Chapter 9
Income Distribution and Economic Growth

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Abstract This paper links access to bank loans and income distribution to productivity growth. Its main focus is on examining how functional income distribution can influence the evolution of productivity and thereby promote economic growth. We obtained key variables and their evolution from the Ethiopian Central Statistical Agency dataset on medium and large scale manufacturing firms. The paper uses the evolutionary economic framework and the evolutionary theory jointly with its evolutionary econometric approach. This sees economic growth as an open-ended process. The major findings and conclusions of this paper are lack of strong evidence of evolution (intra-industry selection) to foster productivity growth and reallocation (structural change). The employment share of each firm within an industry entered the model with a negative sign but a significant coefficient. In economic terms, the positive and negative coefficients of labor share within a firm and employment share of each firm within the industry give us important information about structural changes within the manufacturing sector. The key policy lesson is that access to bank loans is of great importance to firms. This is particularly so for industries such as spinning, tanning and publishing in which all firms that had access to bank loans revealed movements in their employment shares. This is evidence of structural transformation. It is desired that future research includes economy-wide modeling, estimation and more formalization of evolutionary economic models to study the link between access to bank loans and its effects on income distribution and inclusive economic growth.

Keywords Income distribution · Evolutionary economics · Evolutionary econometrics · Productivity · Growth

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9.1 Introduction

Income distribution remains one of the few unanswered questions in economics. Mincer's (1958) thinking is that economists have long theorized about the nature or causes of inequalities in personal incomes. In contrast, the vigorous development of empirical research in the field of personal income distribution is of recent origin. For nearly 200 years, Anglophone economics followed Ricardo (1815) and conceived of distribution as referring to a functional role in economic production.

The functional approach to income distribution has survived a marginal revolution in economics, an industrial revolution, the development of welfare economics, the great depression, the advent of macroeconomics, the creation of a welfare state, the mathematizing of neo-classical economics and several generations of prominent economists arguing that economics should rightly be concerned with the distribution of well-being across individuals and the erosion of the sharp class divisions that gave Ricardo his distribution theory (Goldfarb and Leonard 2005).

While who gets what refers to personal distribution of income across individuals, functional distribution is across suppliers of productive factors because of the distributive consequences and their wider implications are more important than the causes.

Moreover, the emphasis of contemporary research has almost completely shifted from a study of the causes of inequalities to the study of the facts and of their consequences for various aspects of economic activities. One such activity is productivity growth and economic growth.

The question of how inequalities are generated and how they evolve over time has been a major concern of economics for more than a century. Yet, the relationship between inequalities and the process of economic development is far from being an agreed area of research. In developing economies, it is a challenge for both academic and policy circles. There is demand for academicians to investigate this and it is an issue that also needs to be dealt with by policymakers.

Thus, a study of income distribution should not be undertaken for the sake of a study but for its wider implications on economic performance. Economic growth is effected by economic performance because the growth-inequality linkage is both important and controversial.

It is important because policymakers need to understand the way in which an increase in output will be shared among different groups within an economy and the constraints that this sharing may put on future growth. Its controversial aspects arise from the fact that it has been difficult to reconcile the different theories, especially since empirical evidence has been largely inconclusive (Cecilia 2010). For example, Barro (1990) and Persson and Tabellini (1994) argue that moderate redistribution promotes growth whereas a high degree of redistribution will have a negative impact on growth.

The conventional textbook approach on the effect of inequality on growth is that inequality is good for incentives and therefore good for growth, even though incentive and growth considerations might be traded off against equity goals. On the other hand, development economists have long expressed counter-arguments.

For example, Todaro (1997) provides four general arguments why greater equality in developing countries may in fact be a condition for self-sustaining economic growth: (a) dissaving and/or unproductive investments by the rich; (b) lower levels of human capital held by the poor; (c) demand pattern of the poor being more biased toward local goods; and (d) political rejection by the masses.

Overall, the view that inequality is necessary for accumulation and that redistribution harms growth has faced challenges from many fronts. For example, Alesina and Rodrik (1994) and Persson and Tabellini (1994) combine political economy arguments with the traditional negative incentive effect of redistribution. These authors maintain that inequalities affects taxation through the political process when individuals are allowed to vote in order to choose the tax rate (or, equivalently, vote to elect a government whose programs include a certain redistributive policy). If inequalities determine the extent of redistribution, then this will have an indirect effect on the rate of growth of the economy.

In their paper 'Social Conflict, Growth and Income Distribution,' Benhabib and Rustichini (1996) explore the effect of social conflict arising due to income distribution on both short-run and long-run economic growth rates. According to them, despite the predictions of the neo-classical theory of economic growth, poor countries were observed to invest at lower rates and have not grown faster than rich countries. They studied how the level of wealth and the degree of inequalities affected growth and show how lower wealth can lead to lower growth and even to stagnation when the incentives to domestic accumulation are weakened by redistributive considerations.

Perotti (1996) contends that equality has a positive impact on growth while Rehme (2006) argues that redistributing governments may have a relatively stronger interest in technological advances or high economic integration. He observes a positive association between redistribution and growth across countries.

While we can find vast literature on income inequalities and economic growth similar to the studies mentioned earlier, they exclude the role of firms and the mechanisms behind them for the creation and evolution of the links between income distribution and economic growth. However, the existence of firms and their actions are recognized in economic theory.

Thus, our introduction of firms in such an analysis is not arbitrary. Firms play a central role in shaping the path of economic theory and as sources of growth in the process of economic evolution. This argument is theoretically consistent with one of the questions in economics (Coase 1937). Thus, any analysis which omits the role of firms in the creation and evolution of income distribution in the growth process cannot make a complete description. More specifically, empirical evidence on how firms' financial structures can influence their productivity and thereby drive economic growth is scarce. This study bridges this gap.

Two crucial questions arise for policymakers which have policy relevance. The first is whether inequality is a prerequisite for growth. And the second concerns the effects of growth promoting policies on inequalities, and in particular under which circumstances a conflict between the two objectives may emerge.

Thus, our paper takes firms as a hub for generating macroeconomic regularities. Firms generate a link between sources and uses of funds, productivity, income distribution and structural transformation in the market process. We explore the dependence of macroeconomic productivity growth on firm-level productivities. We examine how firms' access to bank loans can influence an aggregate rate of growth. Growth in productivity, output and employment is determined mutually and endogenously. More specifically, this paper answers the following questions:

(a) How do firm-level sources and use of funds (investments from bank loans) influence economic growth?
(b) Does access to bank loans affect intra- and inter-firm reallocation of labor?
(c) Can we find evidence of structural change, that is, reallocation of labor from less productive to more productive industries?
(d) Can we draw some theoretical results and what policy lessons can we draw from this?

The rest of the paper is organized as follows. Section 9.2 discusses economic growth theories. Section 9.3 deals with evolutionary economics and economic growth from an evolutionary perspective. Section 9.4 discusses econometric modeling in the presence of evolutionary change; it also presents empirical evidence and is followed by Sect. 9.5 which presents empirical results from Ethiopia. Section 9.6 gives a conclusion.

