferragina et al. 2014; Pittiglio and Reganati, 2014) provides information on a wide set of economic and financial variables, such as sales, costs, employees, value added, start-up year, sector of activity at the five-digit ATECO 2002, and legal and ownership status.

The 'legal status' variable indicates whether a firm is either active or inactive (i.e. in liquidation, dissolved, or in receivership). Since the status of inactivity could mask a takeover or merger, or even a change in the firm's location midway through the period covered by the analysis, this information has been complemented with that of the Italian Business Register (ASIA) about the timing of the 'real' legal cessation of the firm's activity. In ASIA all active firms that are inactive in both t + 1 and t + 2 years are considered as exit in year t (Istituto Nazionale di Statistica—ISTAT 2012). The comparison with the population of active firms in the subsequent two years is useful for excluding those firms that could be reactivated.

This chapter involves data and information on three cohorts of firms established between 1 January 2004 and 31 December 2006 and examines their likelihood of surviving for up to three years after their birth (i.e. 2007 for 2004 cohort; 2008 for 2005 cohort, and 2009 for 2006 cohort) to 31 December 2014. By considering the dynamics of start-ups from their third year of life, we are able to focus our analysis only on those firms which have reached at least the early-stage phase.

By omitting all observations for which the necessary data are incomplete, we have a sample of about 32,000 new firms for a total of around 160,000 observations over the 8-year period. The selected cohorts span all two-digit ATECO industry classifications. Following the Eurostat-OECD classification (Eurostat 2006), firms are grouped into four classes according to the level of sectoral technological intensity in which they operate. Specifically, we aggregated manufacturing sectors into i) high- and medium-high-technology industries (HMHT) and ii) low- and medium-low-technology industries (LMLT), whereas services sectors into i) knowledge-intensive services (KIS) and less-knowledge-intensive services (LKIS). Figure 1 provides a sectoral distribution of 2004 cohorts firms at the beginning (2007) and the end (2014) of the time span.

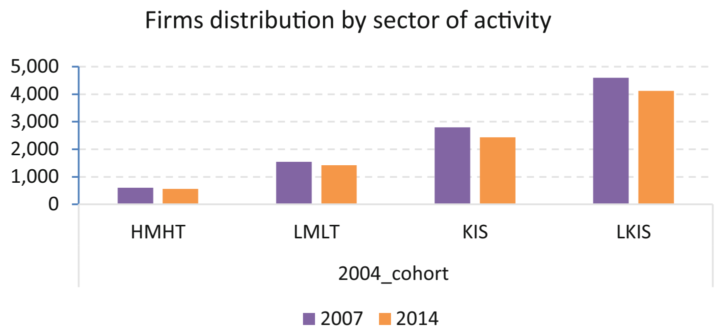

Fig. 1 Firms distribution by sectoral technological intensity

Table 1 Evolution of firm survival over 2007–2014 period—N° of firms

Cohort	2007	2008	2009	2010	2011	2012	2013	2014
2004	9826	9804	9753	9677	9677	9676	9626	8793
2005		6160	6115	6053	6052	6050	5982	5004
2006			7267	7214	7214	7213	7139	5867

In line with ISTAT, we observe a larger presence of firms operating in services, mainly in the less knowledge-intensive services for which we also observe a higher number of firms' exits.

Before testing the relationship between bank loan and start-up survival, some descriptive statistics on firm survival are provided.

Table 1 contains a description of newly founded businesses over the period 2007–2014. The upper part of the table shows the number of companies that survived from the 2004, 2005, and 2006 cohorts to the years 2007–2014. According to the figures, more than 11% of the firms established in 2004 that had survived up until 2007 failed before 2014. This percentage is greater for the 2005 and 2006 cohorts (19% and 20%, respectively).

In order to distinguish the sectorial survival rates, the Kaplan–Meier theoretical survival rates are plotted in Fig. 2. As shown by ISTAT (2016), we also find that the survival rates of start-ups are considerably lower in services than in manufacturing. This higher vulnerability of services start-ups is much more evident after the sixth year of their existence, whereas the likelihood of going out of business is about the same for both during the first years. A similar pattern is also confirmed for the other two cohorts.

With regard to the relationship between survival rate and firm leverage, this preliminary analysis shows that there is some variation in survival rates over time. In Figs. 3 and 4, we compare the survival pattern between the leveraged start-ups, such as those with bank debt, and the others, such as not-indebted companies, distinguishing between short- and long-term debt. The lines relating to ST_DFs and LT_DFs indicate the survival pattern of firms with short- and long-term banking loans, respectively. We find that, whereas the likelihood of firm survival in the

