Hacettepe University Graduate School of Social Sciences
Economics Department
Economics Master's Programme

HABITS, STATUS PREFERENCES, AND OPTIMAL ECONOMIC GROWTH

Sencer KARADEMİR

Master's Thesis

Ankara, 2019

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ACCEPTANCE AND APPROVAL

The jury finds that Sencer KARADEMİR has on the date of 27/05/2019 successfully passed the defense examination and approves his Master's Thesis titled "Habits, Status Preferences, and Optimal Economic Growth".

Assc. Prof. Dr. Bahar BAYRAKTAR SAĞLAM (Jury President)

Asst. Prof. Dr. Mustafa Aykut ATTAR (Main Adviser)

Assc. Prof. Dr. Türkmen GÖKSEL

I agree that the signatures above belong to the faculty members listed.

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ABSTRACT

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Economic theorists have intensively focused on extending their workhorse models with endogenous technology and human capital accumulation in the recent decades. They have also attempted to build models with various types of heterogeneities and inequalities and with non-economic factors such as social norms and psychological foundations. In a strong sense, the mainstream economic theory has returned back to the classical themes of growth and inequality with a broader vision.

In line with Thorstein Veblen's (1899) assessments on how human behavior is influenced by social forces, this thesis investigates the effects of status-seeking behavior and the formation of fertility habits on the cross-section distribution of wealth, the processes of physical and human capital accumulation, and the level of welfare in the long run.

Chapter 1 introduces a discrete-time, overlapping generations (OLG) general equilibrium (GE) model with endogenous growth, status-seeking motive, and heterogeneity in preferences and asset endowments. The wealth distribution analysis focuses on the first two moments of the *detrended* wealth distribution. The basic reason for using the detrended distribution is that agents continue to accumulate wealth over time within the model dynamics, and the wealth stock goes to infinity. In competitive equilibrium, the steady-state variance of detrended wealth, if it exists, depends on the means and variances of preference parameters. Results also show that the status-seeking motive adversely affects the welfare levels of an endogenously determined fraction of agents. Extensions of the simple model have non-trivial implications regarding the sources of inequality, optimal levels of capital income taxes, and redistribution.

Chapter 2 introduces a discrete-time, OLG GE model where habits (or social norms) constrain fertility decisions and affect human capital accumulation. The results show that, if adult agents are strictly conservative, i.e., if they do not question the existing social norms, the economy cannot escape the high-fertility underdevelopment trap that causes the economy to stagnate in the long run. Once the model is extended with secularization that leads to the weakening of religious norms, the economy converges to a balanced growth path where human capital grows perpetually, fertility declines to its replacement level, and the population of the economy is stabilized.

Keywords

status preferences, social norms, fertility habits, Veblen effects, endogenous growth, wealth distribution, unified growth theory

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LIST OF ABBREVIATIONS

OLG	: Overlapping Generations
GE	: General Equilibrium
GDP	: Gross Domestic Product
UGT	: Unified Growth Theory
i.i.d.	: Independently and Identically Distributed
US	: United States
CRS	: Constant Returns to Scale
FOC	: First Order Condition
SGE	: Static General Equilibrium
DGE	: Dynamic General Equilibrium
BGP	: Balanced Growth Path

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INTRODUCTION

> "Like other animals, man is an agent that acts in response to stimuli afforded by the environment in which he lives. Like other species, he is a creature of habit and propensity. But in a higher degree than other species, man mentally digests the content of the habits under whose guidance he acts, and appreciates the trend of these habits and propensities. He is in an eminent sense an intelligent agent."
>
> (Veblen, 1898a, p. 188)

The quest for understanding long-run economic growth and development patterns has been a defining feature of economics. Economists of all generations have developed theories and models that explain why some countries experience sustained economic growth and why others do not. Until the late 1980s, the literature has largely been dominated by neoclassical growth models developed by Solow (1956)-Swan (1956) and Ramsey (1928)-Cass (1965)-Koopmans (1965). In these models, long-run economic growth is explained solely by exogenous productivity growth that is due to exogenous technological progress.

In the 1980s, the Penn World Table data has emerged and purchasing power parity (PPP) adjustments have been made. The neoclassical growth theories have been unable to explain the observed divergence between cross-country income levels alongside the accelerating growth in living standards of the relatively rich economies. The shortcoming of the previous theories has canalized the economists to investigate how technology changes which have lead to the emergence of endogenous growth models where both economic and technological growth are endogenously determined within the models.

The discussions during the late 1980s and early 1990s emphasizing not only the accumulation of economic aggregates but also their distribution underlined the role that heterogeneity plays in macroeconomics. The Bewley (1986) models, i.e., incomplete market models with heterogeneous agents, have emerged as a result of the economic growth literature's attempt to introduce heterogeneity to the growth models. The emphases on the consequences of how equally the economic aggregates are distributed have continued in an accelerated manner. These discussions are now at the center of the macroeconomics literature since several works have pointed out the primary role that economic inequality played on the 2007-2008 global financial crisis. According to Kumhof, Rancière, and Winant (2015), for instance, the sustained increase in the consumer debt that originated from income and wealth inequalities prepared the onset of the crisis. The accumulation and distribution of macroeconomic variables being the primary focus of the macroeconomics literature has pointed out a return to the discussions of the classical economists. In other words, 150 years after Mill (1848) which is the very last work of the classical economists, we have overcome the efficiency problems and returned to the issues on how production is done, how factors are accumulated, and how the output is allocated.

The rising concerns of economists on distributional issues are not limited only to within-country distributions, i.e., the distribution of an economic variable among the agents within a single economy. With the newly available data on historical income levels in mid-1980s, a literature investigating whether there is convergence in cross-country real GDP levels has emerged. Islam's (2003) and Galor's (2010) reviews indicate the literature agrees on the fact that there is no global convergence in per capita income levels. In other words, the neoclassical growth theories' prediction that the relatively poor countries converge to the per capita income levels of their relatively rich peers by attaining higher economic growth rates does not empirically hold for all countries. There is, instead, a club convergence where multiple growth regimes exist and countries with similar characteristics (e.g., human capital levels, saving rates, technologies) converge to the same steady-state per capita income. The more recent works of Milanovic (2016) and Ravallion (2016) show that the growth performances of China and India over the last decades have contributed to a decrease in global inequality, i.e., lead to a more egalitarian global income distribution. However, not all countries have attained high economic growth rates during this period and "the developing world's poorest have been left behind" (Ravallion, 2016, p. 140).

Despite the fact that roughly 250 years have passed after the Great Britain's Industrial Revolution, there are still many countries that have failed to experience their own. Unlike the mid-18th century, the world now consists of three different kinds of societies with explicit differences in their living standards. The first group, the group of developed societies, is experiencing an era of modern economic growth. These societies have sustained and stabilized factor accumulation processes for several generations, have relatively low fertility and mortality rates, high human capital levels, and experience perpetual economic growth of real GDP per capita. In addition, the social and economic aspects of life in these societies are characterized by inclusive institutions such as a well-functioning democracy, the rule of law, and environmental awareness (Acemoglu & Robinson, 2006, 2012). The presence and the effectiveness of these institutions further spur economic development and keep these societies situated on their balanced growth paths. The second group contains the underdeveloped societies. These societies have yet to initiate the take-off stage of their development, as in Rostow's (1959) terms. They have the opposite characteristics of their developed peers; they have relatively high fertility and mortality rates alongside low levels of human capital, and political regimes in a majority of these countries are autocratic or non-democratic. These are the societies where extractive institutions prevail in the social and economic life, and the dominance of these institutions causes prolonged stagnation (Acemoglu, Johnson, & Robinson, 2001; Acemoglu & Robinson, 2006, 2012). The last group is the group of developing societies. Though they have completed their initial processes of economic development, the developing countries have still not reached the regime of modern economic growth. Their per capita income levels are not high enough for the countries to be considered rich, but not low enough for them to be considered poor. The developing societies are on a transition path towards being considered as developed societies, and their social and economic aspects of life contain a mixture of both inclusive and extractive institutions.

The poverty trap models developed at the beginning of 1990s have provided insights on how economies can experience prolonged stagnation, with some noteworthy contributions being those of K. M. Murphy, Shleifer, and Vishny (1989), Azariadis and Drazen (1990), G. S. Becker, Murphy, and Tamura (1990), and Matsuyama (1991). These models have predicted multiple steady-states where economies either get stuck in a stagnation equilibrium or converge to a growth equilibrium. However, these models could only explain the reasons why persistent poverty exist but could not account for the transition from stagnation to growth. Some earlier works of Goodfriend and McDermott (1995), Tamura (1996), Acemoglu and Zilibotti (1997), and Arifovic, Bullard, and Duffy (1997) have focused on the transition process to modern economic growth, but neither work have addressed the demographic transition. The first model that explained an endogenous and gradual transition from stagnation to growth was proposed by Galor and Weil (2000), which led to the emergence of *the unified growth theory (UGT)*. The basic feature of the models under a unified growth framework is that they replicate the historical pattern of the today's developed economies. The common path within a UGT framework is as follows: Initially, the economy experiences several milennia of Malthusian stagnation, which, at some time in history ends after the initiation of human capital accumulation and a demographic transition. Then follows a gradual transition to an era of modern economic growth, where population is stabilized and economic growth is perpetual.

The literature so far, has primarily focused on the economic motives with rigorous assumptions that shape agent behavior. This thesis focuses on the implications of altering one particular presumption that the majority of the economics literature builds upon: It is the presumption that economic agents are isolated from each other in the sense that their preferences and choices do not interact. The theoretical background of the thesis is based on the social and evolutionary dimension of human behavior that Thorstein Veblen discussed in his various works (Veblen, 1898a, 1898b, 1899). Specifically, this thesis argues that the desire to gain *social status* through economic actions and forming *habits* that impose constraints on economic decisions influence the distribution and accumulation of economic aggregates and, hence, the growth rates and welfare levels. The primary goal of the thesis is to capture the forces that affect physical and human capital accumulation when the social motives and norms partially characterize individual decision-making.

The necessity to include a social dimension in economic models arises from the potentially profound influences of the social sphere on individual preferences and decisions. The social structure of a society, e.g., norms, identities, or cultural backgrounds, can have pronounced effects on individuals via either partially determining their preferences or imposing constraints on their decisions that are sometimes more important than economic motives (Akerlof & Kranton, 2010; Akerlof & Shiller, 2010). These influences can explain two contemporary problems that the existing growth literature seeks to answer. First, they can explain the evolution of within-country income and wealth distributions through an accurate portrayal of the accumulation decisions. That each agent gives different weights to the social and economic motives explains the variations in accumulation decisions (wealth or physical capital via bequests and human capital via education), thereby determining the evolution of the distributions of economic aggregates. Second, different cultural heritages can provide insights on why the theories that accurately explain the long-run trends of developed countries cannot account for the rest of the world, especially for the underdeveloped countries situated away from their balanced growth paths.

The impact of the social sphere that this thesis seeks to analyze is two-fold. First, by affecting preferences of each individual, social motives generate a heterogeneous preference structure and an interdependency among individuals. The heterogeneity that social interactions cause, in turn, affects the distribution and evolution of economic aggregates. One particular element that socially-motivated preferences affect is wealth accumulation. Veblen (1899) argues that wealth determines the relative position and power of an agent in the social sphere. His theory, therefore, directly connects the interdependence of agents and wealth accumulation through the social motives behind holding greater portions of the total wealth. That physical capital and wealth being directly linked through the capital market makes the motives behind wealth accumulation vital to understand how physical capital is accumulated. Furthermore, heterogeneity in terms of the weights individuals assign to their relative position in the society causes wealth accumulation to differ among them and is able to explain how wealth is distributed in equilibrium.

The second goal of this thesis is to analyze the effects of the constraints that social structures impose on individual decision-making processes. Social norms can have economy-wide effects by imposing barriers on individual decisions. As argued by Montgomery and Casterline (1996) and Bernardi and Klärner (2014), for instance, the effects of social constraints are significant for the decisions that have social values, especially in traditional societies and particularly for fertility decisions. The forces that affect the number of children people have are important because they can directly influence human capital accumulation via the quality-quantity (Q-Q) trade-off, a trade-off between the fertility and education investment decisions originating from the fact that "quality seems like a relatively close substitute for quantity, [and] families with excess children would spend less on each child" (G. S. Becker, 1960, p. 217). Since human capital is a primary source that determines the living standards of societies in the long run, the factors that affect human capital accumulation need to be investigated by considering the potential effects of social norms on the reproductive behavior of agents and their potential implications on the (very) long-run growth path of the economy.

Chapter 1 introduces an infinite-horizon, discrete-time, heterogeneous agent, overlapping generations (OLG) general equilibrium (GE) model where

- economic growth is endogenous with the production technology exhibiting externalities on physical capital accumulation à la Romer (1986), and
- preferences are extended with a status-seeking motive such that adult agents derive utility from (i) consumption, (ii) parental altruism, and (iii) social status.

The utilization of production externalities originating from physical capital accumulation is particularly useful when the analysis mainly focuses on the role of wealth accumulation in an endogenous-growth economy. Romer's (1986) production technology based on increasing returns from positive externalities on labor productivity associated with physical capital accumulation provides a simple yet meaningful endogenous-growth mechanism which can be used to underline the role of physical capital accumulation on long-run economic growth. Therefore, the analysis in Chapter 1 provides insights on the role of social motives on accumulation of physical capital in the long run.

The asset or wealth stock of an agent, relative to the average wealth, represents the social status in the model. This notion is analogous to Veblen's (1899) theory on conspicuous consumption and the leisure class. Veblen (1899) argues that wealth is the prime determinant of social status and agents take conspicuous consumption decisions in order to signal their wealth. When wealth is perfectly observable, it directly determines the social status of an agent without the need for a proxy. The model additionally assumes that agents have a bequest motive in the form of parental altruism. The status and bequest preferences jointly determine the saving rate of an agent. Heterogeneous preferences for social status and bequest create heterogeneity in the saving behavior and hence explain the evolution of the cross-section distribution of wealth. Moreover, since social status determined by relative wealth is an argument of the utility function and relative wealth depends on the economy-wide accumulation of wealth as well, the presence of status-seeking motive creates positive and negative welfare effects through individual and economy-wide wealth, respectively.