9.2 Theory of Economic Growth

Economic growth is a dominant area of theoretical and empirical research in economics in general and in macroeconomics in particular. For example, Nelson (1996: 7) points out that from the beginning of modern economics as a field of study, economic growth has often been the central area of inquiry, but on and off. During the early decades, Hahn and Matthews (1964) presented the most comprehensive survey on the contributions that had been made to the theory of economic growth beginning with Harrods's article in 1939. Salavadori (2003) emphasizes that an interest in the study of economic growth has experienced remarkable ups and downs in the history of economics. It was the central issue in classical political economy from Adam Smith to David Ricardo, and then in the critique by Karl Marx (Nelson 1996; Salavadori 2003).

Then, the growth theory waned (Nelson 1996) and moved to the periphery during the so-called marginal revolution (Salavadori 2003). Undoubtedly, one of the reasons for this was that formal theory had developed which focused on market equilibria. The concern was with what lay behind demand and supply curves and how these jointly determined the observed configuration of outputs, inputs and prices. The troubled economic times after World War I, in particular the great depression, also pulled the attention of economists toward analyzing shorter-run phenomena such as balance of payment disequilibria, inflation and unemployment.

There was a renaissance of interest in long-run economic growth after World War II. One reason for this was that new national product data was first available for USA and later for other advanced industrial nations. This for the first time allowed economists to measure economic growth at the national level (Nelson 1996).

In modern times, the starting point for any study of economic growth is the neo-classical growth model which emphasizes the role of capital accumulation. This model, first constructed by Solow (1956) and Swan (1956), shows how economic policy can raise an economy's growth rate by inducing people to save more. But the model also predicts that such an increase in growth cannot last indefinitely. In the long run, a country's growth rate will revert to the rate of technological progress, which neo-classical theory takes as being exogenous. Underlying this long-run result is the principle of diminishing marginal productivity which puts an upper limit on how much output a person can produce simply by working with more and more capital given the state of technology. Aghion and Howitt (1992, 1998) provide a presentation on this.

9.2.1 The Neo-Classical Growth Theory

In the neo-classical framework, the notion of growth as increased stocks of capital goods was codified as the Solow–Swan growth model, which involves a series of equations that show the relationship between output, labor-time, capital and investment. This was the first attempt to model long-run growth analytically. According to this theory, the role of technological changes was crucial and even more important than the accumulation of capital.

This theory assumes that countries use their resources efficiently and that there are diminishing returns to capital and labor. From these two premises, the neo-classical model makes three important predictions: first, increasing capital relative to labor creates economic growth since people can be more productive given more capital. Second, poor countries with less capital per person grow faster because each investment in capital produces a higher return than in rich countries with ample capital. Third, because of diminishing returns to capital, economies eventually reach a point where any increase in capital no longer creates economic growth.

The model also notes that countries can overcome this steady state and continue growing by inventing new technologies. In the long run, output per capita depends on the rate of saving, but the rate of output growth should be equal to any saving rate. In this model, the process by which countries continue growing despite diminishing returns is 'exogenous' and represents the creation of new technology that allows production with fewer resources. As technology improves, the steady state level of capital increases and the country invests and grows.

The strengths of the neo-classical approach for economic growth are considerable. The neo-classical theory has provided a way of thinking about the factors behind long-run economic growth in individual sectors and in the economy as a whole. The theoretical structure has called attention to historical changes in factor proportions and has focused an analysis of the relationship between those changes and factor prices. These key insights and the language and formalism associated with them have served to effectively guide and to give coherence to research that has been done by many different economists around the globe. The weakness of the theoretical structure is that it provides a grossly inadequate vehicle for analyzing technical change.

The fundamental problems with neo-classical explanations of economic growth are: (1) despite much empirical efforts at the neo-classical production function, the model still faces problems in explaining considerable inter-plant and international differences in productivity as well as differences between developed economies. Even more striking is evidence for single industries, showing big sectoral productivity gaps between different countries (Hodgson 1996); and (2) increasing capital creates a growing burden of depreciation. It is also noted that the economic life of capital assets has been declining. In particular, the orthodox formulation offers no possibility of reconciling analyses of growth undertaken at the level of the economy or the sector with what is known about the processes of technical changes at the microeconomic level. Hodgson (1996) has a detailed account of this and similar arguments.

9.2.2 The Endogenous Growth Theory

In response to some of the problems in the standard neo-classical growth theory, the idea of an endogenous growth theory emerged in the works of Romer (1986, 1987, 1990, 1994), Lucas (1988) and a second generation variant pioneered by Aghion and Howitt (1992, 1998). They developed the endogenous growth theory which includes a mathematical explanation of technological advancement.

This broke from the preceding neo-classical thinking by encompassing learning by doing and knowledge spillover effects. In these models, cumulative divergence of national output and productivity becomes more likely than convergence and thus seems to correspond more adequately to available data.

However, the amended aggregate production function is still at the conceptual foundation of the endogenous growth models, typically embodying features such as increasing marginal productivity of knowledge but diminishing returns in the productivity of knowledge (Hodgson 1996).

Therefore, overall, there are constant returns to capital and economies never reach a steady state. Growth does not slow as capital accumulates, but the rate of growth depends on the type of capital that a country invests in. Research done in this area has focused on what increases human capital (for example, education) or technological change (for example, innovation).

9.3 Economics as an Evolutionary Science and Economic Growth from an Evolutionary Perspective

9.3.1 Why an Evolutionary Approach in Economics?

The basic paradigm in mainstream economic theory, namely that individuals take decisions in isolation using only the information received through some general market signals such as prices, is built on the general equilibrium model. However, as is well known, this model guarantees neither stability nor uniqueness of equilibrium. Since the latter is essential for macroeconomists who wish to use comparative statistics, they have had to avoid this fundamental problem by resorting to what has become the standard paradigm in modern macroeconomics, that is, the representative agent (RA) framework.

The basic assumption is that the behavior of the aggregate can be treated as the behavior of an average individual. The use of such an approach has been frequently contested and has several obvious disadvantages. Firstly, it means that one has to ignore communication and direct interaction among agents and ultimately defines away the problem of coordination (Hahn and Solow 1995; Leijonhufvud 1992). In this setting, interaction and coordination occur only through prices. The role of prices is undoubtedly important, but the price mechanism alone can work only if information is complete; in such a case, one can ignore the influence of other coordination and interaction mechanisms. Here, again, these difficulties can be sidestepped by assuming that a sector of the economy can be described by a RA.

There is no simple, direct, correspondence between individual and aggregate regularities. It may be that in some cases, aggregate choices correspond to those that can be generated by an individual. However, even in such exceptional cases, the individual in question cannot be thought of as maximizing anything meaningful from the point of view of society's welfare. Our approach is exactly the opposite from the representative individual approach. Instead of trying to impose restrictions on aggregate behavior, by using, for example, the first-order conditions obtained from the maximization program of the representative individual, the claim is that the structure of aggregate behavior (macro) actually emerges from the interaction between the agents (micro). In other words, statistical regularities emerge as a self-organized process at the aggregate level: complex patterns of interacting individual behavior may generate a certain regularity at the aggregate level. The idea of representing a society by one exemplar denies the fact that the organizational features of the economy play a crucial role in explaining what happens at the aggregate level.