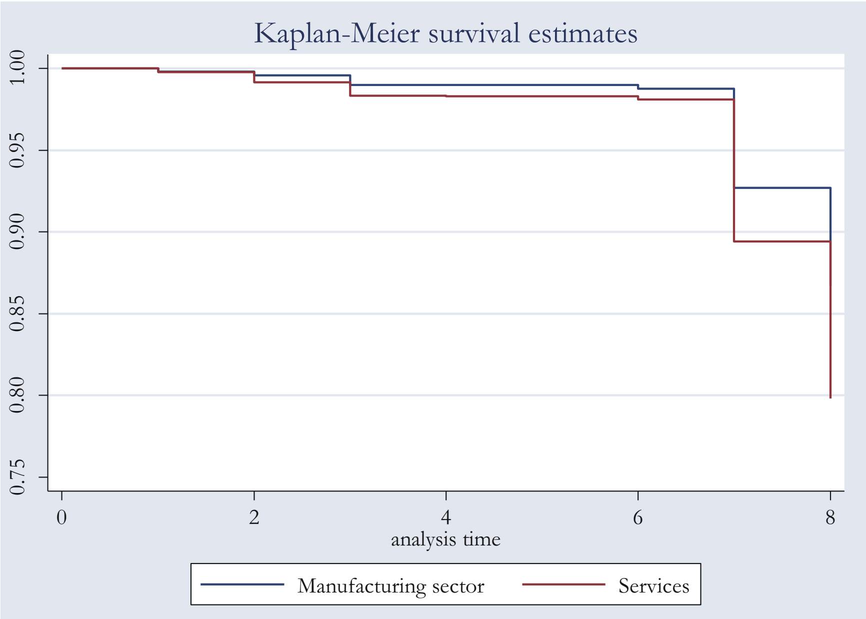

Fig. 2 Survival pattern over the period 2007–2014

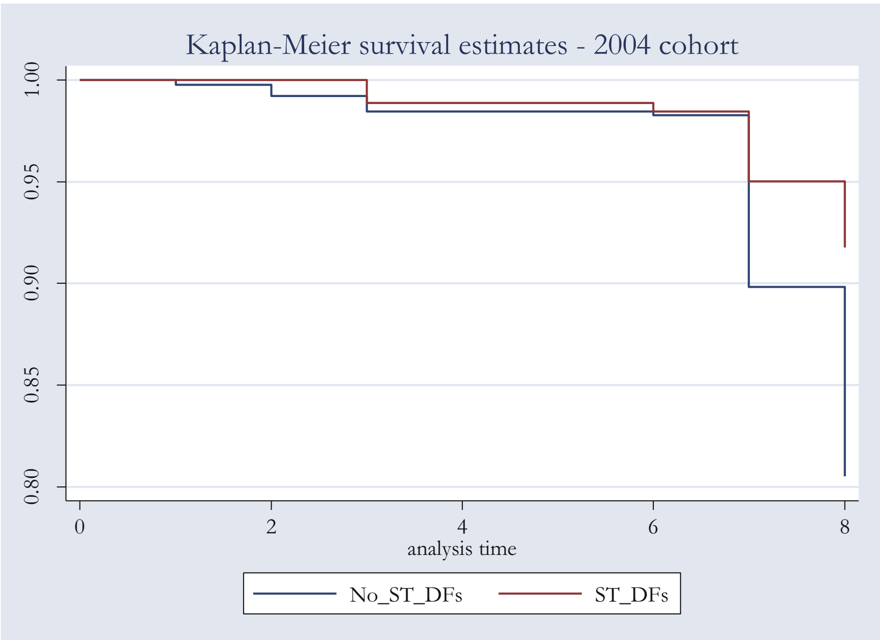

Fig. 3 Survival pattern over the period 2007–2014—start-up with short-term bank indebted versus not-indebted firms

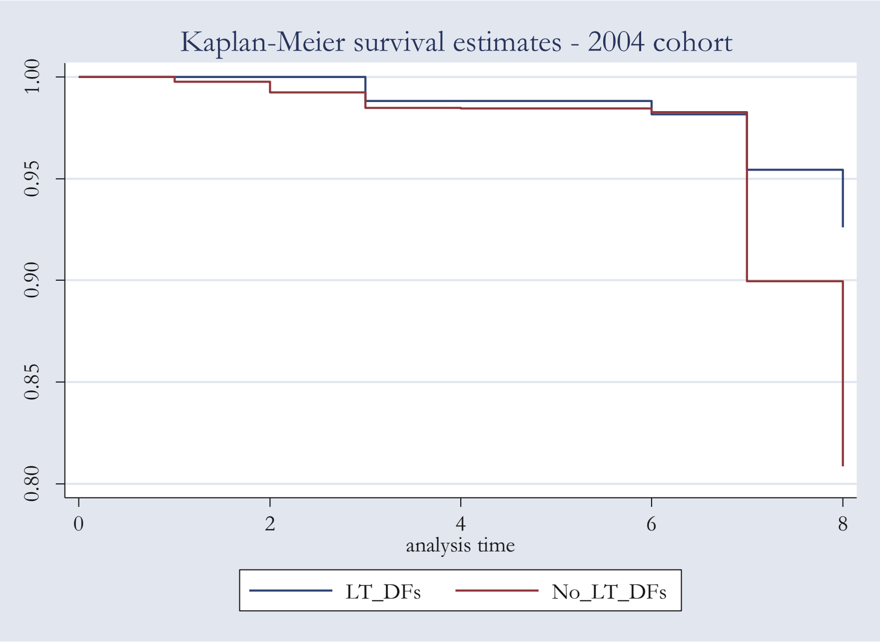

Fig. 4 Survival pattern over the period 2007–2014—long-term bank indebted versus not-indebted firms

beginning years is about the same for both leveraged and unleveraged firms, after six years the likelihood of going out of business is relatively higher for the unleveraged firms.

The Econometric Methodology

The Model

Although firm survival occurs in a continuous time period, data are collected on a yearly basis. An individual firm is observed from one year to the next, that is, from its birth year to the end of the j-th year and so on until it is either complete (the firm exits) or right censored (the firm exits the sample without experiencing the event). Given the discrete nature of the duration variable, a discrete-time hazard model (i.e. an extension of the Cox proportional hazard model used in continuous time survival analysis) is applied.

The discrete-time hazard function of each firm (i.e. the probability of exit in the j-th interval for a firm that has survived up to interval j – 1) is given by:

$$h\,(j, X) = 1 - \exp.\left[-\exp.\left(b'X + \gamma j\right)\right] \tag{1}$$

where γj is the baseline hazard rate for the j-th interval; X is a vector of firm, industrial, and spatial covariates that affect firm survival; and b denotes the vector of parameters to be estimated. The complementary log–log transformation of this function, or cloglog model, is:

$$\log\,(-\log\,(1 - h\,(j, X))) = b'X + \gamma j \tag{2}$$

The cloglog model has several advantages over more conventional event duration models. First, the parameter γj depends on j but not on X and it gives information about the duration dependence in the interval hazard that is assumed to be common to all firms. Moreover, this model specification utilises a panel data structure that can easily accommodate both time-varying and time-constant variables.