The results of the model have potential implications on growth, distribution, and welfare effects of the status-seeking motive. First, the results show that, when preference parameters are independently and identically distributed (i.i.d.) and are independent from the distribution of assets, some common factors such as the capital elasticity of output and the means of preference parameters affect both the rate of economic growth and the variance of the detrended wealth distribution. Second, if the variance of either one of the parental altruism or status-seeking motives is too high, the variance of the detrended wealth distribution explodes, i.e., the distribution becomes less egalitarian over time. Finally, extensions of the model show that taxing capital income and redistributing the revenue can (i) reduce wealth inequality without harming economic performance under i.i.d. preferences, and (ii) increase social welfare despite reducing the growth rate in a two-class society as in Mankiw (2015) if the working class is large enough or negative externalities originating from status-seeking are sufficiently strong.

Chapter 2 focuses on human capital accumulation and introduces an infinite-horizon a discrete-time, representative-agent, OLG GE model where

- social norms impose a habitual constraint on fertility choices, and
- agents gain utility from (i) consumption, (ii) fertility, and (iii) the future consumption prospects of their children.

Montgomery and Casterline (1996) argue that reproduction is not simply an individual choice; the social structure can have non-negligible influences on the fertility choice of the members of any society. The model economy in Chapter 2 introduces an endogenous *habit stock* that represents social norms that are vertically transmitted from one generation to the next and imposes a constraint for the decisions on reproduction. The habit stock of fertility faced by generation-$t+1$ adults is a weighted average of (i) the habit stock of fertility faced and (ii) the average fertility chosen by generation-t adults. It therefore captures the roles of historical persistence, the evolution of social norms, and the transmission of preferences from one generation to the next.

Since the chapter primarily focuses on human capital accumulation, it utilizes a production technology that is linear in human capital. The latter is accumulated through the education expenditure of parents who decide on the number of children they have and the level of education expenditure for the children, i.e., they face a child Q-Q trade-off. The model allows parents to not to invest in education if the returns on education are not high enough. Therefore, the model can generate long periods of both stagnation and growth and is in this sense a unified growth model.

The results of Chapter 2 decipher the long-lasting impact of non-economic institutions on a society's process of economic development. The basic model of the chapter, with strictly conservative agents who do not question social norms, has multiple (separated) steady-state equilibria. One of these equilibria is characterized by binding social norms, high fertility, and either no investment in human capital at all or low levels of investment that generate a low-growth steady-state. An extension of the model shows that how secularization, i.e., questioning the existing religious norms that impose high fertility and limiting the role they play on social life, enables the economy to converge to an asymptotic high-growth equilibrium with high levels of education investment. The model also has important implications on the mechanism of the Q-Q trade-off. It shows that, when individuals are not isolated from each other, the constraints that the social norms impose can prevent an agent to substitute between the number and the education of her children. The model, therefore, can explain why some contemporary societies, mainly traditional and conservative ones, are still stuck with low growth rates or stagnation with high fertility and how they can proceed to later stages of economic development.

The outline of the thesis is as follows: Chapter 1 analyzes the accumulation of physical capital and the distribution of wealth where agents seek to increase their social status through accumulating wealth, and Chapter 2 studies the process of human capital accumulation where social norms constrain individual decision-making through fertility habits. Both Chapters 1 and 2 include discussions of the related literatures, model environments, equilibrium definitions, main results, and implications of the basic models and possible extensions. Finally, the thesis summarizes the results and discussions in Chapters 1 and 2 and concludes with some remarks.

CHAPTER 1

STATUS PREFERENCES, WEALTH INEQUALITY AND ENDOGENOUS GROWTH

> "[...] in order to his own peace of mind, that an individual should possess as large a portion of goods as others with whom he is accustomed to class himself; and it is extremely gratifying to possess something more than others. [...] So far as concerns the present question, the end sought by accumulation is to rank high in comparison with the rest of the community in point of pecuniary strength. So long as the comparison is distinctly unfavourable to himself, the normal, average individual will live in chronic dissatisfaction with his present lot."
>
> (Veblen, [1899] 1922, p. 31-32)

1.1. INTRODUCTION

The evolution of within-country income and wealth distributions have been receiving increasing attention by the economists, especially with the availability of data provided by the World Inequality Database. Illustrating the trends of how income and wealth are distributed, Piketty and Saez (2014) show that both the US and Europe have experienced gradual shifts to more egalitarian distributions from the early 1920s to the early 1970s. On the contrary, the period after 1980s has been of a worldwide trend of increasing inequality, which have counteracted most of the decline in both wealth and income inequalities prior to the early 1970s. Alvaredo, Chancel, Piketty, Saez, and Zucman (2018) provide a more comprehensive analysis on the trends of income and wealth inequalities and demonstrate that the within-country distributions in global economies have become more unequal over the last 30 years. Their data show that income inequality have substantially increased in North America, Asia, and Europe, while remained stable at extremely high levels in sub-Saharan Africa and the Middle East. Alvaredo et al. (2018) point out a greater inequality of wealth compared to income, as their data and estimations suggest that more that 70% of total wealth in the United States, Europe, and China is possessed by the top 10%.

Even though the issue of growing inequality has received some attention before (especially in the form of cross-country income differences), it was after the 2007-2008 global crisis that it has become a central aspect of the macroeconomics literature. Regardless of the increasing attention on inequality, the available data indicate an outstanding divergence in both income and wealth levels for the corresponding period. For example, Atkinson, Piketty, and Saez (2011) displayed that the share of the top 1% in the US total income has risen dramatically after 2007.

The motive behind economists' recent focus on inequality is mostly due to the events took place prior to the 2007/2008 financial crisis and the role that inequality played for the crisis. Several studies singled out the steadily increasing inequality and the destabilizing effects of unequal distributions on economies after the late 1970s as the primary reason for the occurrence of the Great Recession. For instance, Kumhof et al. (2015) argue that the prior unsustainable increase in consumer debt caused the household defaults and financial fragility that triggered the financial crisis in 2007. Furthermore, they argue that the Great Depression and the Great Recession are strikingly similar as they both followed sizable increases in the inequality and debt-to-income ratio of low and middle-income households.[1] Their conclusion is that a decline in inequality prior to the 1980s would have significantly decreased the probability of a crisis. Another study by Cynamon and Fazzari (2015) attribute the slow post-crisis recovery of the US to the inadequate demand that the rise in inequality caused. The discussions on the mainstream literature and the evidence of the profound macroeconomic effects of unequal distributions indicate that the economic theory ought to explain the evolution and determinants of inequality.

Of the two forms of inequality, wealth inequality is of broader interest compared to income inequality due to several reasons. First, income inequality—to some extent—is considered to be less controversial than wealth inequality because of its more merit-based nature. Second, the wealth concentration is much higher in both Europe and the US compared to the income concentration, which, according to Piketty and Saez (2014), makes wealth inequality more extreme. In addition, income is a flow while wealth is a stock that is directly transferred among generations through inheritance. The intergenerational transmission of wealth causes wealth inequality to persist over time. Finally, Piketty and Saez (2014) claim that wealth inequality can become more severe in the future than it is today and may have substantial adverse effects on social and economic life, especially

[1]See C. Jones, Midrigan, and Philippon (2011) for a study on how household debt caused the Great Recession.

due to possible shifts to relatively capital intensive production technologies.

1.1.1 Question

Investigating capital accumulation through intergenerational linkages (i.e., bequests) is a good starting point to understand how the cross-section distribution of wealth evolves. A common assumption in the standard economic theory is that agent preferences, thus saving behaviors, are independent of each other. In other words, each agent makes her saving decision independent of the choices of other agents' decisions. Conversely, a longstanding tradition of thought underlines the role of individuals' desire to attain *social status and esteem* links their preferences and actions. The role that this social motive plays is not less than the role that pecuniary rewards play when deciding on wealth accumulation. The origins of arguments on agent interdependence date back to as early as Smith (1759) and Veblen (1899). Especially Veblen's theory that individuals' pursuit of social status influences them to strive for higher wealth is still prevalent in the contemporary works on interdependent agents. Later studies established further links between social interactions and economic decisions; such as Weber's (1905) protestant ethic and Leibenstein's (1950) relative consumption. Considerable empirical evidence so far supported the influence of social relations on economic decision-making.[2] For instance, a recent experimental research by Castelló and Doménech (2017) on platinum credit cards shows that people accept to bear economic costs for a good that increases their social status but does not offer an economic reward at all. The empirical investigations suggest that social motives influence decision-making and thereby sole economic motives are not sufficient enough to explain resource allocation of agents.

The evident link between saving behavior and social motives makes it essential to address the social structure of an economy to analyze how wealth is accumulated. There is a body of literature integrating the social dimension of household-level or dynastic preferences to representative agent models where households or dynasties are identical. However, the nature of such models suppresses the distributional consequences of household decisions. Atkinson (2015) underlines the central role of heterogeneity in economic modeling to understand the working of an economy and asserts its utmost importance in explaining the economic differences among people. Therefore, an essential challenge to economic theory is not only to investigate the economic aggregates but also to provide insights on how they are distributed. Atkinson's (2015) remark implies that inclusion of a social

[2] See, e.g., Easterlin (1995), Clark and Oswald (1996), Kapteyn, van de Geer, van de Stadt, and Wansbeek (1997), Naumark and Postlewaite (1998), McBride (2001), Christen and Morgan (2005), Luttmer (2005), and Charles, Hurst, and Roussanov (2009).

dimension alone is not sufficient. We need to differentiate individuals with respect to their preferences and social values. Only then may we have a proper understanding of closely related economic phenomena such as growth, wealth, and welfare.

This chapter investigates *how the presence of social motives in decision-making process with the weight given to these motives differing among agents affect (i) economic growth, (ii) welfare, and (iii) wealth distribution*. The presence of status-seeking behavior ensures that each individual's decisions in an economy are interdependent. When the relative position of agents determine their rank in the social hierarchy, an agent's decision to accumulate wealth influences all other agents' incentives to accumulate as well. The inclusion of such motive to an economic model enriches an analysis on the dynamics of the cross-section distribution of wealth. Considering that each agent can give different weights to their relative position in the social hierarchy and allowing for preference heterogeneity provides a more comprehensive framework.

1.1.2 Approach

This chapter follows an approach derived from Veblen's (1899) theory on status-seeking and Atkinson's (2015) assertion on the necessity to work with heterogeneous agents in order to study the cross-section distribution of economic aggregates. It introduces an infinite-horizon OLG GE model where growth is endogenous and agents' preferences and assets are heterogeneous. There are two overlapping generations at a given time: A passive child population and an adult population who are active decision makers. All adults are endowed with one unit of time and their bequeathed wealth. They derive utility from consumption, bequest, and social status. The bequest motive has two components. The first one is a direct component in the form of parental altruism as in Andreoni (1989). The second one is an indirect component in the form of status-seeking. Agents are heterogeneous in their endowments and preference parameters. Endowments and preferences are independently distributed. The model assumes that wealth is perfectly observable, and agents derive social status from their wealth relative to the average wealth stock.

The chapter seeks to study the Veblen effects on economic growth, welfare, and wealth accumulation in the long run. The economic growth analysis is based on identifying the factors affecting the balanced growth rate. The welfare analysis is mainly based on investigating how the different values of the status-seeking motive's parameter in the utility function affect an individual's welfare. Finally, the analysis on wealth distribution primarily focuses on the first two moments of the detrended wealth distribution. The logic behind utilizing the detrended distribution is that the asset stocks of all dynasties (and hence, the aggregate wealth) continue to grow over time in the model economy. Therefore, a detrended distribution captures the basic properties of the cross-section distribution of wealth.

1.1.3 Results and Contributions

The main results and contributions of the chapter are as follows:

1. Economies grow faster with stronger bequest and status-seeking motives, i.e., with larger cross-section means of preference parameters representing these motives. This complements the results of the line of inquiry on how status-seeking affects economic growth.
2. In line with the findings of the literature, status-seeking generates a negative externality on individual welfare. Individual welfare can be better-off or worse-off with status-seeking, depending on the relative weight assigned to social status in the individual's utility. One important contribution of this chapter is by determining the condition under which status preferences negatively affect individual welfare. Particularly, the results identify a threshold weight of status-seeking in individual utility above which individual welfare is worse-off with higher levels of accumulated wealth.
3. The wealth distribution becomes more egalitarian under higher average saving rates but less egalitarian under greater cross-section variances of these parameters and elasticity of capital. The variance of the detrended wealth distribution explodes to positive infinity if there is too much dispersion of the preference parameters around their mean. Additionally, wage income generates a trickle-down mechanism that improves the lifetime earnings of the dynasties with relatively smaller asset stocks. The chapter complements the literature by showing that (i) preference heterogeneity results in persistent inequality and (ii) the trickle-down effect of wealth accumulation. Additionally, it demonstrates that more capital intensive production technologies tend to generate less egalitarian wealth distributions.

Extensions of the simple model contribute to the literature in that they provide further understanding of the long-run determinants of persistent inequality and substantiate a theoretical rationale for taxing capital income. Extending the model with *ex ante* skill differences implies that inherited skills increase inequality (of both income and wealth) in the long run.

Another extension where the government taxes capital income for redistributive purposes shows that taxing capital income is an effective way of decreasing wealth inequality. When preferences and asset stocks are independent of each other, equally redistributing the revenue from a flat tax on capital income among all dynasties does not distort the balanced growth rate. The redistribution generates a more egalitarian steady-state wealth distribution.

A final extension with a two-class society as in Mankiw (2015) implies that taxing capital income can increase social welfare under a utilitarian social welfare function. In this alternative setup where the lifetime earnings of the leisure class originate from their inherited wealth only and the members of the working class earn only wage income, a capital income tax increases social welfare if (i) the size of the working class is sufficiently large, (ii) the capital elasticity of output is sufficiently high, or (iii) the status-seeking motive is sufficiently strong.