The way in which markets are organized is assumed to have no influence on aggregate outcomes. Thus, aggregate behavior, unlike that of biological or physical systems, can be reduced to that of a glorified individual. Such an idea has, as a corollary, the notion that collective and individual rationality are similar. What we suggest is that collective outcomes be thought of as a result of an interaction between agents who may have rather simple rules of behavior and who may adapt rather than optimize. Once one allows for direct interaction among agents, macrobehavior cannot, in general, be thought of as reflecting the behavior of a ‘typical’ or ‘average’ individual.

The key assumption behind the construction of the aggregate production function is that all factor markets are perfect in the sense that individuals can buy or sell as much as they want at a given price. With perfect factor markets (and no risk), the market must allocate the available supply of inputs to maximize total output (extensively found in Gatti et al. 2007 and the literature cited there).

Evolutionary theory in economics is as old as economics itself. It was pioneered by Veblen (1898) when he asked, ‘Why is economics not an evolutionary science?’ and suggested that the only rational approach for economists was to assume that economies evolve. Otherwise, he argued, we can describe an economy but have no effective theory of change and development.

Veblen started his argument by asserting that all modern sciences are evolutionary sciences (1898: 374) while Alchian (1950) brought out the evolutionary approach as an alternative framework in economics. He started by proposing a suggestion for a modification of economic analyses to incorporate incomplete information and uncertain foresight as axioms. In the words of Alchian, this approach dispensed with ‘profit maximization’ and it did not rely on predictable individual behavior that is usually assumed as a first approximation in standard textbook treatment.

The suggested approach embodies the principles of biological evolution and natural selection by interpreting economic systems as an adaptive mechanism which chooses among exploratory actions generated by the adaptive pursuit of ‘success’ or ‘profit.’

Krugman (1996) articulates economics as it is about what *individuals* do: not classes, not ‘correlations of forces’ but individual actors. This is not to deny the relevance of higher levels of analyses, but they must be grounded in individual behavior. Methodological individualism is of the essence. He further notes that individuals are *self-interested*. He extends his argument by saying that there was nothing in economics that inherently prevented us from allowing people to derive satisfaction from others’ consumption, but the predictive power of economic theory came from the presumption that normally people care about themselves.

Individuals are *intelligent;* they do not neglect obvious opportunities for gain. It is often asserted that economic theory draws its inspiration from physics, and that it should become more like biology. If that is what you think, you should do two things. First, read a text on evolutionary theory, like John Maynard Smith’s *Evolutionary Genetics*. You will be startled at how much it looks like a textbook on microeconomics. Second, try to explain a simple economic concept, like supply and demand, to a physicist. You will discover that our whole style of thinking, of building up aggregative stories from individual decisions, is not at all the way they think (Krugman 1996). Veblen and Krugman’s suggestion is that ‘evolutionary economics is the only rational proposition’ (Boulton 2010).

The renaissance in evolutionary economics in the past two decades has brought with it a great deal of theoretical developments and interdisciplinary import (Dopfer and Potts 2004).

Inspired by Veblen's theory, evolutionary economics has become one alternative approach to economic analyses involving complex economic interactions. Recent contributors include Nelson's (1974), *Neo-classical vs Evolutionary Theories of Economic Growth: Critique and Prospectus*. More importantly, Richard Nelson and Sidney Winter's seminal work *An Evolutionary Theory of Economic Change* (1982), Dopfer's *The Evolutionary Foundations of Economics* (2005) and Beinhocker's *The Origin of Wealth, Evolution, Complexity and the Radical Remarking of Economics* (2006) are advancements in the theory of evolutionary economics.

The questions to be answered before using an evolutionary theoretical framework to understand how economies grow are: What is evolutionary economics? Why evolutionary economics? What are the theoretical foundations of evolutionary economics? Where do economies come from? (Beinhocker 2006). How do the behaviors, relationships, institutions and ideas that underpin an economy form, and how do they evolve over time?

Beinhocker has argued that questions about origins play a prominent role in most sciences because like it will be difficult to imagine modern cosmology without the Big Bang or biology without evolution, it would be hard to believe that economics could ever truly succeed as a science if it were not able to answer the question 'Where do economies come from?'

Yet, the question about the origin of economies has not played a central role in traditional economics which has tended to focus on how an economy's output is allocated rather than how it got there in the first place. The process of economy formation presents us with a first-class scientific puzzle and one of the sharpest distinctions between traditional economics and what is described as Complexity Economics (Beinhocker 2006).

But what is evolution in economic science? A relatively narrow definition of evolution is change in the mean characteristics of a population (Andersen 2004). Economic growth, that is, the aggregate change in real output per person, is a consequence of increasing the productivity of the factors of production and of technological changes in a very wide sense. For a constant participation rate, it can be modeled as a change in firm-level mean real output per employee weighted by the firm's employment share in the total number of firms in the economy. In Holm (2014) this is referred to as the evolution of labor productivity.

The key ideas of evolutionary theory are that firms at any time are viewed as possessing various capabilities, procedures and decision rules that determine what they do given external conditions. They also engage in various 'search' operations whereby they discover, consider and evaluate possible changes in their ways of doing things. Firms, whose decision rules are profitable, given the market environment, expand; those firms that are unprofitable contract. The market environment surrounding individual firms may be in part endogenous to the behavioral system taken as a whole; for example, product and factor prices may be influenced by the output of the industry and the demand for inputs (Nelson and Winter 1982).

According to Holm (2014), economic evolution is an open-ended process of novelty generation and the reallocation of resources. Selection is the sorting of a population of agents (firms) that is implicit to their differential growth rates. Firms perform innovations and develop knowledge in attempts to gain decisive competitive advantages over competitors, but firms are intentionally rational agents with limited information and innovation; so more generally, learning may also lead to decreased productivity. Firms prosper or decline as a result of the interaction between their own learning activities, the learning activities of competitors and the external factors that set the premises for the interaction. We can find more on this in Dosi and Nelson (2010) and Metcalfe (1998). Safarzyńska (2010) also has an excellent survey.

Holm (2014) explores how the evolution of productivity or any other characteristic in a population of firms can be described. According to him, evolution can be understood as the sum of two effects, which is referred to by different names in literature: inter-firm or reallocation or selection effect and intra-firm or learning or innovation effect. To this, the effects of entry and exit are added but as far as entry is the introduction of new knowledge by entrepreneurs and exit is the disappearance of an inferior firm, these effects are also learning and selection. As a stylized depiction of economic evolution Holm (2014) expresses evolution as the total effect of selection, learning, entry and exit.

Whereas inter-firm selection is driven by the process of competition, inter-industry selection is driven by the process of structural change, which is somewhat different. Productivity understood as physical efficiency is important in competition among firms which produce homogenous products, for example, within industries. This is less the case with heterogeneous outputs because computing physical efficiency for heterogeneous products does not make sense because as the composition of demand changes over time, not least as a consequence of economic growth in itself, relative prices change as well and this affects inter-industry selection (Holm 2014).