Although the discrete cloglog specification imposes no prior restrictions on the function form of the baseline hazard function, in order to proceed with the estimation, γj must be specified. Here, the baseline hazard is specified using a set of γ j time dummies.

The main interest lies in the identification of the b parameters showing the effect of the explanatory variables on the hazard rate. A positive coefficient indicates larger values of the explanatory variable that increase the hazard of exit, or equivalently, decrease the probability of survival. A negative coefficient suggests that the variable is inversely associated with the hazard and hence positively affects survival.

A potential source of bias in discrete-time hazard models is the presence of unobserved heterogeneity, arising when idiosyncratic risk factors influence the duration. The failure to control for unobserved heterogeneity can produce severe biases in the estimates of the parameters associated with both duration dependence and explanatory variables (Heckman and Singer 1984).

The standard practice in the literature is to introduce a positive-valued random variable, v, into the hazard specification:

$$h\,(j, X, v) = 1 - \exp.\left[-\exp\,\left(b'X + \gamma\ j\right) v\right] \tag{3}$$

where $v > 0$ is a normally distributed ($v \sim N\,(m, \sigma 2)$) individual random effect that scales the no-frailty component.

The cloglog transformation of Eq. (3) is given by:

$$\log\,\Big(-\log\,\,(1–h\,(j, X, v)) = b'X + \gamma\ j + u$$

where

$$u = \log(v) \tag{4}$$

As a final consideration, it must be pointed out that although the random-effects cloglog model (4) allows one to control for unobserved heterogeneity, it still presents some limitations due to the assumption of orthogonality between unobserved heterogeneity and the explanatory variables, which is typical of any random-effects model. Therefore, the econometric results based on this assumption must be interpreted with caution because they cannot be fully understood as causal relations.

The Variables

Key Independent Variables

In order to estimate the relationship between bank debt financing and the likelihood of survival for Italian start-ups, we use two variables: i) the (natural logarithm) firms' ratio of short-term bank debt to total short-term debt (NLdebt_st), and ii) the (natural logarithm) firms' ratio of long-term bank debt to total long-term debt (NLdebt_lt).

Firm-Characteristics Control Variables

Several studies provide evidence of the positive effect of start-up size on the likelihood of firm survival—'liability of smallness' (Audretsch and Mahmood 1995; Mata and Portugal 1994; Segarra and Callejon 2002). Two main arguments help explain this result: first, the output levels of larger firms are more likely to be close to their industries' minimum efficient scales and, second, compared with small firms, large firms have easier access to capital markets and are more capable of recruiting qualified workers. The variable used to capture this effect is (the) firm size (L_SIZE), measured by the natural logarithm of each firm's employment at birth. Moreover, in order to allow for non-linearities, the square of size (L_SIZE_SQ) is also introduced in the model.

Furthermore, empirical analysis finds that legal status at birth matters for firm survival. In our analysis, firms' legal status at birth is controlled for a set of dummy variables, namely (i) public limited companies (Società per azioni, S.p.a.), (ii) private limited companies (Società a responsabilità limitata, S.r.l.), (iii) partnerships limited by shares (Società in accomandita per azioni, S.a.p.a.), and (iv) other legal status (i.e. consortia and cooperatives).

Finally, a set of duration dummies have been included in the empirical model to measure the age after the firm's birth. Naturally, age significantly affects survival probability. Several empirical studies (Evans 1987; Agarwal and Gort 1996) show that age initially reduces exit hazard and then raises it. This can be explained by the fact that the firms' stock of knowledge increases with time but at a decreasing rate, and the relationship between age and survival might not be monotonic, following instead an inverted U pattern. Following this empirical literature, we expect young firms to have a higher risk of failure than older ones because of their opacity, particularly within the financial and labour markets, which makes it difficult for them to adequately procure financing and capabilities.

Industry-Characteristics Control Variables

Industry-specific conditions are captured by three variables computed at the two-digit level of the Italian Classification of Economic Activity—ISTAT (2002): market competition, industry growth, and scale economies.

The degree of market competition is approximated by the logarithm of the Herfindahl index (CONC). Opposite effects can arise from the market concentration; on one side, the firms are subject to more aggressive competition which may threaten their survival, but conversely, it can also lead to higher price–cost margins which increase the probability of surviving. Therefore, the empirical evidence is mixed because some authors find a positive effect of industry concentration on firm survival (Audretsch 1995; Segarra and Callejon 2002), whilst others do not find any statistically significant relationship (Mata and Portugal 1994; Strotmann 2007).

Moreover, as pointed out by Audretsch (1995), the probability of survival for young companies is highly heterogeneous across business sectors. The hypothesis is that provision of bank credit is related to potential and effective sectoral growth rate and is thus heterogeneous across economic activities (Giannetti 2019; Robson et al. 2013). Therefore, we include dummy variables at two-digit NACE sectoral level to control for unobserved heterogeneity in the economic activity sectors.

Finally, the model includes a set of regional dummies (REG) at NUTS-2 level to control for unobserved heterogeneity at the geographical level: furthermore, there are dummy variables for the three cohorts to control for the influence of the business cycle. The summary statistics are reported in Appendix.