1.1.4 Outline

The outline of the chapter is as follows: Section 1.2 extensively discusses the related literature and contributions of this chapter. Section 1.3 introduces the model economy. Section 1.4 presents the main findings on the balanced growth rate, welfare, and the wealth distribution. Section 1.5 discusses the implications of these results and extensions of the basic model. Finally, Section 1.6 concludes.

1.2. RELATED LITERATURE AND CONTRIBUTIONS

Endogenous Growth Endogenous growth theories have emerged in response to the insufficiencies of neoclassical growth models of Solow (1956)-Swan (1956) and Ramsey (1928)-Cass (1965)-Koopmans (1965) variants in explaining sustained economic growth. The rate of economic growth has remained exogenous in these neoclassical models, being independent of preferences technologies, and policies.

The first endogenous growth model that accounts for sustained growth is the AK model developed by Frankel (1962) where the aggregate capital stock increases productivity and the saving rate is fixed. Arrow's (1962) and Uzawa's (1964) papers have then clarified the role of positive Marshallian externalities associated with physical capital and human capital, respectively. These studies have inspired Romer (1986) and Lucas (1988) to integrate positive externalities associated with physical and human capital accumulation into the Ramsey-Cass-Koopmans framework, respectively. More specifically, Romer's

(1986) model introduces a production technology where capital accumulation increases labor productivity as an externality, implying increasing returns as a source of endogenous growth. Other endogenous growth models with different production externalities have also been developed and used for various purposes such as analyzing the cross-country policy differences (King & Rebelo, 1990), the effects of macroeconomic volatility (L. E. Jones, Manuelli, & Stacchetti, 2000), and the effects of terms of trade (Acemoglu & Ventura, 2002) on economic growth.

This chapter particularly focuses on physical capital accumulation, and it therefore builds upon a variant of Romer's (1986) model to endogenize technology. Since the chapter is particularly interested in the role of status-seeking on wealth inequality and endogenous growth, Romer's (1986) model serves as the simplest non-trivial framework in which the accumulation of wealth affects technological progress and *vice versa*.

Status Preferences A substantial theoretical literature has been built upon Veblen's (1899) theory that agents' economic actions are motivated by attaining non-pecuniary rewards, e.g., social status and power, through increasing their relative position in the social hierarchy. Inspired by Veblen (1899); Duesenberry (1949), and Pollak (1976), Frank (1985) have formulated the initial micro-theoretical frameworks concerning consumer interdependence, i.e., the importance of relative income and consumption. Cole, Mailath, and Postlewaite (1992), Robson (1992), Ireland (1994), and Zou (1994) followed the previous works to explain economic outcomes with non-economic motives or origins. The relative consumption concerns of individuals and the consumption externalities they cause have been extensively studied under "keeping (or, catching) up with the Joneses" models with some notable ones being Abel (1990), Gali (1994), Futagami and Shibata (1998), Fisher and Hof (2000), Alvarez-Cuadrado, Monteiro, and Turnovsky (2004), Liu and Turnovsky (2005), and Turnovsky and Monteiro (2007).

This chapter is related with three specific segments of the literature on status preferences. First, it is related with the discussions linking status-seeking and economic growth. Kapur (2005), Pham (2005), Alvarez-Cuadrado (2007), Duernecker (2007), Fisher and Hof (2008), and Alvarez-Cuadrado and van Long (2011) have worked on models with identical preferences for social status and constant returns to scale (CRS) production technologies. Alvarez-Cuadrado and Long (2012) have then extended the CRS technology framework with heterogeneous preferences. Rauscher (1997), Corneo and Jeanne (2001), Liu and Turnovsky (2005), Turnovsky and Monteiro (2007), and Bilancini and D'Alessandro (2012) used frameworks with Romer (1986) type of production externalities and identical preferences, and Futagami and Shibata (1998) and Heikkinen (2015) have worked with heterogeneous preferences. One key finding of this literature is that the presence of status preferences yields faster economic growth in the long run and the growth rate is increasing with stronger preferences.

The model economy of this chapter builds upon Romer (1986) and uses heterogeneous preferences and asset endowments. More specifically, the sources of heterogeneity in the model are bequeathed asset stocks (and, hence, capital income), and preference parameters representing bequest and status-seeking motives. This chapter contributes to the literature by extending the framework of Corneo and Jeanne (2001) with heterogeneous households preferences. The results are in line with those of Corneo and Jeanne's (2001) in that they illustrate the growth-enhancing effects of status-seeking behavior.

Another line of the status preferences literature that this chapter is related with is the welfare implications of status-seeking motives. Kapur (2005) has used relative consumption as a mean for attaining social status and showed that status-pursuit leads to over-consumption and over-accumulation that fosters economic growth but reduces welfare. Pham (2005) has extended a model first proposed by Glomm and Ravikumar (1994) and induced a status-seeking motive where the status is determined by relative wealth. Pham's main finding is that individual welfare does not necessarily increase with economic growth when agents derive utility from their social status. Eaton and Eswaran (2009) have used a static general equilibrium model with a Veblen good to demonstrate the adverse effects of status-seeking on individual welfare. Bilancini and D'Alessandro (2012) have utilized a framework with identical agents to show that the decentralized (or competitive) solution under consumption and leisure externalities results in a higher output growth but a worse individual welfare compared to the centralized (or social planner) solution. Heikkinen (2015) has introduced heterogeneity to Bilancini and D'Alessandro's (2012) framework where there are two types of agents and found the same result.

The analysis of this chapter differs from these works in that it assumes a continuous distribution of preference parameters across dynasties. The results are in line with the existing literature in the sense that status-seeking creates adverse welfare effects. Another contribution of the chapter is determining under which conditions status-seeking adversely affects individual welfare. In the model of this chapter, status-seeking generates two different effects on individual welfare that counterbalance each other. The first one is a welfare-enhancing income effect that the higher growth rate delivers. The second one is a welfare-reducing externality which is an outcome the status deprivation of agents resulting from higher levels of average asset stock in the economy. The net effect depends on whether the individual's status preference parameter is greater than a threshold level or not.

Finally, this chapter is related with a group of works investigating the effects of status preferences on wealth and income inequalities. Corneo and Jeanne (1999), van Long and Shimomura (2004), Pham (2005), and Ray and Robson (2012) have investigated the long-run dynamics of wealth distribution under status preferences with CRS production technologies. This chapter uses a Romer (1986) type of production technology in order to capture the relationship between physical capital accumulation and wealth distribution. Corneo and Jeanne (2001) and Peng (2008) have also used the same technology under a continuous time model with identical household preferences. The analysis of this chapter differs from them in that it uses a discrete-time model with heterogeneous preferences. It shows that differences with respect to the strength of the status-seeking motive result in wealth inequality in the long run, a finding analogous to the findings of Krusell and Smith (1998) and Mulder et al. (2009) who emphasized preference heterogeneity as the primary factor of persistent wealth inequality. Furthermore, if the dispersions of the preference parameters representing bequest and status-seeking motives around their respective means are sufficiently large, they cause an ever increasing variance of the detrended wealth distribution.

Wealth Distribution Early works of Kaldor (1955, 1961) and Kuznets (1955) have demonstrated that inequality and economic development have an inverted-u relationship where inequality increases at the initial stages of development and then decreases at later stages.[3] However, this hypothesis has not received much empirical support. A large body of theoretical literature has proposed that inequality and growth are inversely related and the relation runs through various mechanisms. Some of these mechanisms include reduced incentives to accumulate (Persson & Tabellini, 1992, 1994; Bertola, 1993; Alesina & Rodrik, 1994; Barro, 1999), socio-political instability (Gupta, 1990), credit market imperfections (Banerjee & Newman, 1993; Galor & Zeira, 1993; Benabou, 1996, 2000; Matsuyama, 2000, 2004, 2011), the poor favoring the quantity of children over their quality (de la Croix & Doepke, 2003), and uninsurable labor income risk (Krebs, 2003a, 2003b). Later contributions of Piketty (2011), Piketty and Saez (2014), and Piketty and Zucman (2015) claimed that lower economic growth rates increase the share of capital income, thereupon increase inequality.

This chapter contributes to this literature by analyzing the inequality-growth nexus within a model with endogenous growth and heterogeneous preferences. The results show that

[3] See, e.g., Fields (2002) for a survey.

wealth inequality and economic growth are affected by the same forces, namely those of the saving rate and the capital elasticity of output. A gradual shift towards more capital intensive production technologies represents the "factor-eliminating technical change" as in Peretto and Seater (2013); firms seek to develop technologies where the reproducible factor has higher elasticity in order to eliminate the relatively non-reproducible factors of production. The results of this chapter show that the adoption of such technologies tends to generate less egalitarian wealth distributions through the accumulation of physical capital. This result supports Piketty and Saez' (2014) claim that possible changes in production technologies where production becomes more capital intensive can result in an increase in inequality in the future.

Some theoretical works use models with incomplete markets, Bewley (1986) models, to study the concentration of wealth. The most notable ones are the early works of Hansen and İmrohoroğlu (1992), Aiyagari (1994), Huggett (1996), Carroll (1997), Quadrini (2000), and N. Wang (2003), and the more recent contributions of Benhabib, Bisin, and Zhu (2011), Clemens and Heinemann (2015), and C. Wang, Wang, and Yang (2016). The basic idea of Bewley models is that the key forces that determine wealth concentration are precautionary savings which vary among households. Another line of work emphasized *ex ante* heterogeneities in saving motives. Dutta and Michel (1998), Krusell and Smith (1998), Laitner (2001), Castaneda, Diaz-Gimenez, and Rios-Rull (2003), De Nardi (2004), and Mulder et al. (2009) have demonstrated that preference heterogeneity in the bequest motive determines the concentration of wealth in the long run. Hendricks (2007) has asserted that, even though heterogeneity in the bequest motive cannot explain the movements of the largest observations of wealth, it still has some significant explanatory power. Gokhale and Kotlikoff (2002), Cagetti and De Nardi (2006), and Angelopoulos, Lazarakis, and Malley (2017) have underlined how skill heterogeneity in an economy can influence the wealth and income distributions in the long run.[4]

This chapter contributes to this line of inquiry by the inclusion of a second source of preference heterogeneity alongside the bequest motive, i.e., heterogeneous preferences for status-seeking. The results show that heterogeneity in both preferences is the prime determinant of how accumulated wealth is distributed in the long run. Additionally, the chapter introduces an extension with human capital differences across dynasties (e.g., skill heterogeneity) that accounts for the role of earning abilities on inequality. The extension shows that heterogeneity in earning abilities that is transmitted among generations causes

[4]See, e.g., Gale and Scholz (1994), Menchik and Jianakoplos (1997), Lindh and Ohlsson (1998), Quadrini (1999), Wolff and Zacharias (2007), and C. I. Jones (2015) for empirical works on the factors that affect wealth distribution.

persistent inequality in both income and wealth.

Capital Income Taxation This chapter is also related with the controversial debate on whether taxing capital income for more egalitarian wealth distributions is desirable or not. One side of the debate opposes the implementation of such tax schemes by utilizing various theoretical models. Atkinson and Stiglitz (1976), for instance, have constructed an OLG model and showed that taxing capital income is unnecessary when a labor income tax is already being implemented. Farhi and Werning (2010) have used a different two-period OLG model that shows not taxing capital income works as a subsidy for bequests. Chamley (1986), Judd (1985), and Atkeson, Chari, and Kehoe (1999) have formed infinite-horizon models to argue that the welfare distortion of taxing capital income grows exponentially, thereby implying that such taxes are not desirable. Mankiw (2015) has used a static model with a two-class society to show that taxing capital income reduces the welfare of both classes.

Some other scholars have been in support of a positive capital income tax rate. Atkinson and Sandmo (1980) have constructed a two-period OLG model where capital income taxation enhances welfare if savings cause a sufficiently strong income effect. Farhi and Werning (2013) have used a similar setup with that of Farhi and Werning (2010) to argue that taxing capital income is plausible if the weight assigned to equality in social welfare is sufficiently high. Aiyagari (1995) has utilized a Bewley model to show that the over-accumulation of capital due to market incompleteness creates a rationale to tax capital income. Erosa and Gervais (2002) have used a life-cycle model where insufficient labor income taxation can be corrected through taxing capital income. Piketty and Saez (2013) have supported taxing bequests with an infinite-horizon model where agents have a bequest motive. Straub and Werning (2014) showed that Chamley's (1986) and Judd's (1985) models generate positive optimum capital income taxes under different parametrizations. Tamai (2015) has used a framework with endogenous growth, heterogeneous initial wealth, and a voting equilibrium on redistributive taxation to show that pre-tax inequality adversely affects economic growth while economic growth and after-tax inequality have an inverted-u relationship.

This chapter has two contributions to the literature on capital income taxation. First, it shows that, a social planner can reduce the steady-state wealth inequality without harming economic growth by implementing a flat tax rate on capital income and redistribute the revenue equally among dynasties, if household preferences and asset stocks are independent of each other. Second, an extension of the basic model with leisure and working classes demonstrates that taxing capital earnings of the leisure class and redistributing the revenue equally among workers can decrease the balanced growth rate, but enhance social welfare under a utilitarian social welfare function.

1.3. THE MODEL

This section constructs the model economy. It initially introduces the model environment, market structures, decision problems, and market clearing conditions. Then, the section defines the static and dynamic general equilibria.

1.3.1 The Model Environment

This subsection sets up the model environment. It initially introduces the time, demographics, endowments, and preferences. Then, the subsection presents the production technology.

1.3.1.1 Households

Consider an OLG economy where people live for two consecutive periods, childhood and adulthood. Fertility is asexual and normalized to imply a fixed population at all times; each agent has one parent and one child. Time, denoted by t, is discrete and has an infinite horizon. Agents are passive during childhood and active decision makers during adulthood. There are unit masses of adults and firms at each t, indexed by $i \in [0,1]$ and $j \in [0,1]$, respectively.

The adults have two types of endowments, labor and their asset stocks. The labor endowment is one unit for each agent and supplied elastically. The asset stock $a_{i,t}$ is bequeathed by each agent's parents. The total capital stock in the economy at t is defined as in

$$A_t \equiv \int_0^1 a_{i,t} \mathrm{d}i. \tag{1.1}$$

Note that A_t also represents the average capital stock at t.

