J Evol Econ (2016) 26:765–784
DOI 10.1007/s00191-016-0453-9

REGULAR ARTICLE

Global dynamics, capabilities and the crisis

Jan Fagerberg[1,2,3] · **Martin Srholec**[3,4]

Published online: 19 March 2016

Abstract The financial crisis started in 2007–8, initially in the US, but its consequences have been felt throughout the global economy. However, its effects were far from uniform. While parts of Asia and Africa continued to grow fast, Europe experienced a large set back. This paper emphasizes three important factors: differences across countries in technological development; differences in capacities to exploit the opportunities offered by technology; and differences in the ability to compete in international market. A formal model, based on this approach, is developed and applied to data for 100 countries in the period 1997–2012. Empirical indicators reflecting the various factors are developed, a dataset constructed and econometric estimates of the model performed. The results are used to explore the factors behind the slowdown in economic growth, with a particular emphasis on the continuing stagnation in Europe. A major factor turns out to be the increased financialization of the economy. The negative effect of the growth of finance prior to the crisis is especially pronounced for the countries that suffered most during the crisis.

Keywords Technological capabilities · social capabilities · competitiveness · economic growth · crisis

JEL Classification E11 · F43 · O30

1 Introduction

The financial crisis started in 2007–8, initially in the US, but its consequences have been felt throughout the global economy. However, although most countries in the

✉ Martin Srholec
martin.srholec@circle.lu.se

[1] Center for Technology, Innovation and Culture (TIK), University of Oslo, Oslo, Norway

[2] IKE, Department of Business and Management, Aalborg University, Aalborg, Denmark

[3] CIRCLE, Lund University, Lund, Sweden

[4] CERGE-EI, Economics Institute, Czech Academy of Sciences, Prague, Czech Republic

world were affected in one way or another, the effects were far from uniform. While several industrializing countries in Asia and Africa continued to grow relatively fast, in Europe the financial crisis marked the transition to a period of stagnation and - in parts of the continent - outright decline. This paper is concerned with the explanation of such differences in performance. What are the most relevant factors? Do they work in the same way during the downturn as before the crisis struck? If not, what are the implications?

In addressing these questions, we analyze global growth from a perspective that emphasizes three, interacting factors. The first has to do with technological development, the levels of which differ enormously around the globe. As emphasized by a series of economists and economic historians (Veblen 1915, Cornwall 1976, Abramovitz 1986, Maddison 1991), countries that lag technologically have a potential for high growth through exploitation of more advanced technology already in use elsewhere. But having a large potential for growth is not sufficient; it also needs to be taken advantage of in practice, and for this a country's capacity for doing so has proven to be essential (Gerschenkron 1962). Such national capacities, which have invariably been called "social capability" (Abramovitz 1986), "national technological capability" (Lall 1992) or "social filter" (Rodríguez-Pose 1999), also vary. Thus, the gap in national capacities is the second factor taken into account here. Third, in a global world, a country's growth is also influenced by how what it produces is assessed by customers all over the world, i.e., competiveness (Fagerberg 1988). Failing to meet the required standards, trade and current account deficits may occur, and this may – at least in the longer run – hamper growth (Thirlwall 1979, Kaldor 1981).

Section 2 lays out the facts about global growth from the early 1990s onwards for a sample of 100 countries at different levels of development. A formal model, based on the above approach, is outlined in section 3. Then, in section 4, empirical indicators reflecting the three factors are developed, and a panel dataset constructed, the final period of which covers the financial crisis. The estimation of the model is carried out with particular attention to the possibility of changes in the way variables work across time, such as a different impact during the crisis. The estimated model is then used to explore the factors behind the slowdown in economic growth since the outbreak of the financial crisis. The final section sums up the lessons with respect to the impact on global dynamics and considers the implications for the future research agenda in this area.

2 The stylized facts: the global economy before and after the crisis

Although economists and historians of different leanings, from Veblen (1915) via Gerschenkron (1962) to Solow (1956), often have been very positive in their assessments of the prospects for convergence in productivity and income in the global economy, in practice it has not always worked out that way. In fact, some periods have seen a lot of convergence, such as the decades following the end of the Second World War, while, in other periods, it has been more or less absent. For example there was a virtual standstill in the 1980s and 1990s, leading Easterly (2001) to characterize these years as "lost decades" for development.

Nevertheless, important changes were taking place in the global economy around that time, which eventually would lead to higher growth, particularly in the developing part of

the world, and more convergence. Technological change, particularly in ICTs, spurred the emergence of new business models facilitating coordination of activities on a global scale, as did advancements in transport technology. Moreover, the gradual integration of previously Socialist economies in Asia and Europe into the capitalist world economy added many new workers and even more consumers. The combination of these two trends resulted in rapidly increasing trade and higher economic growth in large parts of the world.

Table 1 reports growth of GDP for ten country groups in four consecutive time periods from 1992 onwards. As the table shows, global growth was particularly strong during the years preceding the outbreak of the financial crisis, with most low income countries growing substantially faster than the developed part of the world. However, since that time, growth has been sluggish. On average, the rate of GDP growth was more than halved between 2002–2007 and 2007–2012. The slowdown has been far from uniform, though. While many countries in Asia and Africa were only marginally affected and continued to catch up with the developed world at a rapid rate, Europe experienced a large set back. As a result, global convergence was particularly strong after the crisis struck.

The diversity in performance is also evident from Fig. 1, which plots growth before the crisis (2002–2007) on the horizontal axis against growth in the years that followed (2007–2012, vertical axis). This leads to a division of the countries into four quadrants, depending on their growth performance. The countries in the upper right quadrant ("Fast") are those that performed above average in both periods. Asian and African countries dominate in this category. Among the Asian countries, China is arguably in a class of its own, but India and Vietnam also experienced fast growth in both periods. On the African continent, Ethiopia, Nigeria, Mozambique, Tanzania and Uganda may be mentioned as examples of fast-growing economies. Those in the upper left quadrant

Table 1 Annual GDP growth, four periods, 1992-2012

	N	1992-1997	1997-2002	2002-2007	2007-2012
Northern EU and EFTA	14	2.9	3.2	3.1	−0.1
Southern EU	6	2.7	3.3	2.6	−1.1
Eastern EU	11	2.3	3.7	6.1	−0.1
Other developed	9	4.8	3.2	3.9	2.1
Other former socialist	10	−4.2	4.4	7.5	2.6
Latin America	14	3.9	1.5	5.3	3.0
Eastern Asia	6	7.0	3.4	6.8	5.3
Southern Asia	4	5.0	4.3	6.7	5.6
Middle East and North Africa	8	4.0	3.7	5.8	3.3
Sub-Saharan Africa	18	3.7	4.1	5.5	5.0
World	100	3.0	3.4	5.2	2.5
Testing for β-convergence:Log of GDP per capita	100	−0.33	−0.39	−0.66	−1.39
		(0.21)	(0.15)**	(0.16)***	(0.15)***