Econometric Results

Baseline Model

As a starting point for the analysis, a discrete-time cloglog model, without controlling for unobserved heterogeneity, is estimated. Table 2 reports the estimates by distinguishing the model with short-term debt from that with long-term debt; the robust standard errors adjusted for clustering at the firm level are in brackets. The Wald test provides satisfactory support for model specifications. In particular, the columns (1–2) show our baseline estimates on Italian start-up firm survival for manufacturing sectors (MAN) corresponding with ATECO 15–37, whilst the

Table 2 Estimation results: cloglog model with robust standard errors

Variables	(1) MAN_short_term	(2) MAN_long term	(3) SERV_short term	(4) SERV_long term
NLdebt_bt	−0.244***		−0.224***	
	(0.00775)		(0.00325)	
NLdebt_lt		−0.158***		−0.130***
		(0.00806)		(0.00358)
LSIZE	−1.683***	−2.662***	−1.442***	−2.335***
	(0.146)	(0.107)	(0.0673)	(0.0536)
LSIZE_sq	0.248***	0.328***	0.177***	0.253***
	(0.0397)	(0.0276)	(0.0170)	(0.0134)
LHI_4	0.553***	0.293***	−0.109	−0.0217
	(0.0952)	(0.0880)	(0.0679)	(0.0616)
D3	−3.092***	−3.932***	−3.625***	−4.333***
	(0.232)	(0.220)	(0.135)	(0.129)
D4	−4.257***	−4.576***	−3.917***	−4.284***
	(0.313)	(0.294)	(0.132)	(0.123)
D5	−4.697***	−4.659***	−5.006***	−4.877***
	(0.319)	(0.299)	(0.155)	(0.143)
D6	−6.144***	−5.896***	−6.069***	−5.786***
	(0.466)	(0.459)	(0.205)	(0.200)
D7	−2.292***	−2.018***	−2.556***	−2.183***
	(0.112)	(0.0958)	(0.0608)	(0.0507)
D8	−1.289***	−1.180***	−1.403***	−1.241***
	(0.0914)	(0.0870)	(0.0481)	(0.0446)
Constant	−1.003**	−0.0605	0.843	0.240
	(0.427)	(0.399)	(0.838)	(0.859)
Legal status dummies	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
N. Obs.	39,756	39,738	119,983	119,919
Log likelihood	−2260	−2790	−9640	−12,054
Wald test	3297	2487	9751	8250

Robust standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

columns (3–4) show those for service sectors (SERV) corresponding with ATECO 40–99.

When looking at our strategic variables (NLdebt_st and NLdebt_lt), in line with previous papers (Castaldo et al. 2020; Cole and Sokolyk 2018; Wamba et al. 2017), we find that access to bank financing exerts a positive effect on firm survival, both in manufacturing and in the services. In particular, the coefficient for bank debt, controlling for a wide range of start-up characteristics, is negative and statistically significant at the 1% level across all specifications. However, in manufacturing, a higher level of bank loans reduces the likelihood of exit more than in the services; both the coefficients related to short- and long-term debt for manufacturing start-ups (−0.24 and −0.16 for short and long term, respectively) are higher than those related to start-ups belonging to the service sectors (−0.22 and −0.13 for short and long term, respectively). This reaffirms that, generally, the financing needs for manufacturing start-ups are larger because the operating scale is greater and consequently the financing demand is higher, especially for banking loans. Our results also indicate that higher levels of short-term debt have a stronger effect on firm survival than long-term debt in both manufacturing and services. This result is not surprising in light of the conclusions resulting from economic analysis of financial constraints for Italian SMEs (for Italy, Sarno 2005, 2008; Donati and Sarno 2014; Butzbach and Sarno 2019). The empirical analysis showed that financial constraints emerge for the financing of operating activity more than for investment. This is especially true for start-ups, for which the starting/initial business plan makes investment financing less difficult than the financing needs arising from ordinary operating activities. Specifically, it should also be considered that the 2007–2008 financial and economic crisis has further exacerbated this condition making the need for young firms to provide working capital and liquidity in order to finance their current activities even more severe.

Turning to firm- and industry-specific control variables, firm size has a significant non-linear effect on survival. A hump-shaped relation emerges between survival and firm size, confirming the results of previous studies (Strotmann 2007; Esteve Pérez and Mañez Castillejo 2008). Up to a certain threshold, an increase in start-up size increases the chances of survival, in line with the liability of smallness hypothesis (Audretsch and Mahmood 1995; Mata and Portugal 1994; Esteve Pérez and Mañez Castillejo 2008). Above that threshold, however, the advantages of having a larger start-up size decrease.

In manufacturing, the degree of industry concentration has a significant and negative effect on survival. In line with Audretsch and Mahmood (1995), findings suggest that since new firms in highly concentrated manufacturing sectors are subject to stronger competition by incumbents, their chances of survival are reduced. The coefficients of the duration dummies are significant and suggest that the likelihood of exit increases over time, but then starts to decrease after the six-year period. This finding supports the liability of adolescence hypothesis (vis-à-vis the 'pure' liability of newness hypothesis), as in Strotmann (2007).

Industry Technological Condition Models

Due to the large size of our database, we are able to better verify the existence of some sector-specific characteristics that may interact with bank debt financing at the start-up of firms. We thus re-estimate our model by disaggregating manufacturing and service sectors according to the level of sectoral technological intensity.

Specifically, following the OECD classification of industry technological intensity, we distinguish the high-technology (HT) industries as:

i. High- and medium-high-technology manufacturing
ii. Knowledge-intensive services and low technology (LT) industries as:
iii. Low- and medium-low-technology manufacturing
iv. Less knowledge-intensive services.

Analysis of the relationship between sectoral technological intensity and the survival probability of firms active in that sector is not clear cut (Audretsch 1995). On the one hand, the highly innovative activity enables firms to grow through launching new products and exploiting new markets. There is compelling evidence that product and process innovations are important for firm growth and survival, because even incumbent firms must continuously innovate to mitigate the disruptive threat of new technologies (Christensen 1997). On the other hand, it has been argued that the risk of exit may be higher for firms in high-tech sectors because of the uncertainty associated with innovation (Ericson and Pakes 1995).