Holm has emphasized the importance of indicating the basic differences between standard growth theories and growth theories in evolutionary economics. Evolutionary economists (for example, Richard Nelson, Eric Beinhocker, Geoffrey Hodgson and John Foster) strongly argue that an evolutionary framework is more encompassing than standard approaches. Carlsson and Eliasson (2003) note that economic growth can be described at the macrolevel but never explained at that level. Economic growth is basically a result of experimental project creation and selection in a dynamic market and in hierarchies of the capacity of the economic system to capture winners and losers. Castellacci (2007) gives a review on the evolution of evolutionary theories in economics which is presented in Table 9.1.

Metcalfe et al. (2006) explored an evolutionary theory of adaptive growth. They supposed economic growth as a product of structural change and economic self-transformation based on processes that were closely connected with but not reducible to the growth in knowledge.

Table 9.1 Contrast between new growth theories and evolutionary growth

Issues	New growth theories	Evolutionary theories
What is the main level of aggregation?	Aggregate models based on neo-classical micro-foundations (methodological individualism)	Toward a co-evolution between micro-levels and macrolevels of analysis ('non-reductionism')
Representative agent or heterogeneous individuals?	Representative agent and typological thinking	Heterogeneous agents and population thinking
What is the mechanism of creation of innovation?	Learning by doing and searching activity by: the R&D sector; radical innovations; and general purpose technologies	Combination of various forms of learning with radical technological and organizational innovations
What is the dynamics of the growth process? How is history conceived?	History is a uniform-speed transitional dynamics	Toward a combination of gradualist and dynamics: history is a process of qualitative change and transformation
Is the growth process deterministic or unpredictable?	'Weak uncertainty' (computable risk): stochastic but predictable process	'Strong' uncertainty: non-deterministic and unpredictable process
Toward equilibrium or never ending	Toward the steady state	Never ending and ever changing

The dominant connecting theme is enterprise, the innovative variations it generates and the multiple connections between investment, innovation, demand and structural transformation in the market process. Metcalfe and Foster (1998) explored the dependence of macroeconomic productivity growth on the diversity of technical progress functions and income elasticities of demand at the industry level and the resolution of this diversity into patterns of economic change through market processes. They show how industry growth rates are constrained by higher-order processes of emergence that convert an ensemble of industry growth rates into an aggregate rate of growth. The growth in productivity, output and employment is determined mutually and endogenously, and its value depends on variations in the primary causal influences in the system.

9.3.2 Econometric Modeling in the Evolutionary Economic Framework

Evolutionary economics in general and evolutionary econometrics in particular are not an arbitrarily choice. They are both relevant and have theoretical foundations. The theoretical basis for such a modeling is drawn from a self-organization approach and analyzed by the logistic diffusion growth model.

Evolutionary economics and the subsequent developments of its estimation techniques have enabled researchers to explore the advantages of evolutionary economics. This methodology is offered to construct an econometric model in the prescience of a structural change of an evolutionary type. In its various approaches, evolutionary economics has been concerned with economic processes that arise from systems which are subject to on-going structural changes in historical time. Foster and Wild (1999a) identified three characteristics that all evolutionary representations of economic processes seem to share:

1. A system that is undergoing a cumulative process of structure building, which results in increasing organization and complexity, cannot easily reverse its structure;
2. In the face of this time irreversibility, structure can change in non-linear and discontinuous ways in the face of exogenous shocks, particularly when the relevant evolutionary niche is filled; and
3. An evolutionary process of on-going structural changes introduces an increasing degree of fundamental uncertainty. Thus, a great deal of structure building involves the installation of protective repair and maintenance sub-systems.

Based on this discussion on evolutionary economics and the underlying theory of the functional income distribution and its implications on economic impact such as growth in productivity, our study tests if there is an indication for structural transformation. This is achieved by investigating the evolution of key variables, that is, evolution of employment share, evolution of market share, evolution of output share at the industry level and the evolution of productivity growth. This is done in two ways. First, by developing and estimating evolutionary econometrics to learn if there is an indication for evolution and second by conducting a graphical simulation.

Based on this background, we use a logistic diffusion equation (LDE) offered by Foster and Wild (1999b) as a theory of historical process. In real terms, it is rooted in the Bernoulli Differential Equation of the type shown in the equation in Annexure 1. The last line in this equation is a Logistic Differential Equation of First Order (LDEFO). Thus, based on the equation in Annexure 1, Foster and Wild (1999b) have developed an econometric model in the presence of evolutionary change as:

$$\frac{\mathrm{d}X}{\mathrm{d}t} = b\left(1 - \frac{X}{K}\right) \tag{9.1}$$

In Eq. 9.1, b is the net, that is, it allows for deterioration or deaths, firm entry-exit rate or diffusion coefficient, and K is the carrying capacity of the environment, for example, total industry or economy's market size, employment or output over which each firm will compete to capture as much of it. K is a constraint, for example, the total sales of an industry and X could be a firm's sales so that X/K is the firm's market share.

Two points must be raised about Eq. 9.1. First X/K can be understood as any share. If we are to work at the macrolevel, we may interpret X/K as the ratio of GDP to capital stock. This ratio is less than 1 because at any point in time the total national output is some fraction of inputs, the magnitude of the fraction depending on the productivity of the economy.

Equation 9.1 can be expanded to employ the existing econometric framework for estimation. Foster and Wild (1999b) have acknowledged that the application of the LDE of this type has been common in literature on the economics of innovation, following Griliches's (1957) pioneering work. However, economists have tended to view LDE in terms of disequilibrium adjustments from a stable equilibrium state to another in economics of the evolutionary growth theory.

As it stands, Eq. 9.1 depicts a smooth process tending toward infinite time. Only in a discrete interval version of LDE, we can generate the kinds of discontinuities that we can see in historical data. However, discrete interval dynamics are not pronounced features of most aggregated economic data. Thus, it is unlikely that we can generate a discontinuity endogenously in most cases.

Now, it is convenient for the purposes of an econometric investigation to rearrange Eq. 9.1 in the following way to obtain the Mansfield (1981) variant, employed in many such studies. Dividing both sides of Eq. 9.1 by K and rearranging, we arrive at:

$$\begin{aligned} X_t - X_{t-1} &= X_{t-1} b\left(1 - \frac{X_{t-1}}{K}\right) + u_t \\ \text{In} X_t - \text{In} X_{t-1} &= b - bX_{t-1}/K + e_t \quad \text{where } e_t = u_t/K \end{aligned} \tag{9.2}$$

The transformation into approximation in Eq. 9.2 allows the logistic equation to be estimated linearly and the error term is corrected for bias because of the upward drift of the mean of the X-series.