See Table 2 for source and definition of GDP growth. N is the number of countries. Countries included in the groups are listed in Appendix Table 7. Robust standard errors are in parentheses. *, **, *** denote significance at the 10, 5 and 1 % levels

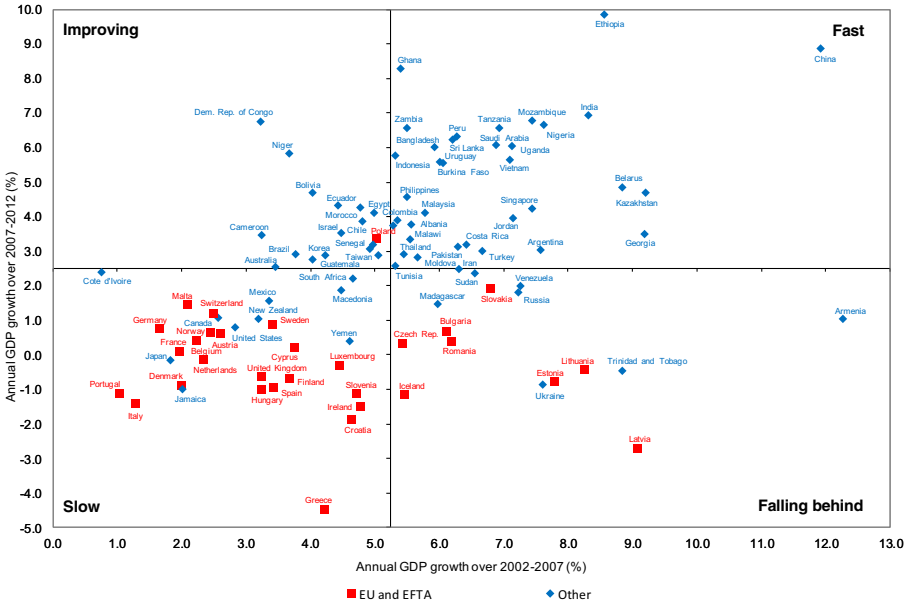

Fig. 1 Growth before and after the financial crisis

("Improving") consist of countries that, at least in relative terms, improved their growth performance after the crisis struck. Several countries in Africa and South America belong to this category. In contrast, the countries in the bottom left quadrant grew at a below average rate in both periods ("Slow"). Most European countries and other developed economies are to be found here. Finally, in the bottom right quadrant ("Falling behind") we find the countries that were most severely affected by the crisis, i.e., previously fast growing countries that now perform below average. A number of previously socialist countries in Eastern Europe and elsewhere are included here.

Hence, the impression of a "global" economic crisis is to some extent misleading. Clearly, Europe has slid into stagnation and the change is especially evident for the countries of Eastern Europe, which grew fast and caught up rapidly prior to the crisis. However, although most countries were affected to some extent, many developing countries continued to grow and catch up with the developed part of the world at a rapid rate.

3 Analyzing global growth: a formal model

To analyze the diversity in growth performances highlighted above, we use a framework that allows for the interaction of three important factors, namely differences across countries in technological development, in capacities to exploit the opportunities offered by technology and, finally, in the ability to compete in international market and the repercussions that this may have on a country's growth. The model builds on previous work by Fagerberg (1988) and Fagerberg et al. (2007).[1]

[1] However, while this earlier work assumed strictly balanced trade, the model presented below allows for deviations from this rule.

Consider a two-economy model, in which one country interacts with the "rest of the world". Let exports be X, imports be M and W be world (foreign) demand, all measured in terms of volume. In addition, we take into account the country's level of technological development (T) and its (social) capacity to exploit technology commercially (C), and we also allow for the possible impact of differences in price competitiveness (P), i.e., relative prices on tradeables in common currency.

The exports of a country can be expressed as:

$$X = f(T, C, P, W), \tag{1}$$

where T, C, P is technology, capacity and price competitiveness in country i, relative to the world: $T = \frac{T_i}{T_{world}}$, $C = \frac{C_i}{C_{world}} P = \frac{P_i}{P_{world}}$

Since imports in this model are the "world's" exports, we can model imports in the same way, noting that the competitiveness variables in this case are the inverse of those in Eq. (1) and that domestic demand (Y) replaces world demand:

$$M = g\left(\frac{1}{T}, \frac{1}{C}, \frac{1}{P}, Y\right) \tag{2}$$

If we take world demand and technology, capacity and price competitiveness as given, Eqs. (1)-(2) give us two relationships between three endogenous variables (Y, X and M). To solve the model for, say, GDP growth we need an additional constraint linking growth to trade. It is common to assume in the literature that there exist economic mechanisms[2] that prevent a country from continuing on paths that would not be sustainable in the long run, such as accumulating ever-increasing debt or claims on a grand scale vis-à-vis the rest of the world. A simple way to take this into account, suggested by Thirlwall (1979), would be to assume strictly balanced trade. However, in the real world, deviations from this requirement do occur and such deviations arguably have economic effects that should be taken into account. For the sake of realism, we will therefore allow the balance (B), defined as the ratio between the value of exports and that of imports, to vary:

$$B = \frac{XP}{M} \tag{3}$$

Our expectation is that, in the longer run, $dY/dB > 0$, which means that an increase in the deficit will have a negative effect on growth (and vice versa).

Technology does not only depend on national sources (N) but also on diffusion (D) from abroad:

$$T = h(N, D). \tag{4}$$

It will be assumed, as is common in many models, that the contribution from diffusion of technology from abroad follows a logistic curve (Metcalfe 1988). This

[2] This may occur through adjustments of the fiscal and monetary policy stance, but it may also be the result of the working of markets, such as the capital, labor and currency markets.

implies that the contribution is an increasing function of the distance between the level of technology appropriated in the country and that of the country on the technological frontier. Hence, for the frontier country, this contribution will be zero by definition.

Let the total amount of technology, adjusted for differences in country size (e.g., per capita), in the frontier country and the country under consideration, be T_* and T_i respectively and let d be the rate of growth of knowledge diffused to the region from the outside world (D):

$$d = \gamma - \gamma\, T^{gap},\ where\, T^{gap} = \frac{T_i}{T_*} \tag{5}$$

By totally differentiating (1)-(5), substituting and rearranging, we arrive at the following solution for growth of GDP, using small case letters for growth rates (e.g., $y = \mathrm{d}Y/Y$ etc.)[3]:

$$y = \gamma\ \varepsilon_{TD}\frac{\varepsilon_{XT}+\varepsilon_{MT}}{\varepsilon_{MY}} - \gamma\ \varepsilon_{TD}\frac{\varepsilon_{XT}+\varepsilon_{MT}}{\varepsilon_{MY}}T^{gap} + \varepsilon_{TN}\frac{\varepsilon_{XT}+\varepsilon_{MT}}{\varepsilon_{MY}}n + \frac{\varepsilon_{XC}+\varepsilon_{MC}}{\varepsilon_{MY}}c + \frac{\varepsilon_{XP}+\varepsilon_{MP}+1}{\varepsilon_{MY}}p - \frac{1}{\varepsilon_{MY}}b + \frac{\varepsilon_{XW}}{\varepsilon_{MY}}w \tag{6}$$

where $\varepsilon_{YT} = \frac{\partial Y}{\partial T}\frac{T}{Y}$ refers to the partial elasticity of GDP with respect to technology (similar for other variables).