Adult agents derive utility from consumption $c_{i,t}$, the bequest $a_{i,t+1}$ that they leave to their child at the end of period t, and the social status (hereafter, *status*) of their child denoted by $s_{i,t+1}$. Wealth is assumed to be perfectly observable. In line with Veblen's (1899) theory, the status' of agents are derived from their relative wealth. $s_{i,t}$ represents the status of agent i at period t and is defined as in

$$s_{i,t} \equiv \frac{a_{i,t}}{A_t}. \tag{1.2}$$

Children inherit preferences from their parents. Agent i's preferences at t are represented by the utility function

$$u_{i,t} \equiv u\left(c_{i,t}, a_{i,t+1}, s_{i,t+1}\right) = \left(1 - \beta_i - \gamma_i\right) \ln\left(c_{i,t}\right) + \beta_i \ln\left(a_{i,t+1}\right) + \gamma_i \ln\left(s_{i,t+1}\right).$$

The parameters $\beta_i \in (0,1)$ and $\gamma_i \in (0,1)$ denote the bequest and status preferences of agent i, respectively.[5] Agents have a joy-of-giving type of bequest motive as in, e.g., Andreoni (1989). Both β_i and γ_i are i.i.d. among agents. The means of β_i and γ_i are denoted by μ_β and μ_γ, respectively. Similarly, σ_β^2 and σ_γ^2 denote the variances of β_i and γ_i, respectively. It is also assumed that the distributions of β_i and γ_i are independent from the distribution of $a_{i,t}$. Note here that, by the definition of $s_{i,t+1}$, agents whose offspring's asset stocks are smaller than the average wealth gain disutility from status-seeking.

To simplify the exposition, define λ_i as in $\lambda_i \equiv \beta_i + \gamma_i \in (0,1)$ with mean μ_λ and variance σ_λ^2.[6] Substituting λ_i and (1.2) in the utility function implies

$$u_{i,t} \equiv u\left(c_{i,t}, a_{i,t+1}; A_{t+1}\right) = \left(1 - \lambda_i\right) \ln\left(c_{i,t}\right) + \lambda_i \ln\left(a_{i,t+1}\right) - \gamma_i \ln\left(A_{t+1}\right). \tag{1.3}$$

Two remarks are in order: First, adult agents' bequest motive has two components, one direct component represented by β_i and the indirect component mediated through status-seeking and represented by γ_i. Second, status-seeking creates a negative externality through the future value A_{t+1} of the aggregate wealth stock since adults bear a loss of status for larger values of the aggregate wealth by construction.

1.3.1.2 Firms

Firm j produces the consumption good with the technology defined as in

$$Y_{j,t} \equiv Y\left(K_{j,t}, L_{j,t}; X_t\right) = K_{j,t}^{\alpha}\left(X_t L_{j,t}\right)^{1-\alpha} \tag{1.4}$$

[5] $\beta_i + \gamma_i < 1$ is a feasibility constraint for $c_{i,t} > 0$ for all i.

[6] Consequently, μ_λ is the sum of μ_β and μ_γ. σ_λ^2 is also the sum of σ_β^2 and σ_γ^2 since β_i and γ_i are i.i.d. random variables.

where $Y_{j,t}$, $K_{j,t}$, and $L_{j,t}$ denote the volume of output, the stock of physical capital, and the flow of worker hours, respectively, $\alpha \in (0,1)$ denotes the capital elasticity of output, and X_t is the Harrod-neutral productivity term. The productivity variable is defined as in

$$X_t = \psi K_t \tag{1.5}$$

where K_t is the total capital stock in the economy at t and $\psi > 0$ is another productivity parameter. Assume that ψ is sufficiently large to promote economic growth. The basic idea behind introducing an externality to the production technology, as discussed in the endogenous growth literature, is that the aggregate experience in investment activities and production promotes new useful knowledge via learning-by-doing.

1.3.2 Market Structures

Three markets in this economy are the good, labor, and capital markets. Households supply labor and capital, and they demand the consumption good. Firms produce and supply the consumption good, and they demand labor and capital.

The goods market is perfectly competitive, and firms make zero profit in equilibrium. Households and firms are both price takers. The consumption good can either be consumed or invested, and it is the numéraire.

Households and firms are both price takers in the labor and capital markets. The (real) wage and rental rates are denoted by $w_t > 0$ and $r_t > 0$, respectively. The depreciation rate is denoted by $\delta \in [0,1]$, and, for simplicity, the entire physical capital stock is assumed to depreciate from t to $t+1$, i.e., $\delta = 1$. Households are assumed to be paying for depreciation as in Stokey, Lucas, and Prescott (1989, Section 2.3).

1.3.3 Decision Problems

This subsection defines the decision problems. The problems are those of the generic household and the representative firm.

1.3.3.1 Households

The household i chooses $c_{i,t}$ and $a_{i,t+1}$ and maximizes the utility defined in (1.3) subject to the budget constraint

$$c_{i,t} + a_{i,t+1} \leq r_t a_{i,t} + w_t. \tag{1.6}$$

Equivalently, the problem is

$$\begin{aligned} \max_{a_{i,t+1}} \quad & (1-\lambda_i)\ln\left(r_t a_{i,t} + w_t - a_{i,t+1}\right) + \lambda_i \ln\left(a_{i,t+1}\right) - \gamma_i \ln\left(A_{t+1}\right) \\ \text{subject to} \quad & a_{i,t+1} \geq 0. \end{aligned} \tag{1.7}$$

Under the assumption that agents do not internalize the effect of their decisions on A_{t+1}, the first order condition (FOC) for the household's problem implies

$$a_{i,t+1} = \lambda_i \left(r_t a_{i,t} + w_t\right). \tag{1.8}$$

Notice from this solution that λ_i is the saving rate of agent i for all t.

1.3.3.2 Firms

Given r_t and w_t, the firm j chooses $K_{j,t}$ and $L_{j,t}$ to maximize its profit

$$\Pi_{j,t} = Y\left(K_{j,t}, L_{j,t}; X_t\right) - r_t K_{j,t} - w_t L_{j,t}. \tag{1.9}$$

Equivalently, the firm's problem is

$$\max_{k_{j,t}} \quad X_t L_{j,t}\left(k_{j,t}^{\alpha} - r_t k_{j,t} - \frac{w_t}{X_t}\right) \tag{1.10}$$

where $k_{j,t} \equiv K_{j,t}/\left(X_t L_{j,t}\right)$. The FOC for the firm's problem returns

$$r_t = \alpha k_{j,t}^{\alpha-1}. \tag{1.11}$$

Consequently, the zero-profit condition gives w_t as in

$$w_t = (1-\alpha) X_t k_{j,t}^{\alpha}. \tag{1.12}$$

1.3.4 Market Clearing Conditions

The market clearing conditions for each market operating within the economy are given by the following equations. Here, the quantity supplied for each market is denoted by the left-hand side while the quantity demanded is denoted by the right-hand side.

The goods market clears via

$$\int_0^1 Y_{j,t} \mathrm{d}j = \int_0^1 c_{i,t} \mathrm{d}i + \int_0^1 a_{i,t+1} \mathrm{d}i. \tag{1.13}$$

Then, the labor market clears via

$$\int_0^1 1 \mathrm{d}i = \int_0^1 L_{j,t} \mathrm{d}j. \tag{1.14}$$

Finally, the capital market clears via

$$\int_0^1 a_{i,t} \mathrm{d}i = \int_0^1 K_{j,t} \mathrm{d}j. \tag{1.15}$$

1.3.5 Static General Equilibrium

This subsection defines the static general equilibrium (SGE). Then, it proves the existence of a unique SGE and lists its features.

Definition 1.1 *An SGE for any $t \in \{0,1,...\}$ is a collection*

$$\left\{ \left\{c_{i,t}, a_{i,t+1}\right\}_{i\in[0,1]}, \left\{Y_{j,t}, K_{j,t}, L_{j,t}\right\}_{j\in[0,1]} \right\}$$

of quantities and a pair $\{r_t, w_t\}$ of relative prices such that, given $\{a_{i,t}\}_i$ and $A_t \equiv \int_0^1 a_{i,t} di$,

- *$(c_{i,t}, a_{i,t+1})$ solves the household's problem* (1.7)*,*
- *$(K_{j,t}, L_{j,t})$ solves the firm's problem* (1.10)*, and*
- *the labor and capital markets clear via* (1.14) *and* (1.15) *respectively.*[7]

Proposition 1.1 *There exists a unique SGE where*

$$r_t = \alpha \psi^{1-\alpha} \equiv r > 0, \tag{1.16}$$

[7] The goods market clearing condition (1.13) is satisfied via Walras' Law.

$$w_t = (1-\alpha)\,\psi^{1-\alpha} A_t > 0, \tag{1.17}$$

$$a_{i,t+1} = \psi^{1-\alpha}\lambda_i\left[\alpha a_{i,t} + (1-\alpha)A_t\right] > 0, and \tag{1.18}$$

$$c_{i,t} = \psi^{1-\alpha}\,(1-\lambda_i)\left[\alpha a_{i,t} + (1-\alpha)A_t\right] > 0 \tag{1.19}$$

for any $i \in [0,1]$.

1.3.6 Dynamic General Equilibrium and the Balanced Growth Path

This subsection defines a Dynamic General Equilibrium (DGE) and proves its existence. Then, it introduces the Balanced Growth Path (BGP) of the model economy.

The law of motion of A_t must be specified before defining the DGE. By definition and (1.18), the aggregate wealth at $t+1$ reads

$$A_{t+1} = \int_0^1 \psi^{1-\alpha}\lambda_i\left[\alpha a_{i,t} + (1-\alpha)A_t\right]\mathrm{d}i, \tag{1.20}$$

which, as in (Bertola, 2000, p. 512) reduces into

$$A_{t+1} = \psi^{1-\alpha}\mu_\lambda A_t \tag{1.21}$$

since λ_i and $a_{i,t}$ are independently distributed random variables.

Definition 1.2 *Given* $\left\{a_{i,0}\right\}_i$ *and* $A_0 \equiv \int_0^1 a_{i,0}di$*, a DGE is a sequence of SGEs that satisfy the laws of motion* (1.18) *and* (1.21) *together with the sequences* $\left\{\left\{a_{i,t}\right\}_i, A_t\right\}_{t=1}^{+\infty}$.

Proposition 1.2 *A DGE exists and is unique.*

That a DGE exists and is unique motivates the following proposition:

Proposition 1.3 *For sufficiently large* ψ*, there exists a unique BGP where variables* c_t*,* A_t*, and* Y_t *grow at a constant balanced growth rate* G^* *for the remaining history satisfying*

$$G^* = \psi^{1-\alpha}\mu_\lambda > 1. \tag{1.22}$$

Furthermore, with $G_t \equiv G^*$ *for all* t*, i.e., the output growth rate for all* t *being time invariant, the economy is on its unique BGP for the entire history.*

1.4. MAIN RESULTS

This section presents the main results. First, it discusses the determinants of the balanced growth rate G^*. Then, the welfare effects of status-seeking and wealth inequality are demonstrated and briefly discussed. Finally, the section concludes by showing that how status-seeking and economic growth affect the wealth distribution.

1.4.1 The Balanced Growth Rate

Corollary 1.1 *The balanced growth rate G^* is increasing in average saving rate μ_λ, i.e., the sum of the cross-section means of parameters representing bequest and status-seeking motives. That is, growth is faster in an economy where agents have stronger status-seeking and bequest motives on average. Additionally, G^* is strictly increasing in the productivity parameter ψ and strictly decreasing in the capital elasticity α. G^* is independent of the initial cross-section distribution of wealth.*

Corollary 1.1 follows simply from Proposition 1.3. Since G^* is the growth rate of aggregate wealth as well, it positively depends on the average saving rate μ_λ. The balanced growth rate G^* of the economy also positively depends on productivity parameter ψ since a larger level of productivity per unit of physical capital increases both labor income and capital income. The capital elasticity α, on the other hand, diminishes the role of ψ as a result of the Harrod-neutral formulation of technological progress. These results are in line with those of Corneo and Jeanne (2001) and Liu and Turnovsky (2005) who have used similar setups for technology and status preferences.

The independence of wealth accumulation decisions from the wealth distribution is a consequence of the fact that agents in this model obtain status-related utility from their child's holdings of wealth, not from their position in a cumulative distribution function $H_t(a)$ of wealth. In Corneo and Jeanne's (2001) and Ray and Robson's (2012) papers, agent i's status is defined as the fraction of agents whose wealth levels are less than the wealth of agent i, i.e., $H_t(a_{i,t})$. Thus, the wealth distribution, that is, its parameters, would affect the saving behavior of status-seeking agents and the process of economic growth if social status was defined as in $s_{i,t} = H_t(a_{i,t})$. In that case, the gap between the wealth levels of the relatively poor and rich would discourage poorer individuals from accumulating in order to catch up with their wealthier peers. Their lack of effort to catch-up, then, would have discouraged the relatively rich to accumulate in order to maintain their status. Therefore, economic growth would have been lower with less egalitarian distributions of wealth.[8] This is clearly not the case here. At any t, the marginal utility of $a_{i,t+1}$ depends only on the agent's choice of $a_{i,t+1}$ and her preferences, which are independent from the agent's asset stock or her relative wealth. Hence, agents accumulate the same portion of their incomes no matter how wealth is distributed, and the balanced growth rate is not affected from the parameters of the wealth distribution.