Equation 9.2 offers a representation of the endogenous growth of a self-organizing system subject to time irreversibility and constrained by boundary limits. To come up with the complete econometric model, Foster and Wild qualified their argument in the following ways:

(a) Regulation in the economic system can restrict economic agents and their organizations to particular market niches. This means, again, that the principle of competitive exclusion is significantly weakened. For example, governments restrict the issue of bank licenses, which preserves a niche which non-bank financial institutions have difficulty entering. Typically, competition in the economic sphere is overlaid by 'public interest' regulations that attempt to limit competition;
(b) Economic sub-systems rely on an interaction with the wider economic system in order to engage in trade. Thus, the K limit for a particular system will tend to rise continually in line with the general expansion of economic activity; and
(c) Increasing politicization of an economic system will lead to more predator–prey type interactions. This will tend to occur in saturation phases of LD growth. Thus, we do not always witness smooth transitions from one LD growth path to another but, instead, Schumpeterian 'creative destruction', dominated by

conflict and discontinuous dissipation of an accumulated structure (that is, a rapid fall in K).

Taking into account these qualifications, we arrived at the following LDE which is suitable for application in economics:

$$\text{In}X_t - \text{In}X_{t-1} = [b(\cdot)]\left[1 - \left\{\frac{X_{t-1}}{K(\cdot)} - a(\cdot)\right\}\right] + e_t \tag{9.3}$$

Thus, b and K are now themselves functions of other variables. The function $(\cdot)$ allows for factors that affect the diffusion coefficient, rendering it non-constant over time and $K(\cdot)$ takes into account the factors in the greater system that expand or contract the capacity limit faced by the system in question. The resource competition term, $a(\cdot)$, is now a more general functional relationship than the simple mechanism containing, for example, relative prices and existing demand for a particular product, the general economic condition in the environment.

A potential problem with Eq. 9.3 is that as X tends to its limit, growth in X will tend to zero so that the impact of factors in $b(\cdot)$ will also tend to zero. This is unlikely to be the case, so it is more appropriate to allow exogenous variables that affect the diffusion rate to influence the rate of growth of X with the same strength at all points on the logistic diffusion:

$$\text{In}X_t - \text{In}X_{t-1} = [b(\cdot)]\left[1 - \left\{\frac{X_{t-1}}{K(\cdot)} - a(\cdot)\right\}\right] + b(\cdot) + e_t \tag{9.4}$$

As it stands, Eq. 9.4 could be viewed as a disequilibrium process tending to an equilibrium defined in terms of $K(\cdot)$ and $a(\cdot)$. However, such an equilibrium interpretation differs from that in conventional usage. The non-stationary process modeled by Eq. 9.4 represents neither a mean reversion process in the presence of a deterministic trend, nor a co-integrated association between X and variables in $K(\cdot)$ and $a(\cdot)$, in the presence of a stochastic trend.

The stationary state to which the logistic trajectory tends is the limit of a cumulative, endogenous process, not a stable equilibrium outcome of an unspecified disequilibrium mechanism following an exogenous shock. The functions $K(\cdot)$ and $a(\cdot)$ allow for measurable shocks to the capacity limit and $(\cdot)$ encompasses the effect of exogenous shocks which alter the diffusion rate.

One final development is necessary. Although an equilibrium correction mechanism is inappropriate in this type of a model, homeostasis will occur in the short period around what can be viewed as a moving equilibrium.

Equation 9.4 relates to the momentum of a process and, as such, some path dependence is likely to exist in the sense that the system in question will still have a (decelerating) velocity even if all endogenous and exogenous forces impinging on the system cease to have an effect.

This is likely to be stronger the more non-stationary the variable in question is and the shorter the observation interval. Imposing a simple AR (1) process, we get:

$$\text{In}X_t - \text{In}X_{t-1} = [b(\cdot)]\left[1 - \left\{\frac{X_{t-1}}{K(\cdot)} - a(\cdot)\right\}\right] + b(\cdot) + c(\text{In}X_t - \text{In}X_{t-1})_{t-1} + e_t \tag{9.5}$$

In conventional treatments of path dependence in time-series data, constructs like the ‘partial adjustment hypothesis,’ concerning the presumed disequilibrium movements of levels of variables, are used to rationalize the use of lagged dependent variables. Inclusion of a lagged dependent variable requires upward revision of the estimated coefficients on explanatory variables in order to obtain their ‘equilibrium’ values. Here, the interpretation is different, but related. Instead of viewing a lagged dependent variable as evidence of sluggishness, we view its presence in our growth specification as evidence of momentum in the process (Foster and Wild 1999b). In Eq. 9.5, we can note that the left hand side is equivalent to the growth rate of series X. In our paper, it could be the growth rate of productivity.

9.3.3 Empirical Evidence of Evolutionary Econometrics

Empirical literature on evolutionary economics is scarce. However, there are some works which focus on the macrolevel, for example, Foster (1992, 1994) and Hodgson (1996).

Foster (1992) looked into a new perspective on the determination of sterling M3 using econometric modeling under the presence of evolutionary change. First, he obtained a logistic diffusion model from the first-order differential equation. Next, he modeled the evolution of M3 in log-linear specification in the form of evolutionary econometrics. He noted the ordinary least squares (OLS) and recursive least squares (RLS) as favored estimation methods in such a condition. He estimated datasets over 1963–1988 obtained from the UK monetary authority. He concluded that it was possible to understand the determination of M3 by viewing it as money supply, rather than money demand magnitude which is an outcome of a historical process. Such a process has been modeled as institutionally driven and subject to evolutionary change.

In Foster (1994), we can also find an evolutionary macroeconomic approach stressing institutional behavior used for estimating a model for Australian dollar M3. The conclusion is that since Australia and UK have the same cultural and institutional heritage, evolutionary econometrics captured a similar M3 creation process in both countries implying the appropriateness of an evolutionary approach for studies involving the diffusion process.

The most interesting out of these is Hodgson (1996) as it is the most direct theoretical and empirical research in long-term economic growth. He argues that his work is in part inspired by works on institutional economics such as those by Nelson and Winter and Thorstein Veblen (who was the first to suggest the use of economics as an evolutionary analogy taken from biology). His empirical estimation starts by placing major stress on institutional disruptions such as wars or revolutions and on the existence of political institutions such as multiparty systems.

Hodgson used a regression analysis to provide some preliminary empirical validation for his ideas. He admitted that it was not a fully fledged macroeconomic model, saying that the available data was crude and limited for providing a more ambitious and adequate test. He used real GDP per worker-hour as the index of productivity from Madison's data and summarized his findings as: first, two kinds of disruptions (disruption of extensive foreign occupation of home soil and revolution) seemed to be significant in determining and eventually advancing productivity growth. Second, there was evidence that the growth trajectory was determined by the timing of industrialization. Third, a relatively stable international order was found to be significant and positively related to growth.