Hence, following this approach the growth of a country depends on five factors: (1) the potential for exploiting technology developed elsewhere, which depends on the country's level of technological development relative to the world frontier, this potential being largest for less-developed countries; (2) domestic efforts to increase the technological capability of the country; (3) change in the (social) capacity to exploit knowledge; (4) change in relative prices in common currency[4]; (5) change in the trade balance (as reflected by the exports to imports ratio); and (6) growth of world demand.

In the following, we are going to exploit this framework to assess the impact of each of these explanatory factors on economic growth. We will do this in the form of a regression of indicators reflecting the right hand side variables in (6), which will be treated as exogenous, on the dependent variable. Reverse causation, from economic growth to the various factors assumed to explain it, cannot be excluded a priori, but is considered less likely. [5] However, to reduce the possibility of simultaneity bias as much as possible, a one period lag between the explanatory factors and economic growth is

[3] See Appendix 4 for details on how Eq. (6) was derived.

[4] As can be seen from Eq. (6), the expected sign of the effects of changing relative prices on growth depends on whether or not the so-called Marshall-Lerner condition is satisfied.

[5] We hold it as unlikely that changes in a country's technological capability and social capacity can be seen as mere reflections of its rate of economic growth. A stronger case may exist for an effect of economic growth on price growth, since the price-level by definition is a relation between the value and quantity of what is produced. However, the largest share of value added consists of wages, which often are determined through negotiations of various sorts, and subject to influence by institutions, politics etc., which we in the present context have chosen to consider as exogenous.

introduced. The exception to this rule is growth of world demand, which is assumed to have an instantaneous relationship with economic growth.[6]

4 Explaining the diversity

To study global growth, a dataset with broad country coverage, relevant and reliable information, and long time series is desirable. In practice, broad country coverage may easily come into conflict with the latter. For example, some types of data, such as R&D statistics, are often not available on an annual basis. Furthermore, time-series going back much longer than the mid-1990s may be problematic for the former socialist countries. Hence, the dataset used here contains 100 countries between 1997 and 2012. Since annual data were not always available, a panel of three periods was constructed, 1997–02; 2002–2007; and 2007–2012. In a few cases, there were missing data points that had to be estimated. [7]

Table 2 gives the definitions and sources. As an approximation to the growth rates of the theoretical model, log differences were used, whenever appropriate.[8] While some of the variables are reasonably straightforward to measure, other variables – especially the growth of technology and (social) capacity - require careful consideration. For the level of technological development we use, as is common in the literature, [9] a broad productivity measure, i.e., GDP per capita. Regarding the growth of domestic technological capability, we use a broad set of indicators reflecting aspects such as the quality of science and engineering, invention, R&D expenditure and capabilities in ICT.

Factor analysis was used to summarize the growth of the technology indicators taken into account here into a synthetic measure, which we for convenience label "Technology". The results of the analysis are reported in Table 3. One eigenvalue higher than unity (1.51), explaining 37.7 % of the total variance, was retained. As the table shows, the four indicators taken into account are closely correlated, lending support to the procedure.

In the case of the growth of (social) capacities, we include the three aspects particularly emphasized by Abramovitz (1986, 1994a, b), namely, the supply of skills (education), access to finance and the quality of governance. The latter is measured by three different indicators (based on surveys and expert assessments) reflecting the quality of bureaucracy, freedom from corruption and the working of the legal system, respectively. In these data, countries are ranked on a fixed-point scale, which makes calculation of growth rates problematic. Hence, for these three indexes, changes from one period to the next were used instead. As previously, factor analysis was used to synthesize the evidence into one, common variable, "Governance" Table 4. One eigenvalue higher than unity (1.23),

[6] In principle, this increases the possibility for reverse causation. Arguably, most countries are too small to have a significant influence on world demand. Nevertheless, there may be a few countries among the one hundred taken into account here for which this assumption can be questioned, and we will test for the sensitivity of the estimates to this.

[7] Missing observations were estimated using the impute procedure in Stata 11.2, for more information see Stata (2005, pp. 217–221). The procedure, which is regression-based, uses information from other variables in the data set to fill in missing values. This applies to the following cases (% of estimated observations in brackets): R&D expenditures (11 %); gross tertiary enrolment (1 %); quality of bureaucracy (9 %), freedom from corruption (1 %) and external debt (10 %).

[8] If necessary unity was added to avoid logs of zero.

[9] See Fagerberg (1994) for an overview and discussion.

Table 2 Variables, data and sources

Label	Name	Description	Source
Y	GDP	GDP (USD converted to 2013 price level with updated 2005 EKS PPPs)	Conference Board (2014)
T^{gap}	Gap	$\ln(T_i/T_{us})$; T is GDP per capita (USD converted to 2013 price level with updated 2005 EKS PPPs), the frontier is represented by the United States	Conference Board (2014)
N	Technology	Scientific and engineering articles (per mil. people)	National Science Board (2012 and 2014)
N	Technology	USPTO utility patents granted (per mil. people)	USPTO (2014)
N	Technology	R&D expenditures (% of GDP)	UNESCO (2014), OECD (2014), Castellacci and Natera (2011) and national sources
N	Technology	Internet users (per 100 people)	World Bank (2014)
C	Education	Gross tertiary enrolment ratio (%)	UNESCO (2014) and World Bank (2014)
C	Governance	Quality of bureaucracy (index)	Kaufmann, et al. (2014); based on Economist Intelligence Unit
C	Governance	Freedom from corruption (index)	Heritage Foundation (2014); based on the Corruption Perceptions Index by Transparency International
C	Governance	Judicial independence (index)	Kaufmann, et al. (2014); based on Global Insight Business Condition and Risk Indicators
C	Finance	Domestic credit to private sector (% of GDP)	World Bank (2014)
P	Price	Real effective exchange rate	Darvas (2012)
B	Trade balance	Export–import ratio of goods and services (in current USD)	World Bank (2014)
W	Demand	Demand index (for details see Footnote 5)	UNCTAD (2014)

Variable symbols (the first column) refer to the theoretical model, while variable names in second column refer to the empirical model below

Table 3 Technology: Results of the factor analysis

	Factor loadings
Scientific and engineering articles (per mil. people)	0.63
USPTO patent grants (per mil. people)	0.71
R&D expenditures (% of GDP)	0.68
Internet users (per 100 people)	0.39
Number of observations	200

The extraction method is principal-component factors based on pooled data of growth rates in 100 countries in 1997–2002 and 2002–2007, hence 200 observations in total. Due to the choice of a one period lag in the estimated model, and in order to avoid unnecessary estimation of missing values for the most recent year, only data for the two first periods is used here

Table 4 Governance: Results of the factor analysis

	Factor loadings
Quality of bureaucracy	0.68
Freedom from Corruption	0.64
Judicial Independence	0.61
Number of observations	200

The extraction method is principal-component factors based on pooled data of changes in the quality of governance for 100 countries in 1997–2002 and 2002–2007, hence 200 observations in total. Due to the choice of a one period lag in the estimated model, and in order to avoid unnecessary estimation of missing values for the most recent year, only data for the two first periods are used here

explaining 41.2 % of the total variance, was retained. As in the previous case, the selected indicators turned out to be closely correlated .