1.4.2 The Welfare Analysis

Note once again that, by construction, the agents whose offspring's asset stock is below the average wealth, i.e. $s_{i,t} < 1$, gain disutility from status-seeking. On the contrary, the findings on the balanced growth rate demonstrate that the economy grows faster with stronger status preferences, which, in turn, increases the utility of each agent by an increase in wage income (see (1.12)). The net effect of status-seeking on individual welfare is ambiguous. To solve for $u_{i,t}$, plug (1.18) and (1.21) in the utility function from (1.7). These imply

$$u_{i,t} = \phi_i + \ln[\alpha a_{i,t} + (1-\alpha)A_t] - \gamma_i \ln(A_t) \tag{1.23}$$

where

$$\phi_i \equiv (1-\lambda_i)\ln(1-\lambda_i) + \lambda_i \ln(\lambda_i) + (1-\gamma_i)\ln\left(\psi^{1-\alpha}\right) - \gamma_i \ln(\mu_\lambda). \tag{1.24}$$

Proposition 1.4 *Agent i's utility $u_{i,t}$ is decreasing in the aggregate wealth stock A_t if agent i's status-seeking motive γ_i is greater than the threshold $\hat{\gamma}_{i,t}$ defined as in*

$$\hat{\gamma}_{i,t} \equiv \frac{1-\alpha}{\alpha s_{i,t} + 1 - \alpha}. \tag{1.25}$$

$\hat{\gamma}_{i,t}$ is decreasing in $s_{i,t}$. In other words, the threshold level of status-seeking motive for attaining disutility from a larger aggregate wealth stock is smaller for agents with relatively high status.

The status-seeking motive generates an effect that crowds out the benefits of higher levels of income that accumulated wealth provides. Suppose that the average wealth level in the economy increases while agent i's asset stock remains constant. The higher level of average wealth creates an income effect for agent i through increasing her wage income. However, the higher average wealth causes a status deprivation for agent i. If her

[8] See, e.g., Corneo and Jeanne (2001) for a discussion on this issue.

status-seeking motive is sufficiently strong, the adverse effect outweighs the income effect. The threshold level of status-seeking motive $\hat{\gamma}_{i,t}$ decreases with the agent's status. That is, economic growth can adversely affect relatively wealthy agents while benefiting the others.

Turning to the evolution of status or, equivalently, of detrended wealth, the law of motion for $s_{i,t}$ is obtained from (1.2), (1.18) and (1.21) as in

$$s_{i,t+1} = \frac{\alpha \lambda_i}{\mu_\lambda} s_{i,t} + \frac{(1-\alpha)\lambda_i}{\mu_\lambda}. \tag{1.26}$$

Proposition 1.5 *If the saving rate λ_i of agent i is strictly less than μ_λ/α, then the status of agent i converges to a steady-state value s_i^* defined as in*

$$s_i^* = \frac{(1-\alpha)\mu_\lambda}{\mu_\lambda - \alpha\lambda_i}. \tag{1.27}$$

An agent's status at the steady-state depends on (i) her saving rate (which is determined by parameters representing bequest and status-seeking motives), (ii) the average saving rate of the society, and (iii) the capital elasticity of output. The steady-state value, if it exists, is higher for agents with higher saving rates and the effect of the saving rate on the steady-state is nonlinear.

1.4.3 The Wealth Distribution

Let the counter-cumulative distribution function of detrended wealth at generation $t+1$ be denoted by $H_{t+1}(s)$. By definition, we have

$$H_{t+1}(s) = \Pr(s_{i,t+1} > s), \tag{1.28}$$

and using (1.26) to eliminate $s_{i,t+1}$ returns

$$H_{t+1}(s) = \Pr\left(s_{i,t} > \frac{\mu_\lambda s}{\alpha\lambda_i} + \frac{1-\alpha}{\alpha}\right). \tag{1.29}$$

Assuming that the cross-section distribution of the saving rate λ_i has density $f(\lambda)$ and support $\Lambda \equiv [\lambda_{\min}, \lambda_{\max}]$ implies

$$H_{t+1}(s) = \int_{\lambda\in\Lambda} H_t\left(\frac{\mu_\lambda s}{\alpha\lambda} + \frac{1-\alpha}{\alpha}\right) f(\lambda)\mathrm{d}\lambda. \tag{1.30}$$

This integral equation is the difference equation that characterizes the equilibrium evolution of the cross-section distribution of detrended wealth from t to $t+1$. However, such an equation does not have a closed-form solution for well-known densities $f(\bullet)$ and a given initial distribution $H_0(s)$. Since the equation cannot be solved under a discrete-time setup with a continuous distribution of $a_{i,t}$, the rest of the analysis focuses on the first and second moments of the detrended wealth distribution.

The explicit analysis of the evolution of the wealth distribution is feasible for any $f(\bullet)$ and $H_0(\bullet)$ if the scope is limited with the evolution of the expected value and variance of $s_{i,t}$. Before proceeding to this analysis, it is useful to note that relative wealth in this model determines the social status and, additionally, the distribution of status is identically the distribution of the detrended wealth because of the definitions of status and wealth.[9] Thus, the variance of status, through representing the dispersion of the wealth distribution, can depict wealth inequality.

Taking the expectations of both sides of (1.26) returns the expected value of $s_{i,t+1}$ as in

$$\mu_{s,t+1} = \alpha\mu_{s,t} + 1 - \alpha. \tag{1.31}$$

After taking the variances of both sides of (1.26), the variance of $s_{i,t+1}$ is obtained as in

$$\sigma^2_{s,t+1} = \frac{\alpha^2\left(\sigma^2_\lambda + \mu^2_\lambda\right)\sigma^2_{s,t}}{\mu^2_\lambda} + \frac{\left(\alpha\mu_{s,t} + 1 - \alpha\right)^2\sigma^2_\lambda}{\mu^2_\lambda}. \tag{1.32}$$

Proposition 1.6 *Given the law of motion* (1.31)*, the expected value of status (or detrended wealth) converges to a steady-state value μ^*_s such that*

$$\mu^*_s = 1. \tag{1.33}$$

Let CV_λ denote the coefficient of variation of the saving rate λ_i where

$$CV_\lambda \equiv \frac{\sigma_\lambda}{\mu_\lambda}. \tag{1.34}$$

Given the law of motion (1.32) *and a sufficiently small CV_λ such that*

$$CV_\lambda < \sqrt{\frac{1-\alpha^2}{\alpha^2}}, \tag{1.35}$$

[9] The status $s_{i,t}$ is defined as the asset stock $a_{i,t}$ of an agent divided by the average wealth stock A_t. Since the average wealth stock is also equal to the total wealth stock in this model, the distribution of $s_{i,t}$ can be interpreted as the distribution of wealth divided by the total wealth stock.

the variance of status (or detrended wealth) converges to a steady-state value σ_s^{2*} *where*

$$\sigma_s^{2*} = \frac{\sigma_\lambda^2}{\mu_\lambda^2 - \alpha^2\left(\mu_\lambda^2 + \sigma_\lambda^2\right)}. \tag{1.36}$$

If CV_λ *is not sufficiently small, i.e., the dispersion of the saving rates around the average saving rate is large, the variance of status (or detrended wealth) explodes and goes to infinity.*

Proposition 1.6 shows that too much dispersion of either one of the bequest or status-seeking motives around their respective means would result in an exploding variance of status and wealth over time. Additionally, the steady-state variance of status and wealth is independent of the initial cross-section distribution of wealth; it only depends on the capital elasticity of output and the expected values and variances of preference parameters.

(1.31) implies that the evolution of the expected value of status and wealth is only affected by the capital elasticity α. Besides, this effect is only limited to the transition. 1.6 shows that the expected value of status and wealth converges to its steady-state value of unity and is not affected by any factor. See Figure 1 for the dynamics of $\mu_{s,t}$.

The steady-state value of the variance of status σ_s^{2*} and the transition process depend on three parameters; the average saving rate μ_λ, the dispersion in saving preferences σ_λ^2, and the capital elasticity α.

Figure 2 illustrates how changes in the expected values of the parameters governing bequest or status-seeking motives affect the dynamics of $\sigma_{s,t}^2$. Both a higher μ_β and a higher μ_γ cause an increase in the average saving rate μ_λ, and this creates two types of effects on the steady-state value of the variance and the transition process. The first is a level effect, a smaller steady-state variance of status and wealth. The second is a growth effect, implying that the variance of status and wealth grows at a slower pace over time.

Both a higher σ_β^2 and a higher σ_γ^2 cause an increase in the dispersion of the saving rate among the society, and this creates level and growth effects on the steady-state variance and the transition process as well. The level effect results in a larger steady-state variance of status and wealth. The growth effect implies that the variance of status and wealth grows at a faster pace over time. See Figure 3 for the effects of the dispersion of status and bequest preferences among the society on the dynamics of $\sigma_{s,t}^2$.

Finally, a higher α indicate that the production technology is a relatively capital intensive one, which creates two effects on the steady-state variance of status and the transition process. The level effect generates a larger steady-state variance while the growth effect cause a slower transition to the steady-state; see Figure 4.

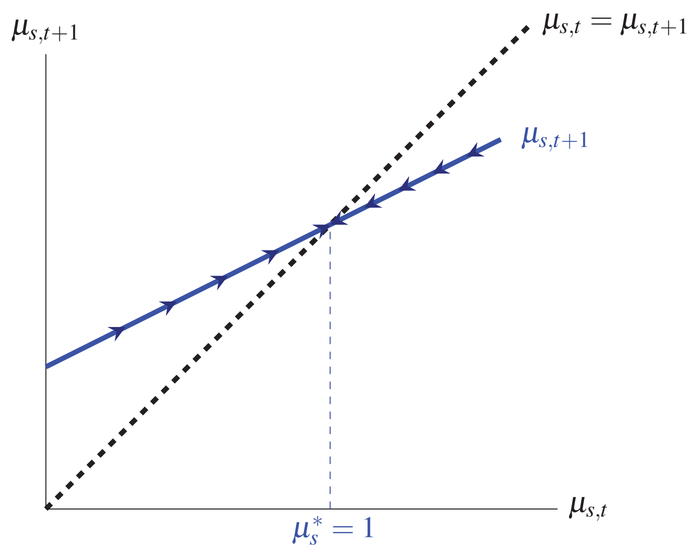

Figure 1: $\mu_{s,t}$ Dynamics

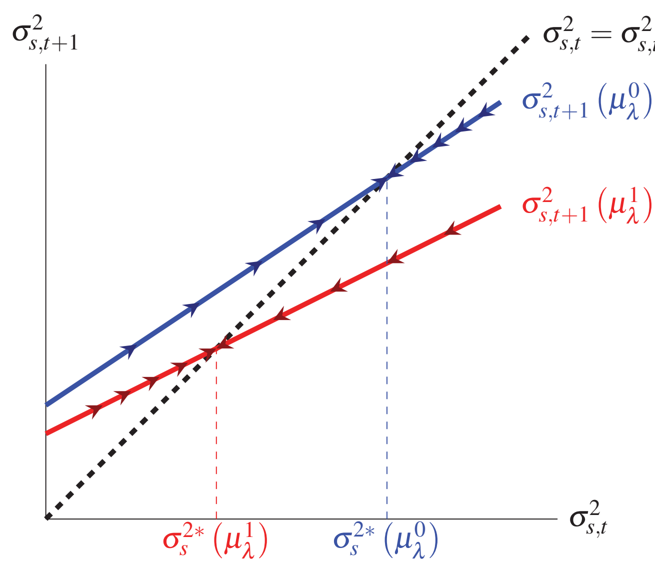

Figure 2: $\sigma^2_{s,t}$ Dynamics for μ^0_λ and μ^1_λ Where $\mu^0_\lambda < \mu^1_\lambda$

Note: Given $\mu^0_\lambda < \mu^1_\lambda$, a change from μ^0_λ to μ^1_λ, i.e., an increase in either one of the average bequest or status-seeking motives, causes a level effect that results in a smaller variance of status at $t+1$ and a growth effect that makes the variance grow slower over time. The ultimate outcome of a change from μ^0_λ to μ^1_λ is a slower convergence to a smaller steady-state variance of status.

A final remark of this section is on the shape of the detrended wealth distribution. Under certain general conditions, the cross-section distribution of $s_{i,t}$ converges to a Power Law distribution. More specifically, let $f(\lambda)$ be the density of saving rates, let $\alpha\lambda_i/\mu_\lambda$ be

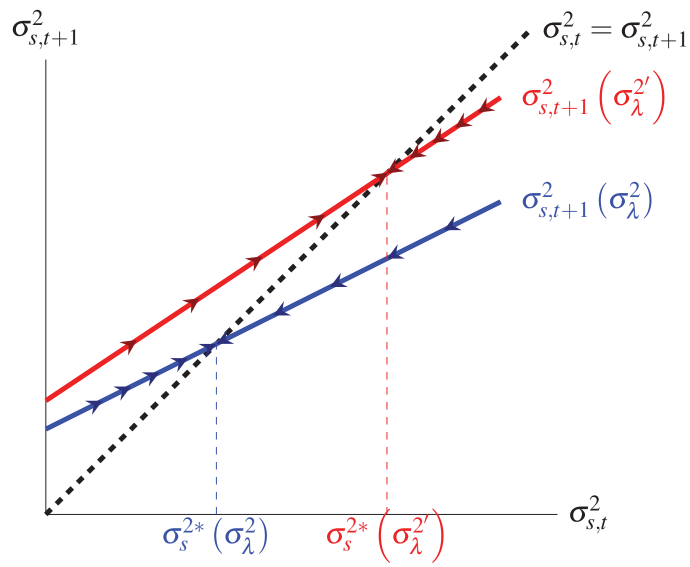

Figure 3: $\sigma^2_{s,t}$ Dynamics for σ^2_{λ} and $\sigma^{2'}_{\lambda}$ Where $\sigma^2_{\lambda} < \sigma^{2'}_{\lambda}$

Note: Given $\sigma^2_{\lambda} < \sigma^{2'}_{\lambda}$, a change from σ^2_{λ} to $\sigma^{2'}_{\lambda}$, i.e., an increase in either one of the variances of bequest or status-seeking motives, causes a level effect that results in a larger variance of status at $t+1$ and a growth effect that makes the variance grow faster over time. The ultimate outcome of a change from σ^2_{λ} to $\sigma^{2'}_{\lambda}$ is a faster convergence to a larger steady-state variance of status.