The regression results reported separately for manufacturing and services in Tables 3 and 4 are discussed below. Looking at Table 3, we observe that the coefficients on bank debt variables for start-up firms operating in high- and medium-high-technology—HMHT—sectors are higher than those for start-up firms operating in low- and medium-low-technology—LMLT—industries; moreover, they confirm that short-term debt affects survival probability more than long-term debt. The outcomes suggest that ceteris paribus for the firms belonging to higher technology industries (manufacturing and services), access to the credit market impacts more crucially on their survival probability than for the start-ups of traditional industries. That is to say, for firms that compete in highly dynamic contestable markets, access to external financing more effectively expands their ability to face global market outlets.

Similar results are obtained for start-ups in the services. First, results confirm that the effect of banking credit on survival is higher when start-ups have access to short-term bank loans, and then reaffirm that credit bank access has a greater positive effect on new firm survival in the knowledge-intensive market services than in the less knowledge-intensive market services (Table 4).

Finally, the results obtained for other firm-specific independent variables are generally in accordance with expectations and are similar to those obtained in the more aggregate analysis.

Robustness Check

As a robustness check, here is the evidence from the random-effects version of the cloglog model (re-cloglog), which controls for unobserved firm heterogeneity (Table 5). The relative importance of unobserved individual heterogeneity is indicated by the parameter ρ measuring the share of individual variation in the hazard

Table 3 Estimation results for the manufacturing: cloglog model with robust standard errors

	(1)	(2)	(3)	(4)
	MAN_short term	MAN_short term	MAN_long term	MAN_long term
Variables	HMHT	LMLT	HMHT	LMLT
NLdebt_st	−0.293***	−0.221***		
	(0.0198)	(0.00281)		
NLdebt_lt			−0.164***	−0.131***
			(0.0226)	(0.00328)
LSIZE	−1.637***	−1.394***	−2.910***	−2.257***
	(0.283)	(0.0594)	(0.209)	(0.0479)
LSIZE_sq	0.264***	0.170***	0.363***	0.248***
	(0.0644)	(0.0158)	(0.0425)	(0.0124)
LHI_4	0.0852	0.140***	0.114*	0.0799***
	(0.0650)	(0.0151)	(0.0664)	(0.0147)
D3	−2.657***	−3.661***	−3.789***	−4.308***
	(0.552)	(0.107)	(0.520)	(0.103)
D4	−4.913***	−4.032***	−5.324***	−4.325***
	(1.095)	(0.116)	(1.041)	(0.109)
D5	−4.867***	−5.016***	−4.817***	−4.835***
	(0.848)	(0.139)	(0.782)	(0.130)
D6	−5.428***	−6.207***	−5.067***	−5.836***
	(0.769)	(0.189)	(0.740)	(0.186)
D7	−2.442***	−2.546***	−2.094***	−2.120***
	(0.264)	(0.0479)	(0.216)	(0.0398)
D8	−1.180***	−1.413***	−1.071***	−1.224***
	(0.215)	(0.0397)	(0.197)	(0.0377)
Constant	−0.0153	0.410***	−0.312	0.272**
	(0.764)	(0.122)	(0.693)	(0.117)
Legal status dummies	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
N. Obs.	9628	150,158	9628	150,076
Log likelihood	−395	−11,917	−533	−14,828
Wald test	670	13,058	446	9698

Robust standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

rate due to unobserved factors. Unobserved heterogeneity (‘frailty’) is unimportant only for the specification in Column (1) since the likelihood ratio test cannot reject the null hypothesis of $\rho = 0$.

Substantially, the results from the re-cloglog model are similar to those presented above. Nevertheless, it is worth mentioning that, after having controlled for frailty, the estimated coefficients turn out to be slightly higher, in line with the literature on survival (Jenkins 2005; Gullstrand and Tezic 2008).

Table 4 Estimation results for the services: cloglog model with robust standard errors

Variables	(1) SERV_short term KIS	(2) SERV_short term LKIS	(3) SERV_long term KIS	(4) SERV_long term LKIS
NLdebt_st	−0.200***	−0.241***		
	(0.00426)	(0.00387)		
NLdebt_lt			−0.0975***	−0.157***
			(0.00459)	(0.00476)
LSIZE	−0.759***	−1.642***	−1.720***	−2.526***
	(0.108)	(0.0624)	(0.0816)	(0.0555)
LSIZE_sq	0.0505*	0.216***	0.185***	0.274***
	(0.0296)	(0.0149)	(0.0197)	(0.0138)
LHI_4	0.227***	0.0182	0.166***	0.00425
	(0.0230)	(0.0176)	(0.0236)	(0.0179)
D3	−4.168***	−3.249***	−4.589***	−4.105***
	(0.178)	(0.130)	(0.172)	(0.124)
D4	−4.111***	−4.067***	−4.201***	−4.526***
	(0.171)	(0.162)	(0.158)	(0.154)
D5	−5.105***	−4.964***	−4.760***	−4.919***
	(0.208)	(0.184)	(0.191)	(0.174)
D6	−6.546***	−5.961***	−6.056***	−5.679***
	(0.314)	(0.226)	(0.308)	(0.222)
D7	−2.844***	−2.381***	−2.343***	−2.019***
	(0.0808)	(0.0582)	(0.0674)	(0.0488)
D8	−1.571***	−1.305***	−1.319***	−1.162***
	(0.0651)	(0.0489)	(0.0617)	(0.0465)
Constant	−0.196	0.864***	−0.401**	0.652***
	(0.231)	(0.148)	(0.201)	(0.143)
Legal status dummies	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
N. Obs.	45,002	114,784	44,999	114,705
Log likelihood	−4789	−7380	−5763	−9439
Wald test	4100	9438	3335	6653

Robust standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Policy Implications

The aim of this section is to discuss the main policy implications linked to our analysis. Our findings confirm that access to short- and long-run bank debt represents a strong predictor of start-ups' probability of default. Especially, in Italy where the bank channel is almost the unique channel for obtaining new external finance (for both liquidity and new investments), these findings cannot