Growth of world demand is computed by weighting the growth of global demand by product (g_j) with the initial composition (specialization) of each country's exports (s_{ij})[10]:

$$w_i = \sum_{j=1}^{m} \left(g_j \times s_{ij}\right), s_{ij} = \frac{X_{ij}^{t-1}}{\sum_{j=1}^{m} X_{ij}^{t-1}} \text{and} g_j = \ln\left(\sum_{i=1}^{n} X_{ij}^{t}\right) - \ln\left(\sum_{i=1}^{n} X_{ij}^{t-1}\right), \tag{7}$$

where X_{ij} denotes country's i ($i = 1 \ldots n$) exports of a product group j ($j = 1 \ldots m$) and t is time. A high score indicates favorable demand conditions for a country's exports.

The empirical model to be estimated, which corresponds to the theoretical model derived above, is:

$$\begin{aligned} \Delta \text{GDP} = {} & a_0 + a_1 \text{Gap} + a_2 \Delta \text{technology} + a_3 \Delta \text{education} + a_4 \Delta \text{governance} + a_5 \Delta \text{finance} \\ & + a_6 \Delta \text{price} + a_7 \Delta \text{trade balance} + a_8 \Delta \text{world demand} + a_i X_i + e_i \end{aligned} \tag{8}$$

where X_i is a set of control variables and e_i is the error term.

As noted above, these core variables, except the "Gap", were used in the estimates in log-differences or changes (denoted by "Δ"). With the exception of growth of world demand, the independent variables were lagged one period to reduce simultaneity bias in the estimates. This restricts the number of periods included in the estimations to two, which implies that panel data estimation techniques are not suitable. However, to reduce the possible omitted variable bias as much as possible, a set of control variables, reflecting differences in economic structure, geography, nature and culture (see Appendix Table 8 for their definitions and sources), [11] were added to the model.

[10] Both merchandise trade and trade in services are included. While merchandise trade is used at 3-digit level of SITC, rev. 3, with 255 product categories, the available data on trade in services only allow us to distinguish three service categories (transport, travel and other services).

[11] Several other potentially relevant control variables were tested for possible inclusion in the model. However, as the estimated coefficients did not come out anywhere close to being significant at conventional levels, they were not retained in the model. This includes the size of government (general government final consumption expenditure as % of GDP), income inequality as measured by the Gini index, access to ocean or navigable rivers, Köppen–Geiger ecozones, Holdridge life zones and the composition of religious adherence.

Table 5 reports the estimates.[12] The results are broadly consistent with the theoretical model. As expected, differences across the globe in levels of technological development, given by the gap variable, present poorer countries with promising opportunities, the realization of which requires continuous upgrading of technological and social capabilities. The important role played by world demand for growth is confirmed. As expected, deviations from balanced trade tend to be followed by a correction. Price competitiveness is, consistent with earlier studies (Fagerberg 1988, Fagerberg et al. 2007), found to be of minor importance. The results are robust to the inclusion of control variables (Table 5, column 2) and to the exclusion of the two largest economies in the world, the USA and China (for which the usual small-country assumption is questionable). The estimates of the crisis (2007–2012) dummy are insignificant in all cases. Finally, the model was re-estimated by a regression method robust to outliers, using the procedure suggested by Li (1985). The results are very similar to those reported in the paper. [13]

However, in contrast to previous research (Fagerberg and Srholec 2008), an increase in a country's financial capacity (as reflected in private credit) was not found to have a significant positive effect on growth. A similar finding has been reported by Arcand et al. (2015) in a cross-country study of finance and economic growth over the period 1990–2010. A possible explanation for this finding is that, while access to finance may be essential for growth and development, "too much finance" may actually be a bad thing, because it may lead to increased volatility and crowding out of resources from other sectors of the economy. If so, the contribution from an increase in financial capability to economic growth should be expected to depend on the level of financial capability. We test for this by introducing an interaction variable between the growth of financial capability and its level. The interaction variable is found to have a significant, negative impact on economic growth (Table 5, column 3), which is consistent with the thesis of diminishing returns to further increases in the size of the financial sector for countries in which this sector is already fairly well developed.[14]

Moreover, an interaction variable between the growth of the external balance and the level of country's foreign debt was added to test for the possibility that the strength of the correction following a change in the external balance depends on the country's degree of indebtedness. The argument is that countries with a high debt may be under much stronger pressure to restore the external balance through adjustments in the macro-economic policy stance than countries with little or no debt, and hence more freedom to pursue the policies they want. The result confirms (Table 5, column 4) that the correction is indeed much stronger in countries with high debt.

Taking the basic model as the point of departure, we also tested for the possibility that there are differences over time in the way the various variables work. This was

[12] Beta values are reported, i.e. the variables enter the analysis with mean of zero and standard deviation of one, thus the estimated coefficients refer to the impact of change by one standard deviation.

[13] Results from these additional tests are available from the authors on request.

[14] Arcand et al. (2015) suggest that the effect of financial development (F), measured in different ways, on economic growth should be modelled as $F = a_1 S + a_2 S^2$, where S is an indicator of the size of the financial sector. However, according to the model developed in this paper, it is the growth of financial capability, not its initial level, that should be expected to affect subsequent economic growth, and this leads to a different specification. Note that, by totally differentiating F we get $dF = a_1 dS + 2 a_2 S dS$, i.e., the two terms included in the model here.

done for one variable at a time, by allowing the estimated coefficient to vary between the pre-crisis and crisis period (see Appendix Table 9 for the results). Only one highly significant difference was found, for finance, the impact of which changed from positive (though not significant) to strongly negative (and significantly so) after the crisis struck (Table 5, column 5). [15]

The model with the highest explanatory power is reported in the final column in (Table 5 column 6). This model includes the interaction terms for the growth and level of finance and for the growth of trade balance and the level of external debt, and allows the impact of finance to differ between the two periods. The results suggest that there has been a change in the relationship between finance and economic growth. Before the crisis, increases in financial capability had a positive impact on growth for the majority of countries in our sample. This effect was particularly pronounced in developing countries with poorly developed financial capabilities. However, with the crisis, this positive impact completely disappears.