Stockhammer et al. (2008) estimated the relationship between functional income distribution and aggregate demand (AD) in the Euro area. They modeled AD as: AD is the sum of consumption (C), investment (I), net exports (NX) and government expenditure (G). All variables are in real terms. In their general formulation, consumption, investment and net exports are written as a function of income(Y), the wage share (Ω) and some other control variables (summarized as z). The latter are assumed to be independent of output and distribution. Government expenditure is considered to be a function of output (because of automatic stabilizers) and exogenous variables (such as interest rates). However, as our paper focuses on the private sector, this will play no further role in our analysis. AD thus is:

$$\mathrm{AD} = C(Y, \Omega) + I(Y, \Omega, z_1) + \mathrm{NX}(Y, \Omega, z_{NX}) + G(Y, z_G) \tag{9.6}$$

Stockhammer et al.'s (2008) basic assertion for the inclusion of income distribution in consumption, investment and net export and government expenditure terms in Eq. 9.6 is: in the consumption function wage incomes (W) and profit incomes (R) are associated with different propensities to consume. The Kaleckian assumption is that the marginal propensity to save is higher for capital incomes than for wage incomes; consumption is therefore expected to increase when the wage share rises. They argue that Keynesian as well as neo-classical investment functions depend on output (Y) and the long-term real interest rate or some other measure of the cost of capital. The latter is part of z_1. The authors further argue that in addition to output and interest rate, investments are expected to decrease when the wage share rises because future profits may be expected to fall. Moreover, it is often argued that retained earnings are a privileged source of finance and may thus influence investment expenditures.

They claim that first, the policy implications of their findings are that wage moderation in the EU is unlikely to stimulate employment. They suggest that wage moderation leads to a (moderate) contraction in output. Since an expansion in output can be regarded as a necessary (but not sufficient) condition for an expansion in employment, wage moderation (at the EU level) is not an 'employment-friendly' wage policy. Their second implication refers to wage coordination; they contend that their findings suggest that demand is wage-led in the Euro area. This finding does not extend to individual Euro member states.

Our paper takes advantage of the formalization of evolutionary economics by Foster (1994, 2014) and Foster and Wild (1999a, b).

9.4 Empirical Results

9.4.1 The Data and Variables

This section examines if firms' access to bank loans has any effect on growth through[1] its effects on functional income distribution. The dataset is the medium and large manufacturing industries as compiled by the Central Statistical Agency (CSA) of Ethiopia. The available panel data covers 1996–2009 with 611 and 1943 firms in 1996 and 2009, respectively.

If access to bank loans first affects functional income distribution and if functional income distribution affects productivity growth that would imply that facilitating access to bank loans might ultimately foster growth in the economy. To achieve this objective, we first explore the real firms over the period on some key variables and econometrically estimate Eq. 9.5 using the generalized method of moments (GMM). Finally, alternative policy simulation scenarios are performed to understand the full effect of bank loans, income distribution and productivity growth linkage.

First, from firm-level data, the parameters of interest are computed for each firm for each year:

- Employment share (EMPSHAFIRM): Is supposed to capture if there is an indication of a structural change, that is, the movement of labor from less productive to more productive sectors;
- Market share (MKTSHARE): This is the available resource over which firms have to compete. It is through this competition process that decisions to invest in productivity fostering factors are undertaken;
- Output share (OUSHA): Firms can also compete over industry output; and
- Productivity growth (GROWTHPRO): Is the main variable of interest. Its growth rate is understood as the growth of mean characteristics in evolutionary economics. Thus, growth is perceived to mean growth in productivity.

Based on these variables, our paper draws some inferences about the connection between access to bank loans, functional income distribution and productivity growth.

[1]In the evolutionary growth framework, growth is mainly understood as growth of any mean characteristics (in our case productivity growth).

9.4.2 Results from Data Exploration

The evolution of employment shares, market shares, output shares and growth in productivity are shown in Figs. 9.1, 9.2, 9.3 and 9.4 in Annexure 2. The purpose of these figures is to learn if there is any indication of a structural transformation process within the manufacturing sector. If there is a change in the structure of production in the manufacturing sector, we expect the labor share to be continuously shifting within the industry. The shift should take place from low productivity to high productivity industries. This would mean higher labor productivity and consequently higher labor incomes which will form a positive feedback loop with productivity.

In Fig. 9.1, we observe movements for employment share within the industries only for 11 industries. We identified these industries from the data as:

- Production, processing and preserving of meat, fruits and vegetables
- Manufacture of animal feed
- Manufacture of non-metallic NEC
- Manufacture of basic iron and steel
- Manufacture of other fabricated metal products
- Manufacture of pumps, compressors, valves and taps
- Manufacture of other general purpose machinery
- Manufacture of batteries
- Manufacture of bodies of motor vehicles
- Manufacture of parts and accessories
- Manufacture of furniture.

From the firm-level dataset, it was possible to learn that most of the firms within these industries had access to bank loans. For example, overall, the 105 firms within the production, processing and preserving of meat, fruits and vegetables industries had access to bank loans. In the manufacture of animal feed industry, out of 98 firms, 37 had access to bank loans. Generally, all the indicated firms had access to bank loans during the years of observation. In Fig. 9.1, we can observe that in these industries, there is a significant movement (fluctuation) in employment shares. The only exceptions are spinning, tanning and publishing industries in which all firms had access to bank loans. However, any indication of movement in their employment share is not displayed.

One can argue that the employment share must be within the same sector (industries) and not across industries. If the reallocation of labor was taking place across industries, we could have observed variations in the employment share in the rest of the industries, but this is not evidenced.

Whether these industries are high productivity sectors and hence growth and equality promoting can be another area of enquiry. But looking at their face value alone, we may tentatively conclude that those industries which are related to metallic manufacturing in particular are connected to the government (see Fig. 9.1 in Annexure 2).