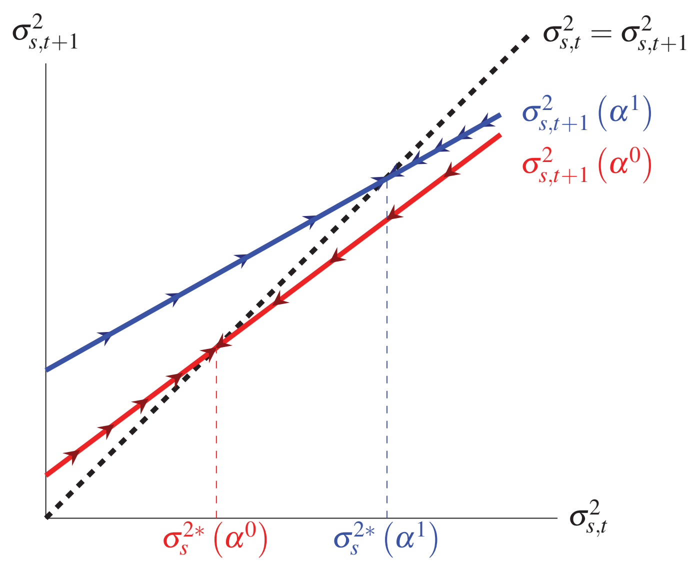

Figure 4: $\sigma^2_{s,t}$ Dynamics for α^0 and α^1 Where $\alpha^0 < \alpha^1$

Note: Given $\alpha^0 < \alpha^1$, a change from α^0 to α^1, i.e., a shift to a more capital intensive production technique, causes a level effect that results in a larger variance of status at $t+1$ and a growth effect that makes the variance grow slower over time. The ultimate outcome of a change from α^0 to α^1 is a slower convergence to a larger steady-state variance of status.

non-degenerate, and let there exist a Pareto exponent ξ satisfying

$$\mathrm{E}\left[\left(\frac{\alpha\lambda_i}{\mu_\lambda}\right)^{\xi}\right] = 1, \tag{1.37}$$

then the counter-cumulative distribution of $s_{i,t}$ is stationary with a Pareto tail with

$$\Pr(s_{i,t} > s) = \theta s_{i,t}^{-\xi} \tag{1.38}$$

where $\theta > 0$ is an arbitrary constant and (1.26) is a Kesten process. The proof and detailed explanations of the conditions can be found in Gabaix (2009, p. 262) via referring to Kesten (1973). Note once again that, from the definition of $s_{i,t}$, it can be treated as the detrended wealth. Gabaix (2009, p. 262) and (1.37) jointly show that higher elasticity of capital (greater α) and smaller mean of saving rate (smaller μ_λ) decrease ξ which generate fat-tailed Pareto distributions. A Pareto distribution has a fat tail in the sense that relatively larger fractions of accumulated wealth are possessed by a smaller portion of the society, i.e., the top wealth distribution is less egalitarian.

Recall that (1.26), the law of motion for $s_{i,t}$, and the gross growth rate of household i's status is obtained by

$$\frac{s_{i,t+1}}{s_{i,t}} = \frac{\alpha\lambda_i}{\mu_\lambda} + \frac{1-\alpha}{\alpha s_{i,t}}. \tag{1.39}$$

Note that the household's status growth (thus, wealth growth) is faster with a higher elasticity of capital and slower with a higher average saving rate. A relatively high elasticity of capital indicates that the wealth of households with relatively large asset stocks grow faster than the average wealth growth. As a consequence, the relative share of households with relatively large asset stocks in total wealth increases. In other words, a larger fraction of aggregate wealth gets concentrated at the hands of fewer households. On the other hand, the average wealth growth increases with a higher average saving rate, which, in turn, decreases the relative wealth growth of households with larger assets. That is, the average saving rate generates a more egalitarian wealth distribution and a thinner Pareto tail.

1.5. DISCUSSION AND EXTENSIONS

The recognition of status-seeking as a motive that influences human behavior is not new. The early writings of classical economists, e.g., Smith (1776), have long recognized the non-pecuniary motives behind economic actions. What is new for the literature, however, is the wide recognition of status motives as influential factors on macroeconomic outcomes. Weiss and Fershtman (1998) and Heffetz and Frank (2011) present some discussions and surveys of the theoretical and empirical studies on the economic implications of status-seeking motive.

The model of this chapter introduces status preferences to the individual utility function where the relative wealth defines status. These preferences, in line with Atkinson's (2015) assertion, are heterogeneous. Allowing agents to give different weights to economic and social incentives presents a deeper understanding of the distributional consequences of individual actions. This chapter investigates the roles that heterogeneity and status preferences play on the long-run economic growth, individual and social welfare, and the wealth distribution.

Some basic results of the model show that (i) the wealth distribution and the balanced growth rate are affected by the same factors (ii) stronger preferences for attaining higher social-status through wealth accumulation increase the balanced growth rate but can have adverse effects on welfare and (iii) the wealth distribution depends on heterogeneity in preferences in the long run. The remaining part of this section discusses some possible implications of these results.

1.5.1 Inequality and Growth

The inequality-growth nexus is a central topic of contemporary macroeconomics literature. The earlier works of Kaldor (1955, 1961) and Kuznets (1955) have focused on how economic growth affects inequality, but more recent works study whether inequality influences economic growth. The model economy of this chapter shows that both the wealth distribution and economic growth rate are affected by the same factors, namely those of the capital elasticity of output α and the average saving rate μ_λ that depends on how strong the bequest and status-seeking motives are.

First, higher values of α decrease the balanced growth rate and increase wealth inequality, indicating that more capital intensive technologies result in slower economic growth with less egalitarian wealth distributions. As argued above, the negative effect on growth stems from the way technological progress is introduced. Higher values of α imply lower degrees of exploiting the production externalities.

Regarding the distributional effect of α, note that a higher value of α increases the ratio of capital income to wage income given the status (or detrended wealth) $s_{i,t}$:

$$\frac{ra_{i,t}}{w_t} = \frac{\alpha a_{i,t}}{(1-\alpha)A_t} = \frac{\alpha}{(1-\alpha)} s_{i,t}, \tag{1.40}$$

This implies that a higher α raises the lifetime income of households with larger asset stocks, ultimately resulting in greater wealth inequality. The basic model studied above shows that the wage income works as an equalizing force, allowing households with smaller assets to catch up with their richer peers. Suppose that the distribution of detrended wealth is at its steady-state, and the production technology becomes more capital intensive. This clearly increases the capital income and decreases wage income. Agents with relatively higher asset stocks start earning more than the others relative to the initial state of the economy. Therefore, their assets relative to the average increases while the others' relative wealth decreases. The economy, then, converges to another steady-state where the detrended wealth distribution is less egalitarian. Furthermore, if the change in α is sufficiently high that the coefficient of variation of λ_i violates (1.35), the economy enters to a path where inequality continuously increases. Therefore, factor-eliminating technical change as in Peretto and Seater (2013), which enhances the role of the relatively reproducable factor (i.e., capital) at the expense of the relatively non-reproducable factor (i.e., labor) would lead to a shift of balanced growth path from a stable detrended wealth distribution to an unstable dynamic of an exploding variance.

The upper tail of the wealth distribution is also affected by α. Newman (2005) as cited in Nirei and Aoki (2016) shows that, when wealth has a Pareto distribution at its upper tail where the Pareto exponent satisfies $\xi > 1$, a fraction $D^{\frac{\xi-1}{\xi}}$ of the total wealth is held by the the population's top D fraction. The factors that affect ξ, thus, directly affect the wealth distribution and the *Gini coefficient* of wealth by determining the size of the wealth possessed by the relatively rich minority. (1.37) shows that ξ, if it exists, is decreasing in α and higher values of α generate fatter upper tails of the wealth distribution. This indicates that higher levels of α are associated with higher Gini coefficients.

Second, stronger bequest and status-seeking motives on average increase the balanced growth rate while decreasing wealth inequality. The bequest motive directly encourages capital accumulation and its impact on growth is straightforward. Agents, though, continue to accumulate wealth for status even if their status is constant in the long run. The intuition is as follows: If an agent withholds from accumulating wealth, it would lead to the status deprivation of her offspring due to the higher accumulation rates of the other agents. Every household, therefore, continues to accumulate for status concerns even if their status does not change in the long run. With greater levels of aggregate capital increasing the total output, the accumulation of wealth and the expansion of the stock of capital being one-to-one related, and the status-seeking behavior promoting wealth accumulation, status preferences foster economic growth.

The effects of bequest and status-seeking motives on the wealth distribution are twofold.

First, given the dispersions of preference parameters around their respective means, weaker bequest and status-seeking motives increase wealth inequality. (1.37) illustrates this effect through the negative relationship between μ_λ and the Pareto coefficient ξ. When μ_λ is low, the saving rates of those with stronger bequest and/or status-seeking motives are much higher relative to those with weaker motives. This implies that, the agents with higher saving rates possess relatively larger fractions of the total wealth.

The second effect of bequest and status motives on the wealth distribution originates from the presence of wage income w_t. Wealth accumulation promotes labor productivity growth, which, in turn, increases the wage rate. Households with relatively small asset stocks have higher lifetime incomes with an increase in the wage rate. They would have had lesser incomes if their sole income sources were their bequeathed wealth, i.e., capital income. In other words, the wage income of each household increase with higher average wealth in the economy from which the relatively poor benefit. Therefore, the presence of a wage income generates a trickle-down mechanism from the rich to the poor as in Aghion and Bolton (1997).

1.5.2 Human Capital and Inequality

According to Krusell and Smith (1998) and Mulder et al. (2009), persistent inequality is the outcome of preference heterogeneity which affects the intergenerational wealth transmission. The results of this chapter support their findings. The results of this chapter show that the existence of a positive variance of the detrended wealth distribution stems from preference heterogeneity, i.e., $\sigma_\lambda^2 > 0$. Yet, preference heterogeneity is not the only source of inequality. Several works investigating the factors affecting inequality in the long run have argued that preference heterogeneity alone cannot explain the observed inequality. Hendricks' (2007) analysis have demonstrated that preference heterogeneity, although explaining some part of the observed wealth inequality, falls short in explaining the largest wealth observations.

One particular source of persistent inequality that the literature supports is heterogeneity in earning abilities. De Nardi (2004) and Cagetti and De Nardi (2006) have argued that wealth distribution is affected by heterogeneities in both bequest motives and earning abilities. An empirical work by Wolff and Zacharias (2007) utilizing the Forbes 400 data provide support to their findings. Wolff and Zacharias' (2007) analysis separates lifetime earnings into two components, those of the income from wealth and income from other sources. They show that income from other sources is the primary reason of wealth inequality.

The model economy of this chapter can be extended with an *ex ante* earning ability heterogeneity to account for the findings of Cagetti and De Nardi (2006) and Wolff and Zacharias (2007). Let h_i be an i.i.d. variable that denotes the effective labor and is perfectly inherited by children from their parents.[10] The wage income of the generic household would then become $h_i w_t$. Assume that h_i has an expected value of 1, such that $\int_0^1 h_i \mathrm{d}i = 1$. Since the aggregate effective labor is also equal to 1, the market clearing conditions and the solution to the firm's problem are the same with those of the basic model. The household's problem, on the other hand, becomes

$$\begin{aligned} &\max_{a_{i,t+1}} \quad (1-\lambda_i)\ln\left(r_t a_{i,t} + h_i w_t - a_{i,t+1}\right) + \lambda_i \ln\left(a_{i,t+1}\right) - \gamma_i \ln\left(A_{t+1}\right) \\ &\text{subject to} \quad a_{i,t+1} > 0. \end{aligned} \tag{1.41}$$

The FOC for (1.41) is $a_{i,t+1} = \lambda_i \left(r_t a_{i,t} + h_i w_t\right)$, and substituting w_t and r_t gives

$$a_{i,t+1} = \lambda_i \psi^{1-\alpha}\left[\alpha a_{i,t} + (1-\alpha) A_t h_i\right]. \tag{1.42}$$

Since λ_i, h_i, and $a_{i,t}$ are distributed independently from each other, the aggregate (and the average) asset stock at $t+1$ reads

$$A_{t+1} = \alpha \mu_\lambda \psi^{1-\alpha} A_t + (1-\alpha)\mu_\lambda \psi^{1-\alpha} A_t \int_0^1 h_i \mathrm{d}i = \mu_\lambda \psi^{1-\alpha} A_t. \tag{1.43}$$

Note that A_{t+1} is increasing in the average effective labor $\int_0^1 h_i \mathrm{d}i$. Dividing $a_{i,t+1}$ by A_{t+1} returns

$$\frac{a_{i,t+1}}{A_{t+1}} \equiv s_{i,t+1} = \frac{\alpha \lambda_i s_{i,t}}{\mu_\lambda} + \frac{(1-\alpha)\lambda_i h_i}{\mu_\lambda}. \tag{1.44}$$

The equation of motion for the expected value of $s_{i,t}$ is the same as in (1.31), but the equation of motion for the variance of $s_{i,t}$ becomes

$$\sigma_{s,t+1}^2 = \frac{\alpha^2\left(\sigma_\lambda^2 + \mu_\lambda^2\right)\sigma_{s,t}^2}{\mu_\lambda^2} + \upsilon_t \tag{1.45}$$

and

$$\upsilon_t \equiv \frac{\left(\alpha \mu_{s,t} + 1 - \alpha\right)^2 \sigma_\lambda^2 + (1-\alpha)^2 \sigma_h^2 \left(\sigma_\lambda^2 + \mu_\lambda^2\right)}{\mu_\lambda^2} \tag{1.46}$$

[10] There can be other representations of human capital heterogeneity. Some other cases can be, e.g., an i.i.d. $h_{i,t}$ that is redistributed at each t, or an $h_{i,t+1}$ that is a function of $h_{i,t}$ and an i.i.d. learning ability ε. For simplicity, this extension assumes an i.i.d. h_i that is inherited by children from their parents. The rest is left for future research.

where $\sigma_h^2 \geq 0$ denotes the variance of h_i. Note that the equation of motion of $s_{i,t}$ is the same with that of the basic model for $\sigma_h^2 = 0$, i.e., without human capital heterogeneity.