Table 6 provides a prediction of the slowdown in GDP growth based on the estimated model (Table 5, column 6). For most of the country groups, particularly for the developing part of the world, the drop in world demand goes a long way in explaining the difference, which is to be expected, given the high degree of interdependencies that exist globally. However, there are also other factors at play. First, while before the crisis rich countries managed to compensate for the increasing competitiveness of the developing world by advancing their technological lead (Fagerberg et al. 2007), this is no longer the case, leading to slower growth in the developed part of the world. Second, high debt and deteriorating trade balances have slowed down growth, particularly among the other former socialist countries. Finally, a major factor turns out to be the increased financialization of the economy prior to the crisis. The negative effect of the growth of finance is especially pronounced for the countries that suffered most during the crisis years, i.e., the Eastern Europe, for which around one third of the predicted slowdown can be explained in this way.

Slower growth in technological capabilities in the rich part of the world was pointed to as one of the factors behind the slowdown of their economic growth. To analyze this issue in more depth, Fig. 2 depicts the growth of technological capability from the end of the 1990s onwards. There was a notable change taking place early in the new millennium when the global economy grew particularly fast. Before that (left panel), the developed countries had actually managed to increase their technological lead vis-à-vis the developing part of the world. During the high growth period that preceded the crisis (mid panel), growth in technological capability in the richest countries slowed down considerably, while several other country groups, Eastern Asia in particular, expanded their technological capabilities at a faster rate than before. The relatively high growth in technological capability in Eastern and Southern Europe during this period is also noteworthy. This pattern essentially continues in the most recent period, after the financial crisis struck (right panel). If sustained this may indicate that the world is undergoing a transition to a new growth regime in which growth of technology will no longer be based just on advances in a few, highly developed economies but will draw on much larger and geographically less concentrated base.

Figure 3 delves deeper into the other major factors emphasized above by plotting the contribution of the increased financialization against the combined

[15] We also tested for a possible change in the impact of the interaction terms ((Δ finance × finance) and (Δ trade balance × external debt)) during the crisis; however, this hypothesis was not supported.

Table 5 Explaining GDP growth (pooled OLS for periods 2002–2007 and 2007–2012)

	(1)		(2)		(3)		(4)		(5)		(6)	
	Basic Model		With control variables		With interaction between the growth and level of finance		With interaction between the growth of trade balance and level of external debt		With interaction between the growth of finance and the crisis dummy		Full model	
Gap	−0.44	(7.89)***	−0.53	(5.94)***	−0.48	(5.16)***	−0.52	(6.10***	−0.58	(6.56)***	−0.52	(6.16)***
Δ technology	0.15	(2.95)***	0.10	(1.99)**	0.11	(2.17)**	0.10	(1.95)*	0.12	(2.35)**	0.13	(2.53)**
Δ education	0.12	(2.54)**	0.12	(2.48)**	0.11	(2.28)**	0.11	(2.30)**	0.11	(2.53)**	0.10	(2.12)**
Δ governance	0.15	(2.77)***	0.14	(2.99)***	0.13	(2.81)***	0.13	(2.78)***	0.14	(2.91)***	0.12	(2.54)**
Δ finance	−0.07	(1.32)	−0.08	(1.51)	0.10	(1.30)	−0.07	(1.38)	0.08	(1.47)	0.29	(2.71)***
Δ price	−0.03	(0.64)	−0.04	(0.76)	−0.03	(0.53)	−0.02	(0.42)	−0.02	(0.45)	0.01	(0.11)
Δ trade balance	0.16	(2.90)***	0.15	(3.22)***	0.14	(3.01)***	−0.38	(1.63)	0.13	(2.60)***	0.41	(1.54)
Δ demand	0.41	(7.38)***	0.49	(3.48)***	0.48	(3.57)***	0.48	(3.50)***	0.43	(3.24)***	0.41	(3.23)***
Natural disasters		..	−0.09	(2.23)**	−0.10	(2.39)**	−0.09	(2.23)**	−0.08	(1.91)*	−0.09	(2.09)**
Malaria		..	−0.19	(2.54)**	−0.17	(2.26)**	−0.19	(2.50)**	−0.22	(2.85)***	−0.19	(2.54)**
Oil and gas		..	−0.23	(3.54)***	−0.24	(3.64)***	−0.25	(3.72)***	−0.21	(3.34)***	−0.23	(3.61)***
External debt		..	−0.14	(2.22)**	−0.14	(2.32)**	−0.15	(2.47)**	−0.12	(1.93)*	−0.13	(2.29)**
Industry		..	0.13	(1.92)*	0.12	(1.73)*	0.15	(2.18)**	0.15	(2.30)**	0.16	(2.37)**
Cultural diversity		..	0.14	(2.76)***	0.13	(2.55)**	0.14	(2.82)***	0.15	(2.93)***	0.14	(2.78)***
Crisis (2007–2012) dummy		..	0.06	(0.45)	0.05	(0.35)	0.04	(0.32)	0.09	(0.66)	0.09	(0.70)
Δ finance × finance		..		..	−0.21	(2.67)***		..		..	−0.22	(2.46)**
Δ trade balance × external debt		..		..		..	0.54	(2.36)**		..	0.53	(2.02)**
Δ finance × crisis (2007–2012) dummy		..		..		..		..	−0.26	(3.70)***	−0.28	(4.08)***
F-test	28.61***		22.19***		24.15***		21.79***		23.79***		19.96***	
R^2	0.56		0.64		0.65		0.65		0.66		0.69	
Number of countries	100		100		100		100		100		100	
Number of observations	200		200		200		200		200		200	

See Table 2 and Appendix Table 8 for sources and definitions. Beta values are reported. Absolute values of robust t-statistics are in parentheses. *, **, *** denote significance at the 10, 5 and 1 % levels

contributions from growth in external balance and external debt. The countries in the lower left quadrant are those that are most negatively affected, while those in the upper right quadrant have benefitted. It is interesting to observe that those that have benefitted from these developments are low-income countries in Asia, Africa and Latin America, while those that were most negatively affected are predominantly European. In fact, almost the entire EU belongs to this category, while a number other developed countries do not. This clearly begs further questions about the nature of EU integration and policies prior to the crisis. [16]

5 Conclusions

This paper has analyzed the growth of the global economy with particular emphasis on the period after the financial crisis. It was shown that, although most countries were affected to some extent, the impact has been far from uniform. To explore this diversity, the paper has made use of a perspective that takes into account three interrelated phenomena: differences in levels of technological development and trends; differences in (social) capacities for exploiting (technological and economic) opportunities; and differences in "competitiveness". The empirical analysis, based on data for 100 countries from all over the globe, suggests that such differences go a long way in explaining the variations in growth performance. On a general level the policy implications of the analysis for countries in the process of development are clear. Catching up, technologically and economically, is possible, but requires continuous improvements of technological and social capabilities. Arguably, without such complimentary investments in capability-building, catching up is likely to run into problems.