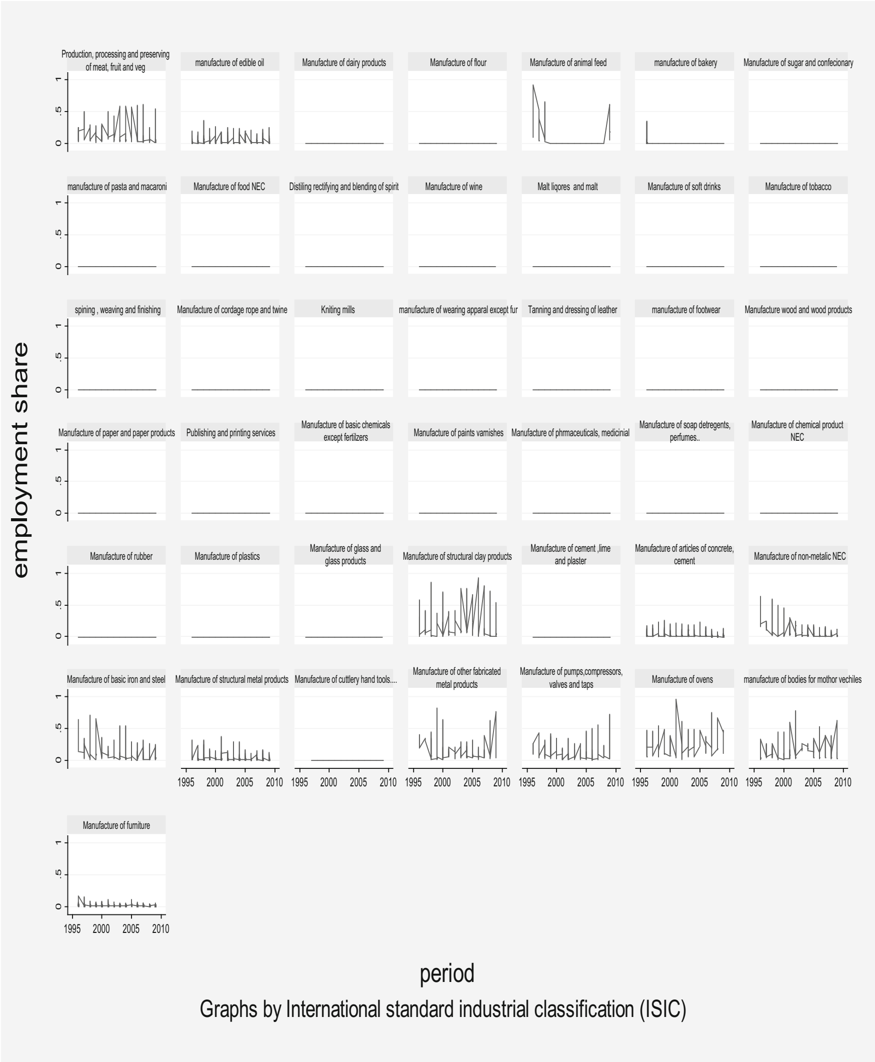

Fig. 9.1 Evolution of employment share

Referring to Fig. 9.3, firms' shares in total industry output are more pronounced than their market shares. This tells us the underlying market structure, which may subsequently have an effect on functional income distribution and productivity growth (see Fig. 9.3 in Annexure 2).

Fig. 9.2 Evolution of market share

It has been discussed that firms are at the heart of an evolutionary approach to economic growth and growth in productivity at the firm level is a key to economic growth. We can see from Fig. 9.4 that there are fluctuations in the productivity growth rate (from −20 to 10%). We also note that, for example, the productivity growth for production, processing and preserving of meat, fruits and vegetables remained positive, which might be an indication of the effect of access to bank loans (see Fig. 9.4 in Annexure 2).

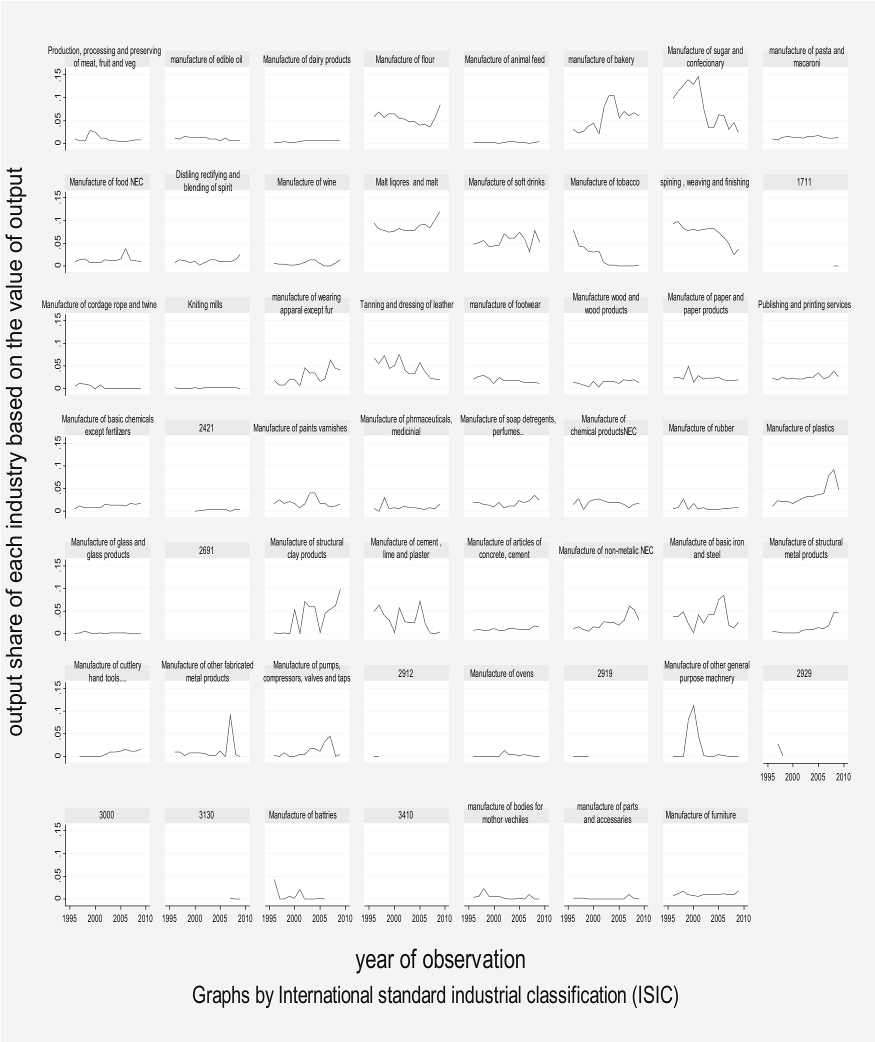

Fig. 9.3 Evolution of output share at the industry level

9.4.3 Econometric Results

This section deals with the econometric estimation of the logistic differential equation in Eq. 9.5. The variables entering the model are two natured: the evolutionary component and the exogenous component.

We estimated Eq. 9.5 using firm-level panel data. To achieve this, the data was transformed (logarithms, growth rates, lags and differences) so that the transformed data was consistent with the evolutionary econometric framework.