Table 5 Estimation results: random-effects version of the cloglog model

VARIABLES	(1) MAN_short_term	(3) MAN_long term	(5) SERV_short term	(7) SERV_long term
NLdebt_bt	−0.244***		−0.225***	
	(0.00834)		(0.00320)	
NLdebt_lt		−0.162***		−0.136***
		(0.00866)		(0.00387)
LSIZE	−1.683***	−2.789***	−1.449***	−2.523***
	(0.157)	(0.124)	(0.0663)	(0.0673)
LSIZE_sq	0.248***	0.349***	0.179***	0.281***
	(0.0410)	(0.0307)	(0.0173)	(0.0145)
LHI_4	0.553***	0.337***	−0.110	−0.0414
	(0.102)	(0.0913)	(0.0769)	(0.0747)
D3	−3.092***	−4.044***	−3.630***	−4.488***
	(0.247)	(0.233)	(0.129)	(0.132)
D4	−4.257***	−4.697***	−3.924***	−4.444***
	(0.348)	(0.308)	(0.123)	(0.125)
D5	−4.697***	−4.782***	−5.015***	−5.064***
	(0.356)	(0.316)	(0.143)	(0.145)
D6	−6.145***	−6.032***	−6.078***	−5.978***
	(0.489)	(0.470)	(0.204)	(0.206)
D7	−2.292***	−2.124***	−2.564***	−2.338***
	(0.144)	(0.105)	(0.0642)	(0.0676)
D8	−1.289***	−1.230***	−1.406***	−1.308***
	(0.102)	(0.0888)	(0.0482)	(0.0488)
Constant	−1.003**	−0.0812	0.854	0.335
	(0.437)	(0.415)	(1.166)	(1.181)
Legal status dummies	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
N. Obs.	39,756	39,738	119,983	119,919
Log likelihood	−2260	−2788	−9640	−12,041
Wald test	1927	1413	9531	4874

Robust standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

be undermined. In this vein, policy initiatives oriented to facilitate access to credit for SMEs and start-ups are definitely targeting a crucial driver for the growth and survival of new business.

The role of the small and medium-sized enterprises (SMEs) and start-ups in the economy and the importance of access to credit is one of the pillars of the European Commission (2017). To help SMEs and start-ups to access credit for their investment or liquidity needs, governments have frequently intervened on the bank credit market by using loan measures such as direct lending, co-funding, interest rate subsidies, and public credit guarantee (PCG) schemes. The advantages of such different policies have been well documented through theoretical models (Minelli and Modica 2009; Arping et al. 2010). PCG, in particular, is a scheme largely implemented worldwide which represents a 'financial product that small entrepreneurs can take as a partial substitute for collateral; it is a commitment by a guarantor to pay to the lender all or part of the loan if the borrower defaults' (Deelen and Molenaar 2004). This scheme aims at alleviating financial constraints amongst SMEs and start-ups, who suffer from particularly sharp information asymmetries due to both adverse selection and moral hazard (Stiglitz and Weiss 1981) and lack sufficient collaterals. The debate abounds, however, on whether intervening through PCGs is the best alternative to address this market imperfection. PCG is a mechanism that, if not well-designed, might also exacerbate ex post moral hazard problems compared to mechanism based on private guarantees (amongst others Holmstrom and Tirole 1997), at least for three reasons. First, borrowers may have high incentive to fail, since part of collateral, fulfilled by a credit guarantee institution, is not belonging to firms. In addition, in case of firm's default the loss will be covered by the guarantee institution. Secondly, financial institutions, for its virtually risk-free status, may lack incentives to maintain vigorous credit assessment and to monitor the firm. Finally, public loan guarantees do not have any role in signalling the creditworthiness of the borrower (Besanko and Thakor 1987) compared to those offered privately. Empirical evidence on these aspects is still needed: whilst the positive impact on credit availability is well documented, the effectiveness of PCG on firm performance and other credit variables is inconsistent and inconclusive.

Concluding Remarks

Small and medium-sized enterprises (SMEs) and start-ups play an important role in the economy, especially in Europe. The conditions of their access to external finance are of crucial importance and the policies to remove obstacles that sometimes make such access difficult are central to the European Commission's policy agenda.

Using a discrete-time proportional hazard model, this chapter presents an empirical analysis regarding the impact of access to banking credit on the survival of start-up firms in Italy between 2004 and 2014, a period covering both the global financial crisis (2007–09) and the sovereign debt crisis (2011–2012). The results largely confirm that whatever the macro sector of activity, access to bank financing exerts positive effects on the survival of Italian start-up firms, although these results must be interpreted with some caution because of potential endogeneity biases connected with firm-level unobserved heterogeneity. Our results also indicate that higher levels of short-term bank loans have a stronger effect on firm survival than long-term bank loans. The more detailed exercise that we performed (breaking down our dataset according to the degree of technological/knowledge intensity of the sector where start-ups operate) supported our main conclusions.

Finally, from a policy perspective this result is potentially important, particularly in a country such as Italy where the bank channel is by far the main source of external finance. Our results here suggest that access to short- and long-term banking credit can be considered as a predictor of the probability of start-up survival, given the sectorial or technological conditions. Therefore, we believe that policies facilitating access to credit by SMEs and start-ups are a crucial driver for the growth and resilience of new businesses.

Appendix

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Size	161,190	9.081646	44.99551	0	5925.9
HI_4	161,190	61.54	147.2076	3.9	3364.2
Long-term_bank_debt (thousand €)	160,894	94.97	2846.246	0	324752.6
Short-term_bank_debt (thousand €)	160,894	101.6	2169.88	0	347315.4

References

Agarwal R, Gort M (1996) The evolution of markets and entry exit and survival of firms. Rev Econ Stat 78:489–498.

Aghion P, Fally T, Scarpetta S (2007) Credit Constraints as a Barrier to the Entry and Post-entry. Growth of Firms. Econ Policy 22:731–779.