However, technological and social capabilities, and their distribution in space, are not carved in stone but evolve, and this presents countries with new challenges and opportunities. One finding that deserves to be highlighted concerns the role of technological capability in global growth. Gone are the days when it could be assumed, as Raymond Vernon famously did in his "product cycle model" (Vernon 1966), that technological capability is something that only exists in the US (and possibly a few other highly developed economies), from which the results diffuse to the rest of the world in an orderly fashion. Rather what is emerging is a global system in which technological capabilities, including advanced ones, are widely dispersed. As the analysis shows, this transformation is ongoing, and at a high speed. Thus, we would expect developing countries with rapidly increasing technological capabilities to continue increasing their role in the global economy.

As for social capability, earlier work (Gerschenkron 1962, Abramovitz 1986, 1994a, b) placed strong emphasis on developing financial institutions and markets. The results provide a more chilling picture. Recent research has provided evidence suggesting that expanding finance beyond a certain threshold might have a negative effect on economic growth (Cecchetti and Kharroubi 2012, Law and Singh 2014 and Arcand et al. 2015), and this is also confirmed by the present study. However, our results also indicate that the virtuous relationship between the expansion of finance and growth, however limited, completely broke down during the crisis. Thus, from being a capability supporting

[16] See Fagerberg and Verspagen (2015) for a more in-depth discussion of this issue.

Table 6 Explaining the slowdown in annual GDP growth after 2007 (difference between the 2007–2012 and 2002–2007 periods)

	N	Actual slowdown	Predicted slowdown	Estimated contributions								
				Gap	Technology	Education	Finance	Governance	Price	Trade balance and debt	Demand	Other
Northern EU and EFTA	14	−3.1	−3.7	0.0	−0.6	−0.1	−0.7	−0.2	0.0	−0.4	−2.2	0.7
Southern EU	6	−3.7	−2.8	0.0	0.0	0.0	−0.6	−0.2	0.0	−0.5	−2.0	0.5
Eastern EU	11	−6.2	−4.0	−0.3	−0.2	−0.2	−1.5	0.1	0.0	−0.3	−2.3	0.6
Other developed	9	−1.8	−2.6	−0.1	−0.5	0.0	−0.1	0.0	0.0	0.0	−2.0	0.1
Other former socialist	10	−4.9	−5.0	−0.3	−0.1	−0.1	−2.1	0.1	0.0	−0.4	−2.5	0.3
Latin America	14	−2.3	−2.1	−0.1	0.0	0.0	−0.2	0.1	0.0	−0.2	−2.2	0.5
Eastern Asia	6	−1.6	−1.7	−0.2	0.0	−0.2	−0.3	0.2	0.0	0.0	−1.9	0.6
Southern Asia	4	−1.1	−1.3	−0.2	0.2	0.3	−0.5	0.0	0.0	−0.1	−1.6	0.7
Middle East and North Africa	8	−2.5	−2.4	−0.1	0.1	0.0	−0.5	0.0	0.0	−0.2	−2.3	0.5
Sub-Saharan Africa	18	−0.4	−1.2	−0.1	0.2	0.1	−0.6	0.2	0.0	0.4	−2.0	0.6

Based on Table 5, last column.N is the number of countries. See Appendix Table 7 for definition of the country groups. Column “other” reports the contribution from the control-variables and the crisis (2007–2012) dummy. Sums of contributions may not add up because of rounding

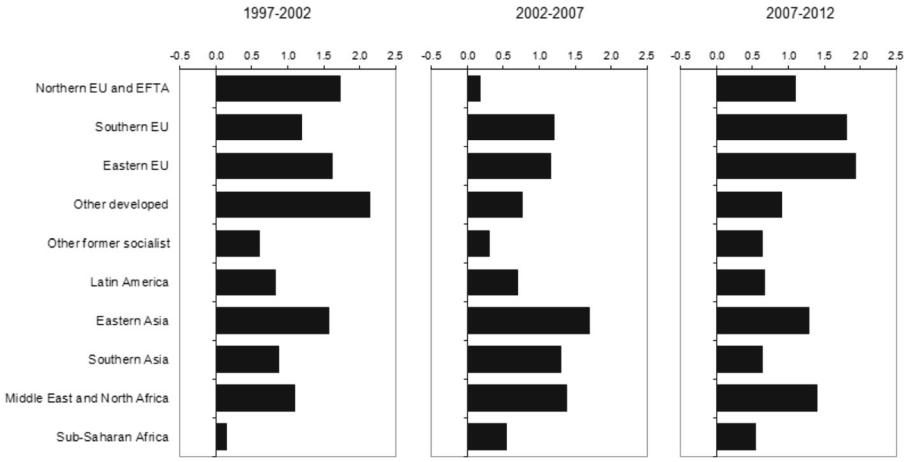

Fig. 2 Growth of technology, 1997–2012

economic growth, further growth of the financial sector has turned into a liability, dragging down the rest of the economy. Whether this is a change for the longer run, or a more specific feature characterizing the recent past, remains to be seen. Nevertheless, these findings clearly beg further work, theoretically as well as applied, on the role of finance in growth and development.

As pointed out earlier, the economic downturn following the outbreak of the financial crisis was very uneven across the globe. While many fast growing countries in Asia and Africa were only marginally affected, if at all, Europe moved into recession. The analysis conducted here points to two factors behind the particularly large slowdown

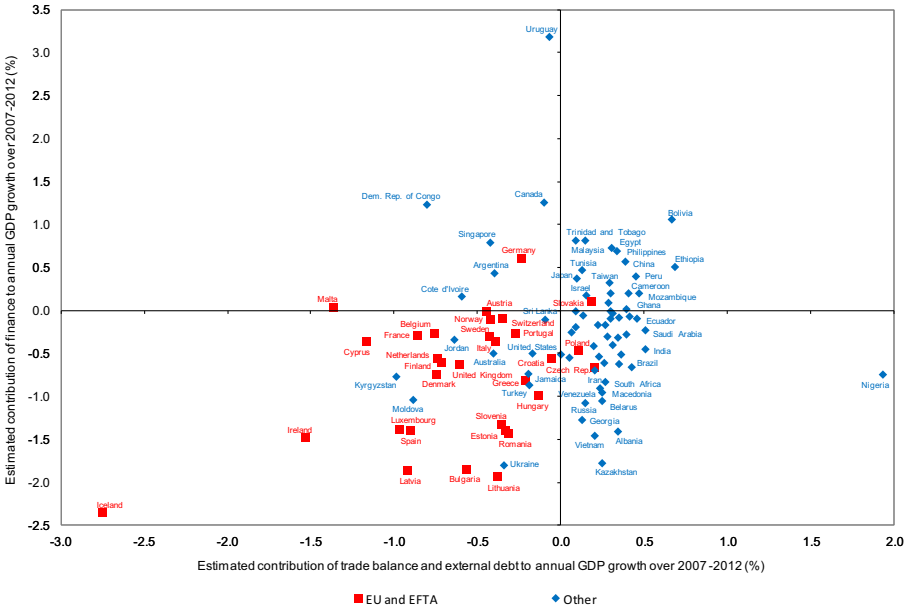

Fig. 3 The impact of finance, trade balance and external debt and on the slowdown