Solving the steady-state variance of status from $\sigma_{s,t+1}^2 = \sigma_{s,t}^2$ and substituting in the steady-state value of status $\mu_s^* = 1$ returns σ_s^{2*} as in

$$\sigma_s^{2*} = \frac{\sigma_\lambda^2 + (1-\alpha)^2 \sigma_h^2 \left(\sigma_\lambda^2 + \mu_\lambda^2\right)}{(1-\alpha^2)\,\mu_\lambda^2 - \alpha^2 \sigma_\lambda^2}. \tag{1.47}$$

Note that the results of the extended model is robust with those of the basic model since the steady-state variances of $s_{i,t}$ of both models are equal for $\sigma_h^2 = 0$. $\partial \sigma_s^{2*} / \partial \sigma_h^2 > 0$ shows that human capital differences alone can cause persistent wealth inequality under the extended model's setup. The persistent effects of human capital heterogeneity is a consequence of the permanent difference in earning abilities that it causes.

Another interpretation of h_i can be made by following Hanushek and Woessmann's (2008) assessment. Hanushek and Woessmann (2008) argue that the cognitive skill differences among individuals significantly affect the evolution of the wealth distribution. Assuming that h_i denotes the cognitive skill of agent i, (1.47) illustrates that the intergenerationally transmitted differences in cognitive skills affect the steady-state variance of detrended wealth.

1.5.3 The Easterlin Paradox

Easterlin's (1974) seminal work have demonstrated the contradiction between the conventional microeconomic theory assumption that one's well-being is proportional to her income at a given time, and the historical trends of average happiness and real income per capita. Though the empirical observations and the economic theory imply a paradox, they are meaningful if one assesses the impact of income on individual welfare in terms of relatives rather than absolutes, i.e., relative income matters rather than absolute income. Of course, a crucial assumption here is that utility and happiness are correlated and can be used interchangeably in an analysis. A welfare analysis with a serendipitous utility function would not provide much information otherwise. See Clark, Frijters, and Shields (2008) for a comprehensive survey on the related literature.

Several works analogous to the findings of Easterlin have argued that economic growth does not necessarily increase welfare when individuals are concerned about their relative positions in the society. For instance, Clark et al. (2008, Section 5) discuss that the presence of relative concerns generate a threshold rate of economic growth, above which average welfare declines. The analysis of this chapter relates to that of Clark et al.'s (2008) in that status preferences are a form of relative concerns. Agents who seek to attain status care about their relative position in the society, which makes status-seeking a relative concern as in Clark et al. (2008). The findings of Bilancini and D'Alessandro (2012) and Heikkinen (2015) provide further support to the adverse effects of relative concerns on individual welfare, despite fostering economic growth. They show that striving to attain higher status reduces welfare despite increasing the total output.

The results of this chapter are in line with those of the literature in the sense that they demonstrate the possible adverse effects of status-seeking behavior on individual welfare. Even though the basic model does not allow an analytical solution for analyzing the precise effects of preferences on social welfare, an inference can be made through investigating the case of the generic agent. Higher A_t increases an individual's income, which results in a corresponding increase in individual welfare through increased consumption and bequest. On the other hand, the presence of status preferences generates a negative externality that reduces individual welfare since a higher A_t, given her bequest, would imply a deprivation of her offspring's status. The net effect of higher economic growth on individual welfare depends on the magnitude of the externality that status-seeking creates. If the status preferences of an agent is sufficiently strong such that $\gamma_i > \hat{\gamma}_{i,t}$, the externality outweighs the income effect of economic growth and the agent's welfare decreases with higher levels of aggregate wealth. The implication here is that if the economy consists of agents with strong status preferences, higher rates of economic growth does not necessarily increase social welfare.

1.5.4 Capital Income Taxation

There is substantial controversy on the appropriate way to tax capital income. The debate on capital income taxation primarily focuses on the so-called equity-efficiency trade-off in economics. Those in favor of not implementing taxes mostly utilize theoretical frameworks to illustrate the distortive effects of taxing capital income on output growth. These arguments resemble the well-known pie metaphor, i.e., what matters is the absolute size of the slice of pie that each individual receives, not the relative size of their slices. On the other hand, the presence of other factors such as intergenerational disagreements (Pavoni & Yazıcı, 2016a), and self-control problems (Pavoni & Yazıcı, 2016b) induce incentives for taxing capital income.

An extension of the basic model with a flat tax rate on capital income shows that capital income taxation does not necessarily "shrink the pie." Introduce a flat tax rate $\tau > 0$ on capital income. Suppose that the government uses taxation solely for redistributive purposes, and distributes the tax revenue T_t equally among all households. The generic agent's budget constraint then becomes

$$c_{i,t} + a_{i,t+1} \leq (1-\tau)\, r_t a_{i,t} + w_t + T_t. \tag{1.48}$$

As in the basic model, the consumption good is the numéraire. The relative prices w_t and r_t are the same as their respective values in the basic model because both labor and asset endowments are supplied inelastically. The government revenue and transfer T_t is equal to

$$T_t \equiv \int_0^1 \tau r_t a_{i,t} \mathrm{d}i = \tau \alpha \psi^{1-\alpha} A_t. \tag{1.49}$$

Solving the household's problem for (1.48) returns $a_{i,t+1}$ as in

$$a_{i,t+1} = \lambda_i \psi^{1-\alpha} \left\{ \alpha \left[1-\tau\right] a_{i,t} + \left[1-\alpha\left(1-\tau\right)\right] A_t \right\}. \tag{1.50}$$

The gross growth rate G_t in $t+1$ thus reads

$$\frac{A_{t+1}}{A_t} \equiv \frac{\int_0^1 a_{i,t+1} \mathrm{d}i}{A_t} = \mu_\lambda \psi^{1-\alpha} \tag{1.51}$$

which is equal to the G_t from the basic model. Hence, the long-run economic growth rate of the model economy is not distorted from taxing capital income when λ_i is independently distributed from $a_{i,t}$.

As for the welfare implications, agent i's utility at t with capital income taxation reads

$$u_{i,t} = \phi_i + \ln\left\{ \alpha \left[1-\tau\right] a_{i,t} + \left[1-\alpha\left(1-\tau\right)\right] A_t \right\} - \gamma_i \ln\left(A_t\right). \tag{1.52}$$

After taking the derivative of $u_{i,t}$ from (1.52) with respect to A_t, the threshold level of $\hat{\gamma}_{i,t}$ above which an individual's utility decreases with the aggregate wealth is

$$\hat{\gamma}_{i,t} = \frac{1-\alpha+\tau\alpha}{(1-\tau)\,\alpha s_{i,t} + 1 - \alpha + \tau\alpha}, \tag{1.53}$$

which is strictly greater than $\hat{\gamma}_{i,t}$ from the basic model for $\tau > 0$. A positive capital income tax rate, therefore, offsets some of the adverse effects of the competition to achieve higher status which will be discussed below.

Dividing both sides of (1.50) by $A_{t+1} = \mu_\lambda \psi^{1-\alpha} A_t$ returns $s_{i,t}$ as in

$$s_{i,t+1} = \frac{\lambda_i}{\mu_\lambda} \alpha (1-\tau) s_{i,t} + \frac{\lambda_i}{\mu_\lambda} [1 - \alpha (1-\tau)]. \tag{1.54}$$

Taking the expected value and variance of $s_{i,t+1}$ returns

$$\mu_{s,t+1} = \alpha (1-\tau) s_{i,t} + (1 - \alpha (1-\tau)), and \tag{1.55}$$

$$\sigma^2_{s,t+1} = \frac{\alpha^2 (1-\tau)^2 \left(\sigma^2_\lambda + \mu_\lambda\right) \sigma^2_{s,t}}{\mu^2_\lambda} + \frac{[\alpha (1-\tau) \mu_{s,t} + 1 - \alpha (1-\tau)]^2 \sigma^2_\lambda}{\mu^2_\lambda}. \tag{1.56}$$

Finally, assuming that the coefficient of variation of saving rate λ_i is sufficiently small, the steady-state variance σ^{2*}_s where $\sigma^2_{s,t} = \sigma^2_{s,t+1}$ is

$$\sigma^{2*}_s = \frac{\sigma^2_\lambda}{\mu^2_\lambda - \alpha^2 (1-\tau)^2 \left(\mu^2_\lambda + \sigma^2_\lambda\right)}, \tag{1.57}$$

which is strictly decreasing in τ.

There are several implications of the extended model on welfare and the wealth distribution. First, $\tau > 0$ can increase welfare (by offsetting some part of the adverse effects of status-seeking behavior) without harming economic growth. (1.25) and (1.53) show that the threshold level of status-seeking motive $\hat{\gamma}_{i,t}$ of the extended model (with a positive τ) is strictly greater than that of the basic model's. Given that the distribution of preferences of the extended model are the same with those of the basic model, a smaller portion of the society remains above the threshold level $\hat{\gamma}_{i,t}$. This means that a smaller portion of the society gains disutility from higher levels of aggregate (and average) wealth stock.

Second, $\tau > 0$ decreases the steady-state variance of the detrended wealth distribution. Even when the coefficient of variance of the saving rate is too high, taxing capital income can be used to prevent the variance of detrended wealth from exploding. $\tau > 0$ can, thereby, achieve a more equal wealth distribution without reducing the economic growth rate.

The result that capital income taxation does not reduce economic growth rate is extremely sensitive to the assumption that household preferences and asset stocks are independent of each other. If this assumption were to be violated in such a way that agents tend to save a relatively larger fraction of their income when they earn more, a positive τ^* would have decreased the balanced growth rate. Yet, there can still exist a positive τ^* that does not harm economic growth when preferences and asset stocks are dependent to each other. Abel (2007), for example, shows that allowing investors to deduct capital expenditures from taxable capital income prevents the distortive effects of taxation. Considering Yunker's (2014) and Fernholz' (2017) findings that even small tax rates on the earnings of the richest 1% can substantially reduce inequality, it is not unreasonable to assume that achieving a more egalitarian wealth distribution without a reduction in the balanced growth rate is possible by taxing capital income and redistributing the revenue.

A more equal wealth distribution, so far, have been argued to provide a more stable economic environment which provides a relatively desirable environment for factor accumulation. Numerous works, e.g., those of Persson and Tabellini (1992, 1994), Alesina and Rodrik (1994), Alesina and Perotti (1996), and Perotti (1996), have underlined how the social conflict and political instability that inequality causes adversely affects economic growth and well-being. Aside from the sociopolitical channel, the degree of inequality affects economic growth through the incentives for factor accumulation. Galor and Moav (2004) show that greater equality fosters economic growth when human capital is the primary source affecting economic development. According to Galor and Moav (2004), the benefits of an equal distribution outweigh its potential adverse effects on saving rates at later stages of development. This extension shows that the saving rate, hence economic growth, does not necessarily decrease with a redistributive tax on capital income, and an economy can reap the benefits of a more equal distribution without bearing potential costs of such taxation.

1.5.5 Two-Class Societies

There are no separate classes of agents in the basic model. The heterogeneity among the households arises from their preference parameters and endowments. This, however, is not the case historically. Veblen (1899) have argued that the societies were historically characterized by two rigorously separated classes. The upper class was exempt from putting effort into occupations (i.e., using their labor), while the lower class took active roles in the production process. Veblen (1899) have defined the upper class as the leisure class, a privileged elite who neither need nor intend to work. The question here, then, is whether an extension of the model can be made to account for Veblen's thought more comprehensively with the inclusion of two distinct classes.

A simple extension is to redefine the households à la Mankiw (2015). Consider a population characterized by two distinct classes such that;

- the leisure class endowed with only bequeathed asset, enjoying utility from consumption, bequest, and status, and

- the working class endowed with only labor, enjoying utility from consumption only.

Let the economy consist of a mass of agents from 0 to $\eta > 1$, where a unit mass of these agents are the members of the leisure class indexed by $i \in [0,1]$ and the remaining are the working class. Assume that interclass transmission is not possible, i.e., the descendants of an agent at $t = 0$ are the members of the same class with that of their ancestors for the entire history.

With the consumption good being the numéraire, the budget constraint of a generic leisure class agent becomes

$$c_{i,t} + a_{i,t+1} \leq (1-\tau)\, r_t a_{i,t}, \tag{1.58}$$

and with (1.3) being her utility function, the leisure class agent's problem is

$$\begin{aligned} \max_{a_{i,t+1}} \quad & (1-\lambda_i)\ln\left[(1-\tau)\, r_t a_{i,t} - a_{i,t+1}\right] + \lambda_i \ln\left(a_{i,t+1}\right) - \gamma_i \ln\left(A_{t+1}\right) \\ \text{subject to} \quad & a_{i,t+1} > 0. \end{aligned} \tag{1.59}$$

Note that the government seeks to optimize social welfare by picking the tax rate on capital income, $\tau \in [0,1]$. The tax revenue to be distributed equally among workers (if positive) is

$$T_t = \int_0^1 \tau r_t a_{i,t} \mathrm{d}i. \tag{1.60}$$

Now, consider the working class indexed by $\nu \in (1,\eta]$. The representative worker enjoys utility only from consumption by the given utility function

$$u_{\nu,t} = \ln\left(c_{\nu,t}\right) \tag{1.61}$$

and the budget constraint

$$c_{\nu,t} \leq w_t + \frac{T_t}{\eta - 1}. \tag{1.62}$$

Proposition 1.7 *There exists a unique SGE and a unique DGE of the extended model with*

$$r_t = \alpha \psi^{1-\alpha} (\eta - 1)^{1-\alpha} \equiv r > 0, \tag{1.63}$$

$$w_t = (1-\alpha)\,\psi^{1-\alpha}\,(\eta-1)^{-\alpha} A_t > 0, \tag{1.64}$$

$$a_{i,t+1} = \lambda_i\,(1-\tau)\,\alpha\psi^{1-\alpha}\,(\eta-1)^{1-\alpha} > 0, and \tag{1.65}$$

$$c_{i,t} = (1-\lambda_i)\,(1-\tau)\,\alpha\psi^{1-\alpha}\,(\eta-1)^{1-\alpha} > 0 \tag{1.66}$$

for any $i \in [0,1]$.