Ang J (1992) On the Theory of Finance for Privately Held Firms. Journal of Small Business Finance 1:185–203.

Arping S, Lóránth G, Morrison AD (2010) Public initiatives to support entrepreneurs: Credit guarantees versus co-funding. J Financial Stab 6:26–35.

Astebro T, Bernhardt I (2003) Start-up Financing, Owner Characteristics, and Survival. J Econ Bus 55:303–319.

Audretsch DB (1995) Innovation and industry evolution. MA: MIT Press. Cambridge.

Audretsch DB, Mahmood T (1995) New-firm survival: New results using a hazard function. Rev Econ Stat 77:97–103.

Bastié F, Cieply S, Cussy P (2011) The Survival of New Firms: Do Bank Loans at Birth Matter? Economics Working Paper Archive WP 2011-10, Center for Research in Economics and Management (CREM), University of Rennes 1, University of Caen and CNRS.

Bastié F, Cieply S, Cussy P (2013) The Entrepreneur's Mode of Entry: The Effect of Social and Financial Capital. Small Bus Econ 40:865–877.

Berger AN, Udell GF (1998) The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. J Bank Financ 22:613–673.

Bernanke BS, Blinder AS (1988) Credit, Money, and Aggregate Demand. Am Econ Rev 78:435–439.

Bernanke BS (1983) Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression. Am Econ Rev 73:257–276.
Bernanke BS, Gertler M, Gilchrist S (1996) The Financial Accelerator and the Flight to Quality. Rev Econ Stat 78:1–15.
Besanko D, Thakor A (1987) Competitive equilibrium in the credit market under asymmetric information. J Econ Theory 42:167–182.
Boyer T, Blazy R (2014) Born to be alive? The survival of innovative and non-innovative French micro-start-ups. Small Bus Econ 42:669–683.
Briozzo A, Vigier H, Martinez LB (2016) Firm-Level Determinants of the Financing Decisions of Small and Medium Enterprises: Evidence from Argentina. Lat Am Bus Rev 17:245–268.
Butzbach O, Sarno D (2019) To What Extent Do Regional Effects Influence Firms' Capital Structure? The Case of Southern Italian SMEs'. Int J Financ Stud 7:1–20.
Calvino F, Criscuolo C, Menon C (2015) Cross-country Evidence on Start-up Dynamics. OECD Science, Technology and Industry, Working Papers 2015/06f 1–61.
Carter R, Van Auken H (2006) Small Firm Bankruptcy. Int J Bus Manag 44:493–512.
Cassar G (2004) The financing of business start-ups. J Bus Ventur 19:261–283.
Castaldo A (2020) Strumenti pubblici per l'accesso alle PMI. In: Amatori F, D'Alberti M (ed) L'impresa Italiana, vol. II, p 171–184.
Castaldo A, De Luca G, Barile B (2020) Does initial access to bank loans predict start-ups' future default probability? evidence from Italy. Contemp Econ Policy 39:83–106.
Christensen CM (1997) Patterns in the evolution of product competition. Eur Manag J 15:117–127.
Cole RA, Sokolyk T (2018) Debt financing, survival, and growth of start-up firms. J Corp Finance 50:609–625.
Collett N, Pandit NR, Saarikko J (2014) Success and failure in turnaround attempts. An analysis of SMEs within the Finnish Restructuring of Enterprises Act. Entrepreneurship Reg Dev 26:123–141.
Colombo MG, Grilli L (2007) Funding Gaps? Access to Bank Loans by High-Tech Start-Ups. Small Bus Econ 29:25–46.
Cooper A, Gimeno-Gascon F, Woo C (1994) Initial Human and Financial Capital as Predictors of New Venture Performance. J Bus Ventur 9:371–395.
Cooper AC, Gimeno-Gascon FJ (1992) Entrepreneurs, Processes of Founding, and New Firm Performance. In: Sexton DL, Kasarda JD (ed) The State of the Art of Entrepreneurship, p301–340. PWS-Kent Publishing Company, Boston.
Cosh A, Cumming D, Hughes A (2009) Outside Entrepreneurial Capital. Econ J, 119:1494–1533.
Cowling M, Liu W, Zhang N (2016) Access to bank finance for UK SMEs in the wake of the recent financial crisis. Int J Entrep Behav Res 22:903–932.
Cressy R (1996) Commitment lending under asymmetric information: theory and tests on U.K. start-up data. Small Bus Econ 8:397–408.
D'Ignazio A, Menon C (2013) The Causal Effect of Credit Guarantees for SMEs: Evidence from Italy, Banca d'Italia Temi di Discussione, N. 900/2013.
de Bettignies JE, Brander JA (2007) Financing entrepreneurship: Bank finance versus venture capital. J Bus Ventur 22:808–832.
De Blasio G, De Mitri S, D'Ignazio A, Finaldi P, Stoppani L (2017) Public guarantees on loans to SMEs: an RDD evaluation. Temi di discussione Banca d'Italia, n. 1111.
Deelen L, Molenaar K (2004) Guarantee funds for small enterprises. International Labour Organization 1–140.
Deloof M, Vanacker T (2018) The recent financial crisis, start-up financing and survival. J Bus Finance Account 45:928–951.
Deloof M, La Rocca M, Vanacker T (2019) Local banking development and the use of debt financing by new firms. Entrep Theory Pract 43:1250–1276.
Diamond DW (1984) Financial intermediation and delegated monitoring. Rev Econ Stud 51:393–414.
Diamond DW (1991) Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt. J Polit Econ 99:689–721.