in Europe. First, prior to the crisis, many European countries were characterized by a rapid build-up of their financial sectors, making them vulnerable when the crisis truck; this was particularly evident for the previously socialist countries. A second factor leading to the slowdown, highlighted by this paper, concerns the increasing trade deficits in these countries and, hence, also levels of foreign debt, a pattern that also extended to the comparatively more developed Southern Europe, which proved unsustainable and contributed to the depression that followed. As a consequence, the catching up of Eastern Europe relative to its more advanced neighbors, and of Europe as a whole vis-à-vis the USA, came to an almost immediate halt, from which Europe has still not recovered. Arguably, the question of how Europe can escape the present deadlock, and instead start to profit from the increases in technological and social capabilities that are documented in this paper, deserves a high place on the agenda.

Acknowledgments Financial support from the VINNOVA Core Funding of Centers for Innovation Systems (project 2010–01370 on 'Transformation and Growth in Innovation Systems: Innovation Policy for Global Competitiveness of SMEs and R&I Milieus'), Czech Science Foundation (project P402/10/2310 on 'Innovation, productivity and policy: What can we learn from micro data?') and Czech Academy of Sciences (institutional support RVO 67985998 and agenda 'Strategie AV21') are gratefully acknowledged. Earlier versions of the paper were presented at the 15th ISS Conference, 27–30 July, 2014, Jena, Germany, the 2013 Eu-SPRI Forum Conference on Management of Innovation Policies, 10–12 April, 2013, Madrid, Spain and the Joint UNU-MERIT/School of Governance Seminar, 6 June 2013, Maastricht, Netherlands.

Appendix 1

Table 7 Regional groups of countries

Regional group	Country
Northern EU and EFTA	Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Sweden, Switzerland, United Kingdom
Southern EU	Cyprus, Greece, Italy, Malta, Portugal, Spain
Eastern EU	Bulgaria, Croatia, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia
Other developed	Australia, Canada, Israel, Japan, Korea, New Zealand, Singapore, Taiwan, United States
Other former socialist	Albania, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Russia, Ukraine
Latin America	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Jamaica, Mexico, Peru, Trinidad and Tobago, Uruguay, Venezuela
Eastern Asia	China, Indonesia, Malaysia, Philippines, Thailand, Vietnam
Southern Asia	Bangladesh, India, Pakistan, Sri Lanka
Middle East and North Africa	Egypt, Iran, Jordan, Morocco, Saudi Arabia, Tunisia, Turkey, Yemen
Sub-Saharan Africa	Burkina Faso, Cameroon, Democratic Rep. of Congo, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mozambique, Niger, Nigeria, Senegal, South Africa, Sudan, Tanzania, Uganda, Zambia

Appendix 2

Table 8 Control variables

Name	Description	Source
Natural disasters	Log of the number of people killed in natural disasters over the period (per million people)	Université catholique de Louvain (2014)
Oil and gas	Log of the initial level of oil and gas exports, SITC, rev. 3 categories 333, 334, 335, 342, 343 and 344, (% of exports of goods and services);	UNCTAD (2014)
Malaria	Malaria fatal risk (estimate of % population at risk of contracting falciparum malaria in 1994)	Sachs (2003)
External debt	Log of the total debt owed to nonresidents repayable in foreign currency, goods, or services (% of GDP)	World Bank (2014) and (2015)
Industry	Industry value added (% of GDP)	World Bank (2014)
Cultural diversity	Cultural fractionalization based on the structural distance between languages (index)	Fearon (2003)

Appendix 3

Table 9 Testing for differences in variable impact between the pre-crisis period of 2002–2007 and the crisis period of 2007–2012 (pooled OLS)

	Coefficient	t-statistics
Gap	−0.46	(4.70)***
2007-2012 (dummy)	−0.12	(0.73)
Gap × 2007–2012 (dummy)	−0.17	(1.75)*
Δ technology	0.15	(2.15)**
2007-2012 (dummy)	0.05	(0.37)
Δ technology × 2007–2012 (dummy)	−0.07	(1.08)
Δ education	0.12	(1.86)*
2007-2012 (dummy)	0.05	(0.34)
Δ education	−0.01	(0.07)
Δ governance	0.16	(2.30)**
2007-2012 (dummy)	0.04	(0.31)
Δ governance × 2007–2012 (dummy)	−0.03	(0.39)
Δ finance	0.08	(1.47)
2007-2012 (dummy)	0.09	(0.66)
Δ finance × 2007–2012 (dummy)	−0.26	(3.70)***
Δ price	−0.01	(0.07)
2007-2012 (dummy)	0.05	(0.36)
Δ price × 2007–2012 (dummy)	−0.05	(0.85)
Δ trade balance	0.18	(2.81)***
2007-2012 (dummy)	0.04	(0.30)
Δ trade balance × 2007–2012 (dummy)	−0.04	(0.65)
Δ demand	0.44	(2.88)***
2007-2012 (dummy)	−0.07	(0.29)
Δ demand × 2007–2012 (dummy)	0.08	(0.56)

Other variables are the same as in Table 5, column 2. Beta values are reported. Absolute values of robust t-statistics are in parentheses. *, **, *** denote significance at the 10, 5 and 1 % levels

Appendix 4: Derivation of the model

From (3):

$$x - m = b - p \tag{9}$$

From (1) – (2):

$$x = \varepsilon_{XT} t + \varepsilon_{XC} c + \varepsilon_{XP} p + \varepsilon_{XW} w \tag{10}$$

$$m = -\varepsilon_{MT} t - \varepsilon_{MC} c - \varepsilon_{MP} p + \varepsilon_{MY} y \tag{11}$$

By subtracting (11) from (10):

$$x - m = (\varepsilon_{XT} + \varepsilon_{MT}) t + (\varepsilon_{XC} + \varepsilon_{MC}) c + (\varepsilon_{XP} + \varepsilon_{MP}) p + \varepsilon_{XW} w - \varepsilon_{MY} y \tag{12}$$

From (9) and (12) follows, by eliminating $x - m$:

$$b - p = (\varepsilon_{XT} + \varepsilon_{MT}) t + (\varepsilon_{XC} + \varepsilon_{MC}) c + (\varepsilon_{XP} + \varepsilon_{MP}) p + \varepsilon_{XW} w - \varepsilon_{MY} y$$