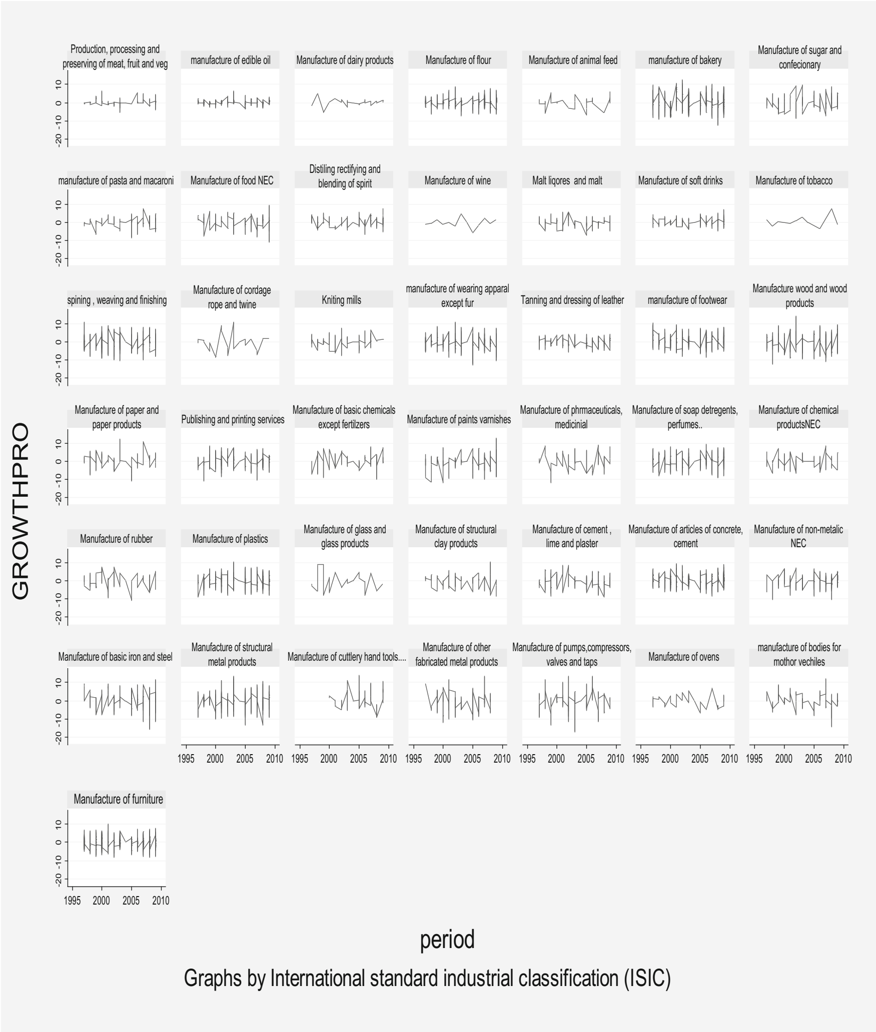

Fig. 9.4 Evolution of productivity growth

The dependent variable is change in the mean characteristics (growth in productivity). The explanatory variables are growth in labor share (GRWTHLSHARE*)*, the complement[2] of output share (COMPVOUSHA*)*, technically one minus output share to fit the first term in Eq. 9.5, complementary market share (COMPMKTSHARE), again the same interpretation as before so that it is consistent with Eq. 9.5, lagged

[2]Here the complement of variable x is equal to $(1 - x)$ (see the first term on the right hand side in Eq. 9.5).

Table 9.2 Estimation results (GMM): dependent variable: growth in productivity

Variable	Coeff.	Std. error	*Z*	*P* > [*Z*]
GRWTHLSHARE	0.00052	0.0001	3.47	0.001
COMPVOUSHA	−5.626	0.409	−13.75	0.000
COMPMKTSHARE	4.251	0.456	9.32	0.000
LAGDELTFP	−0.412	0.0203	−20.20	0.000
EMPSHAFIRM	−4.068	1.556	−2.61	0.009
cons	0.9196	0.421	2.18	0.029

change in labor productivity (LAGDELTFP) which represents the last term of Eq. 9.5 and finally, employment share of each firm (EMPSHAFIRM).

For the evolutionary approach, once the logistic differential in Eq. 9.5 is formulated, it can be estimated using standard panel data econometric techniques (random effects, fixed effects or GMM) which do not require separate treatment here. The reported results are with a Wald Chi-square value of 773.57 with six degree of freedom and probability value of ($p > X^2$) of 0.0000 (Table 9.2).

The estimated results indicate that all explanatory variables entered the estimation with statistically significant estimates. As expected, productivity was positively affected by the growth in labor share. However, the employment share entered with a negative and statistically significant coefficient. We may interpret this as lack of labor movement from low productive to high productive industries.

9.5 Summary, Conclusions, Policy Recommendations and Future Areas of Research

The basic research question in this paper was explaining how firm-level labor share affects firm and industry level productivity and how it affects aggregate productivity in an economy taking the case of Ethiopia.

The most direct interpretation of the estimated results is that evolution and change in mean characteristics (change in productivity) are positively affected by the growth of functional income distribution (the growth in labor share: even if the economic sign of the coefficient is of small order), its statistical significance is quite acceptable.

The other variable of interest here is employment share of each firm within an industry, which entered the model with a negative sign but a significant coefficient. In economic terms, the positive and negative coefficients of labor share within a firm and the employment share of each firm within the industry tell us very important information about structural changes in the manufacturing sector.

If structural change was evident, the employment share would have entered with a positive effect. However, it did not do this. Therefore, this does not support the popular view of a structural bonus hypothesis which postulates a positive relationship between structural change and economic growth. This hypothesis was based on the assumption that during the process of economic development, economies upgrade from industries with comparatively low to those with a higher value added per labor input. For example, Timmer and Szirmai (2000) have a detailed explanation on this.

This result is supported by an almost opposite mechanism, where structural change has a negative effect on aggregate growth; this is revealed by Baumol's hypothesis of unbalanced growth. Intrinsic differences between industries in their opportunities to raise labor productivity (for a given level of demand) shift ever larger shares of the labor force away from industries with high productivity growth toward stagnant industries with low productivity growth and accordingly higher labor requirements. In the long-run, the structural burden of increasing labor shares getting employed in the stagnant industries tends to diminish the prospects for aggregate growth of per capita income. Baumol (1967) is key literature on this.

When the complement of firms' market share enters the regression result with a positive sign, the actual market share would have entered with a negative sign which has a direct and clear economic meaning, that is, since firms may try to capture the market through nominal ways (for example, price competition or advertising or any other institutional arrangements) this will harm productivity. Our major conclusion is lack of strong evidence for intra-industry selection.

The policy lesson is that access to bank loans is of great importance to firms. Particularly those industries (spinning, tanning and publishing) in which all firms had access to bank loans revealed movements in employment share, which is evidence of structural transformation.

There are reasons why it is important to introduce appropriate public loan policies, that is, ensuring a lending channel of monetary policy to work without breaks. First, a credit aggregate can be a better indicator of monetary policy than an interest rate or a monetary aggregate in Ethiopia. Second, monetary tightening that reduces loans to firms can have negative distributional consequences. Particularly for those firms for whom bank loans are a primary source of finance, ease of access to bank loans can have economy-wide distributional consequences. More specifically, the credit policy should be such that manufacturing firms get better access to banks.

It is desired that the future research direction includes economy-wide modeling, estimation and more formalization of evolutionary economic models to study the link between access to bank loans and its effects on income distribution and inclusive economic growth.

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Annexure 1: Basic Logistic Differential Equation

$$\dot{X} + a(t)X = b(t)X^r, \text{ if } r = 1, \text{ it is easily separable and becomes}$$
$$\dot{X} + a(t)X = b(t)X^{\mathrm{r}} \text{ and introducing } Z = X^{1-r}$$
$$\dot{Z} = (1-r)X^{-\mathrm{r}}\dot{X}$$
$$\text{But } \frac{\dot{X}}{X} + a(t) = b(t)X^{r-1} \Rightarrow \dot{X} = \left(b(t)X^{r-1} - a(t)\right)X$$

Therefore,

$$\dot{Z} = (1-r)X^{-r}\dot{X} = (1-r)X^{-r}\left(b(t)X^{r-1} - a(t)\right)X$$
$$\text{(Eq A2)} \quad Z + (1-r)\,a(t) = (1-r)\,b(t)$$

Annexure 2: Evolution of Key Variables

See Figs. 9.1, 9.2, 9.3 and 9.4.

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