Donati C, Sarno D (2014) Are Firms in 'Backward' Areas of Developed Regions More Financially Constrained? The Case of Italian SMEs. Ind Corp Chang 24:1353–1375.
European Commission (2017) *Small and medium-sized enterprises' access to finance*. European Semester Thematic Factsheet.
Ericson R, Pakes A (1995) Markov-Perfect industry dynamics: a framework for empirical work. Rev Econ Stud 62:53–82.
Esteve Pérez S, Mañez Castillejo J (2008) The resource-based theory of the firm and firm survival. Small Bus Econ 30:231–24.
Evans DS (1987) The relationship between firm growth, size, and age: estimates for 100 manufacturing industries. J Ind Econ 35:567–581.
Ferragina AM, Pittiglio R, Reganati F (2014) Does multinational ownership affect firm survival in Italy? J Bus Econ Manag 15:335–355.
Franco M, Haase H (2010) Failure factors in small and medium-sized enterprises: qualitative study from an attributional perspective. Int Entrep Manag J 6:503–521.
Geroski PA, Mata J, Portugal P (2010) Founding conditions and the survival of new firms. Strateg Manag J 31:510–529.
Giannetti C (2019) Debt Specialization and performance of European firms. J Empir Finance 53:257–271.
Gullstrand J, Tezic K (2008) Who Leaves after Entering the Primary Sector? Evidence from Swedish Micro-Level Data. European Review of Agricultural Economics, 35:1–28.
Heckman J, Singer B (1984) A method for minimizing the impact of distributional assumptions in econometric models for duration data. Econometrica 52:271–320.
Hogarth RM, Karelaia N (2012) Entrepreneurial Success and Failure: Confidence and Fallible Judgment. Organ Sci 23:1733–1747.
Holmstrom B, Tirole J (1997) Financial Intermediation, Loanable Funds, and the Real Sector. Q J Econ 112:663–691.
Honjo Y, Kato M (2016) Do initial financial conditions determine the fate of start-up firms? Discussion paper series School of economics Kwansei Gakuin University, 139:1–34.
Huyghebaert N (2001) The capital structure of business start-ups: determinants of initial financial structure. Rev Banc Financ 2:84–88.
ISTAT (2002) Classificazione delle attività economiche Ateco 2002 derivata dalla Nace Rev 1.1, ISTAT, ROMA.
ISTAT (2012) La demografia d'impresa statistiche. Report. Rome: ISTAT.
Jenkins SP (2005) Survival analysis. Mimeo. Colchester: Department of Economics, University of Essex.
Lelarge C, Sraer D, Thesmar D (2010) Entrepreneurship and Credit Constraints: Evidence from a French Loan Guarantee Program, in: Lerner J. and Schoar A., International Differences in Entrepreneurship, University of Chicago Press: 243–273.
Mata J, Portugal P (1994) Life duration of new firms. J Ind Econ 42:227–246.
Minelli E, Modica S (2009) Credit market failures and policy. J Public Econ Theory 11:363–382.
Musso P, Schiavo S (2008) The impact of financial constraints on firm survival and growth. J Evol Econ 18:135–149.
Nofsinger JR, Wang W (2011) Determinants of start-up firm external financing worldwide. J Bank Financ 35:2282–2294.
Ogane Y (2016) Banking relationship numbers and new business bankruptcies. Small Bus Econ 46:169–185.
Pittiglio R, Reganati F (2014) Multinational Enterprises, Technological Intensity and Firm Survival. Evidence from Italian Manufacturing and Services Firms. Atlantic Econ Jour 43:87–106.
Van Praag MC (2003) Business Survival and Success of Young Small Business Owners. Small Bus Econ 21:1–17.
Ramakrishnan RTS, Thakor A (1984) Information Reliability and a Theory of Financial Intermediation. Rev Econ Stud 51:415–432.

Resende M, Cardoso V, Façanha LO (2016) Determinants of survival of newly created SMEs in the Brazilian manufacturing industry: an econometric study. Empir Econ 50:1255–1274.

Robb AM, Robinson D (2014) The Capital Structure Decisions of New Firms. Rev Financ Stud 27:153–179.

Robson P, Akuetteh C, Stone I, Westhead P, Wright M (2013) Credit-rationing and Entrepreneurial Experience: Evidence from a Resource Deficit Context. Entrepreneurship Reg Dev 25:349–370.

Rosenbusch N, Brinckmann J, Bausch A (2011) Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. J Bus Ventur 26:441–457.

Sarno D (2005) Liquidity Constraint on the Production of the Firms in Southern Italy. Small Bus Econ 25:133–146.

Sarno D (2008) Capital Structure and Growth of the Firms in the Backward Regions of the South Italy. Appl Financial Econ 18:821–833.

Scherr FC, Sugrue TF, Ward JB (1993) Financing the Small Firm Start-up: Determinants of Debt Use. The Journal of Small Business Finance 3:17–36.

Segarra A, Callejon M (2002) New firms' survival and market turbulence: New evidence from Spain. Rev Ind Organ 20:1–14.

Stelletto E, Scellato G, Cowling M (2017) Cost of capital and public loan guarantees to small firms. Small Bus Econ 49:319–337.

Stiglitz JE, Weiss A (1981) Credit Rationing in Markets with Imperfect Information. Am Econ Rev 71:393–410.

Storey D (1994) Understanding the Small Business Sector. Routledge: London, UK.

Strotmann H (2007) Entrepreneurial survival. Small Bus Econ 28:87–104.

Stulz R (2001) Does financial structure matter for economic growth? A corporate finance perspective. In: Demirguc-Kunt, Levine Financial structure and economic growth: a cross country comparison of banks, markets and development. The MIT Press Cambridge, Massachusetts, London, England.

Vos E, Forlong C (1996) The Agency Advantage of Debt over the Lifecycle of the Firm. Journal of Entrepreneurial and Small Business Finance 5:193–211.

Wamba LD, Hikkerova L, Sahut, JM, Braune E (2017) Indebtedness for young companies: effects on survival. Entrepreneurship Reg Dev 29:174–196.