By solving for y:

$$y = \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} t + \frac{\varepsilon_{XC} + \varepsilon_{MC}}{\varepsilon_{MY}} c + \frac{\varepsilon_{XP} + \varepsilon_{MP} + 1}{\varepsilon_{MY}} p - \frac{1}{\varepsilon_{MY}} b + \frac{\varepsilon_{XW}}{\varepsilon_{MY}} w \tag{13}$$

From (4) – (5)

$$t = \varepsilon_{TN} n + \varepsilon_{TD} d$$

$$t = \gamma \varepsilon_{TD} - \gamma \varepsilon_{TD} T^{gap} + \varepsilon_{TN} n \tag{14}$$

By substituting (14) into (13):

$$y = \gamma \varepsilon_{TD} \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} - \gamma \varepsilon_{TD} \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} T^{gap} + \varepsilon_{TN} \frac{\varepsilon_{XT} + \varepsilon_{MT}}{\varepsilon_{MY}} n + \frac{\varepsilon_{XC} + \varepsilon_{MC}}{\varepsilon_{MY}} c + \frac{\varepsilon_{XP} + \varepsilon_{MP} + 1}{\varepsilon_{MY}} p - \frac{1}{\varepsilon_{MY}} b + \frac{\varepsilon_{XW}}{\varepsilon_{MY}} w$$

References

Abramovitz M (1986) Catching up, forging ahead, and falling behind. J Econ Hist 46(386):406

Abramovitz M (1994a) The origins of the postwar catch-up and convergence boom. In: Fagerberg J, Verspagen B, von Tunzelmann N (eds) The dynamics of technology, trade and growth. Edward Elgar, Aldershot, pp 21–52

Abramovitz M (1994b) Catch-up and convergence in the postwar growth boom and after. In: Baumol WJ, Nelson RR, Wolf EN (eds) Convergence of productivity – cross-national studies and historical evidence. Oxford University Press, Oxford, pp 86–125

Arcand J, Berkes E, Panizza U (2015) Too much finance? J Econ Growth 20:105–148
Castellacci F, Natera JM (2011) A new panel dataset for cross-country analyses of national systems, growth and development (CANA). Innov Dev 1:205–226
Cecchetti SG, Kharroubi E (2012) Reassessing the impact of finance on growth, BIS Working Paers No 381, Bank for International Settlements, July 2012
Conference Board (2014) Total economy database. January 2014, http://www.conference-board.org/data/economydatabase/
Cornwall J (1976) Diffusion, convergence and Kaldor's Law. Econ J 86:307–314
Darvas Z (2012) Real effective exchange rates for 178 countries: a new database. Working Paper 2012/06, Bruegel, 15 March 2012 (Update, 26 June 2014); http://www.bruegel.org/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/
Université catholique de Louvain (2014) EM-DAT: The OFDA/CRED International Disaster Database. Brussels, www.emdat.be, download on 8. 8.2014.
Easterly W (2001) The lost decades: explaining developing Countries' stagnation in spite of policy reform 1980–1998. J Econ Growth 6:135–157
Fagerberg J (1988) International competitiveness. Econ J 98:355–374
Fagerberg J (1994) Technology and international differences in growth rates. J Econ Lit XXXII(3):1147–1175
Fagerberg J, Srholec M (2008) National innovation systems, capabilities and economic development. Res Policy 37:1417–1435
Fagerberg J, Verspagen B (2015) One Europe or Several? Causes and consequences of the european stagnation. In Fagerberg J, Laestadius S, Martin BR (eds) The triple challenge for Europe economic development, climate change and governance, Oxford University Press, forthcoming
Fagerberg J, Srholec M, Knell M (2007) The competitiveness of nations: why some countries prosper while others fall behind. World Dev 35:1595–1620
Fearon JD (2003) Ethnic and cultural diversity by country. J Econ Growth 8:195–222
Gerschenkron A (1962) Economic backwardness in historical perspective. The Belknap Press, Cambridge
Heritage Foundation (2014) 2014 Index of economic freedom, all index data. The Heritage Foundation, http://www.heritage.org/index/explore?view=by-region-country-year, download on 13.6.2014.
Kaldor N (1981) The role of increasing returns, technical progress and cumulative causation in the theory of international trade and economic growth. Econo Appl (ISMEA) 34:593–617
Kaufmann D, Kraay A, Mastruzzi M (2014) Worldwide Governance Indicators, on-line. World Bank, http://info.worldbank.org/governance/wgi/index.aspx#doc-sources, download on 13.6.2014.
Lall S (1992) Technological capabilities and industrialization. World Dev 20:165–186
Law SH, Singh N (2014) Does too much finance harm economic growth? J Bank Financ 41:36–44
Li G (1985) Robust regression. In: Hoaglin DC, Mosteller F, Tukey JW (eds) Exploring data tables, trends, and shapes. Wiley, New York, pp 281–340
Maddison A (1991) Dynamic forces in capitalist development: a long-Run comparative view. Oxford University Press, New York
Metcalfe JS (1988) The diffusion of innovation: an interpretive survey. In: Dosi G (ed) Technological change and economic theory. Francis Pinter, London
National Science Board (2012) Science and engineering indicators 2012. National Science Foundation, Arlington
National Science Board (2014) Science and engineering indicators 2014. National Science Foundation, Arlington
OECD (2014) OECD.Stat. Paris: OECD, download on 8. 8.2014.
Rodríguez-Pose A (1999) Innovation prone and innovation averse societies: economic performance in Europe. Growth Chang 30(1):75–105
Sachs JD (2003) Institutions don't rule: direct effects of geography on per capita income. NBER Working Paper No. 9490, http://www.nber.org/papers/w9490.
Solow RM (1956) A contribution to the theory of economic growth. Q J Econ 70(1):65–94
Stata (2005) Stata data management, reference manual, release 9. College Station: Stata Press.
Thirlwall AP (1979) The balance of payments constraints as an explanation of international growth rate differences. Banca Nazionale del Lav Q Rev 32:45–53
UNCTAD (2014) UNCTAD Handbook of statistics 2012, UNCTADstat on-line. Geneva: UNCTAD, download on 16. 10. 2014.
UNESCO (2014) Science, technology and innovation; Data Centre. Geneva: UNESCO Institute for Statistics, download on 8. 8.2014.

USPTO (2014) Extended year set - patents by country, State, and Year Utility Patents (December 2013). U.S. Patent and Trademark Office, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utlh.htm, download on 8. 8.2014.

Veblen T (1915) Imperial Germany and the industrial revolution. Macmillan, New York

Vernon R (1966) International investment and international trade in the product cycle. Q J Econ 80:190–207

World Bank (2014) World development indicators 2013, World Bank, last updated on 18. 12. 2013, download on 8. 8.2014

World Bank (2015) Quarterly external debt statistics, World Bank, download on 6. 8.2015