Let $\lambda_i \in [\lambda_{\min}, \lambda_{\max}]$ *where* $\lambda_{\min}, \lambda_{\max} \in [0,1]$. *Assume that* ψ *is sufficiently large such that neither household's asset stock diminishes over time. Then, there exists a unique BGP of the extended model with a gross balanced growth rate* G^* *where*

$$G^* = \mu_\lambda\,(1-\tau)\,\alpha\psi^{1-\alpha}\,(\eta-1)^{1-\alpha}. \tag{1.67}$$

Furthermore, with $G_t \equiv G^*$ *for all* t, *the economy is on a unique BGP from* $t=1$ *to* $t \to +\infty$.

Let the social welfare U_t be

$$U_t \equiv \int_0^1 u_{i,t}\mathrm{d}i + \int_1^\eta u_{\nu,t}\mathrm{d}\nu, \tag{1.68}$$

which is the sum of the welfares of each leisure class and the working class agent, i.e., the social welfare function is a utilitarian one. The government's problem here is to maximize U_t by picking τ.

Proposition 1.8 *Solving the government's problem returns the welfare maximizing level of capital income taxation as*

$$\tau^* = \begin{cases} 0 & if \quad \eta - 1 \le \frac{(1-\alpha)\left(1-\mu_\gamma\right)}{\alpha}, \\ 1 - \frac{1-\mu_\gamma}{\eta-\mu_\gamma} & otherwise. \end{cases} \tag{1.69}$$

The finding that a society may prefer a reduction in inequality at the expense of higher economic growth is analogous to the main findings of Cordoba and Verdier (2008). They show that individuals would give up from not all, but a large portion of their consumption growth to avoid being in an unequal environment. The harmful effects of inequality can even prevent a society from adopting growth-enhancing institutions since these institutions can foster inequality. Some additional remarks in order.

First, τ^* takes a positive value if either one of $\eta-1$ or α is sufficiently high. Note that $\eta-1$ is the size of the working class. (1.63) and (1.64) show that a larger working class increases r_t while decreasing w_t. In other words, the abundance of workers increases the income gap between the leisure and working classes. If the size of the working class is sufficiently high, taxing leisure class' earnings and redistributing the revenue among the workers can increase social welfare under strictly concave preferences.

Similarly, the relative income of the leisure class compared to workers increases with the elasticity of capital, α. If α is relatively high, it promotes a positive τ^* through the extensive margin, i.e., reducing the threshold level of $\eta - 1$.

Then, τ^* takes a positive value if μ_γ is sufficiently high. Status preferences create an additional incentive to accumulate and foster economic growth, thus have a positive income effect on both the leisure and worker classes by increasing the interest and wage rates. However, the relative wealth of each leisure class agent decrease with higher levels of average wealth. The status deprivation that higher average wealth cause can in turn reduce the individual welfare of some leisure class agents. In societies with stronger status preferences, τ^* can reverse the adverse effects of status-seeking behavior by preventing over-accumulation. Taxing capital income reduces the income of the leisure class, but can enhance their welfare depending on the magnitude of the adverse effects of status-seeking. On the other hand, redistributing the revenue among workers can increase their welfare if the transfer that a representative worker receives is higher than the decrease in her labor income (due to the decrease in wage rate), or *vice versa*.

1.6. CONCLUDING REMARKS

This chapter has embedded a status-seeking motive alongside a bequest motive to a basic endogenous growth model à la Romer (1986) and analyzed its implications on economic growth, welfare and wealth distribution. Strictly concave utility functions are assumed to characterize individual preferences, where consumption, social status, and bequests mattered. In parallel with Veblen's (1899) idea, an agent's asset stock relative to the average wealth determines her social status. Individuals also have a joy-of-giving kind of parental altruism.

The first result shows that the output growth is higher with stronger preferences for bequest and status. Under i.i.d. preferences, the sum of the average of both motives determines the saving rate of the economy. Both motives encourage households to accumulate wealth, which results in a higher balanced growth rate. However, the distribution of wealth does not affect the balanced growth rate. In the model setup of this chapter, agents save the same fraction of their income regardless of their relative position in the wealth distribution or how equal the distribution is. However, the factors affecting the wealth distribution and the balanced growth rate are the same. The wealth distribution is more equal and the balanced growth rate is higher with smaller elasticity of capital and higher average saving rate.

Second, striving to attain higher social status via accumulating more generates a negative externality on welfare. The externality causes a decrease in individual welfare due to deprivation of status that a higher average wealth causes. When the status preference is sufficiently strong, the externality can outweigh the positive income effect of wealth accumulation. The presence of status preferences is welfare-enhancing for households with relatively weak concerns for social status while being welfare-reducing for agents with strong status-seeking motives.

An extension of the model by introducing two separate classes of agents, namely the working and leisure classes, with within-group and between-group heterogeneities have further welfare and fiscal policy implications. The extended model shows that increasing social welfare is possible through redistributing the revenues from a flat tax on capital income among workers. Even if such tax reduces the balanced growth rate, it can increase total welfare under strictly concave utility functions, and is higher with a larger working class. In addition, a positive capital income tax can eliminate some part of the negative externality that status-seeking behavior generates. Thus, the optimum rate of tax is higher in societies with stronger status preferences.

Third, the variance of social status (and detrended wealth) in a society converges to a positive constant if the dispersion of the saving rates around its expected value is sufficiently small. The steady-state variance of detrended wealth, if it exists, is determined by the elasticity of capital, the average saving rate, and the dispersion of the preference parameters. The steady-state variance is higher with higher elasticity of capital and dispersion of preference parameters, and is lower with higher average saving rate. In addition, the upper tail of the steady-state detrended wealth distribution have a Pareto distribution under certain conditions. The Pareto distribution has fatter upper tails with greater elasticity of capital and smaller average saving rate meaning that relatively small portions of the society hold relatively larger fractions of the total wealth stock.

The basic model shows that heterogeneity in saving behavior results in persistent inequality. An extension of the model with human capital heterogeneity captures the effect of ex ante earning ability differences on the detrended wealth distribution at the steady state. Another extension with a flat capital income tax shows that under i.i.d. preferences, a redistributive tax on capital income is an efficient way to reduce persistent wealth inequality.

That is, such a tax may generate a more equal distribution without hindering economic growth.

This chapter has provided some explanations to the impacts of status preferences on economic growth, welfare and the wealth distribution in the long run. Investigating the dynamics of each economic aggregates and how they are distributed is essential to determine the sources of inequality. Considering the recent arguments in the literature on how economic inequality contributed to the Great Recession, tackling inequality should be on the agenda of policymakers in order to avoid another economic crisis. The model of this chapter has provided insights on how the social dimension of decision-making process affects the wealth distribution, alongside economic growth and welfare. Possible extensions of the model with endogenous labor supply decisions, differences in earning abilities or two-class societies with interclass transmission can be made to provide a deeper understanding on the dynamics of an economy where social motives have profound effects on decision-making. These extensions are left for future research.

CHAPTER 2

SOCIAL NORMS, FERTILITY, AND HUMAN CAPITAL ACCUMULATION

> "In general, the longer the habituation, the more unbroken the habit, and the more nearly it coincides with previous habitual forms of the life process, the more persistently will the given habit assert itself. The habit will be stronger if the particular traits of human nature which its action involves, or the particular aptitudes that find exercise in it, are traits or aptitudes that are already largely and profoundly concerned in the life process or that are intimately bound up with the life history of the particular racial stock."
>
> Veblen, [1899] 1922, p. 107-108

2.1. INTRODUCTION

The unified growth literature has been a promising research program because unified models provide a comprehensive understanding of the (very) long-run patterns of economic growth and development and explain the underlying causes of both development and underdevelopment. Specifically, unified growth models are useful to understand *why* societies experienced several millennia of stagnation, *why* the first Industrial Revolution occurred when it did and where it did, and *why* the developed societies of the present times experienced their growth take-offs earlier than others.

The basic narrative of development that the UGT of Galor (2005, 2011) proposes is as follows: The growing population offsets the effects of gradual developments in technology for a long period of Malthusian stagnation. Continuing productivity growth, however, lets the returns to human capital accumulation to reach a threshold level at some date. Households then start investing in human capital. They shift resources from quantity to quality of their children, i.e., from fertility to human capital, and this explains the decrease in the number of children, i.e., a demographic transition begins. The economy then experiences sustained economic growth.

The UGT emphasizes the central role that a fertility transition plays in the (very) long run. Galor (2005, 2011) asserts that the fertility transition is a prerequisite for initiating a take-off from a long period of stagnation to modern growth. The role of a voluntary decline in fertility on economic development is two-fold: First, the historical fertility decline breaks the Malthusian inverse relationship between living standards and the size of population *once and for all* since increasing income is not allocated to increase family sizes. Second, being accompanied by human capital investments, i.e., education and health investments, the fertility decline accelerates the accumulation and intergenerational transmission of knowledge, skills, and physical strength, that explain the gradual increases of long-run growth rates along the transition to modern growth. The simultaneous increases in human capital investments and the pace at which fertility declines, according to G. S. Becker (1960, 1981), and Willis (1973), are the outcome of the child Q-Q trade-off, i.e., the trade-off that parents face when deciding on the number of their children and the amount of education they receive. The majority of the UGT literature is based on the notion that "quality (education) seems like a close substitute for the quantity of the children" (G. S. Becker, 1960, p. 217). When human capital investment is activated, the economy enters into a virtuous circle where fertility continues to decline until it reaches the replacement level, and investment in human capital continues with perpetual growth.

2.1.1 Question and Motivation

This chapter seeks to answer *how the presence of fertility habits in the form of social norms affect the long-run path of an economy.* In particular, the chapter investigates (i) how social norms affect the child Q-Q trade-off, (ii) the role of social norms on an economy's development stages, and (iii) whether social norms are factors that can explain the prolonged stagnation of contemporary underdeveloped economies.

Despite the fact that roughly 250 years have passed since the occurrence of the very first Industrial Revolution, there are still many countries that that have yet to experience their own. Considering the essential role of accumulated knowledge when an economy initiates its take-off stage of development, and the technological diffusion through globalization over the last decades (see, e.g., Grossman and Helpman (2015)) it is inevitable to investigate the factors that continue to leave today's underdeveloped economies impoverished. The large number of underdeveloped economies that still cannot initiate a take-off despite relatively suitable conditions compared to the pre-industrial periods of today's developed economies is one source that motivates this chapter.

One crucial assumption largely sustained in the Q-Q trade-off and UGT literatures is that the agents are isolated from the environment they live in and not affected by social factors when they make reproductive decisions. This approach ignores the social dimension of human reproductive behavior and disregards the potential impacts that social relations and pressure can have on the decision-making processes. Veblen (1899) have argued that people can base their decisions on a certain reference stock, i.e., *the habit stock*, characterized by previous or current choices of the society. These habit stocks are more effective in decisions that have relatively higher social values. According to Montgomery and Casterline (1996), fertility is one of these decisions. In societies where there exist strong social ties among agents, i.e., where social interactions are more common in an agent's daily life, the interdependence in decision-making processes is stronger.

Some studies in the literature on the social roots of reproductive behavior demonstrate that fertility decisions are interdependent within a society.[11] Other studies emphasize the role that cultural heritage plays on fertility preferences and show that these preferences are transmitted across generations.[12] Particularly, Chabé-Ferret (2019) have illustrated that cultural heritage plays a particular role on fertility decisions, and the effect is partially reflected through religious beliefs. Given the crucial role of the child Q-Q trade-off on development, it is essential to address the forces that influence decisions on fertility and education as accurately as possible. The lack of precision of the isolated agent models on reproductive behavior, especially for societies where non-economic phenomena are more dominant, hinders the explanatory power of unified growth models.

2.1.2 Approach and Results

The recent studies of de la Croix and Perrin (2018) on the 19th century France and de la Croix and Delavallade (2018) on contemporary South-East Asia show that the social dimension of decision-making have had, and still has, a crucial role on shaping fertility preferences. In line with de la Croix and Perrin's (2018) assertion that social norms have significantly shaped the demographic transition of France, Prettner and Strulik (2017) argue that today's underdeveloped societies suffer from the religious (or cultural) norms that contribute to the persistence of high fertility and prevent the activation of the child Q-Q trade-off. This, in turn, leads to a situation in which countries where social norms have profound effects on decision-making are stuck in a low-growth equilibrium, with

[11] See Bernardi and Klärner (2014) for a survey.
[12] See Fernández and Fogli (2009) and T. E. Murphy (2015) for surveys.

high fertility and low education. Considering the fact that the UGT's primary goal is to explain the gradual transmission from prolonged stagnation to growth, the theory can be extended in a way that accounts for the influence of social norms on decision-making processes.

In order to capture the social aspect of reproductive behavior, this chapter constructs a discrete-time, representative agent, OLG model where social norms influence fertility. The model introduces a habit constraint on fertility that represents existing social norms that each generation faces. The constraint determines *the minimum number of children that a generation is "allowed to" have* and evolves over time with the decisions of each generation. The results show that strict conservatism in the form of complete obedience to social norms results in multiple equilibria (multiple separated steady-states). When the initial state of the model economy is historically correct, i.e., when the economy starts its evolution from a point with high fertility and low population, the economy gets stuck in a steady-state with stagnation or low economic growth. In both of these equilibria, social norms are binding in the long run.

Departing from the notion that religious norms influence fertility, this chapter extends the basic model with the process of secularization as well. For simplicity, secularization is introduced through a single structural parameter that reduces the social significance of religion on individuals' reproductive behavior. More specifically, secularization implies that individuals question the existing social norm on fertility and, hence, do not strictly obey the minimum fertility constraint. This extension enables the economy to converge to the high-growth asymptotic equilibrium where (i) social norms are not binding, and (ii) the population is stabilized at finite time. The degree of secularization and the historical persistence of social norms do not affect the asymptotic equilibrium but influence the transition process.

2.1.3 Outline

The outline of the chapter is as follows: Section 2.2 presents a discussion on related literatures and emphasizes the contributions of this chapter to these literatures. Sections 2.3 and 2.4 construct and solve the basic model, respectively, and 2.5 analyzes the steady-state growth rates. Section 2.6 introduces an extension of the basic model with secularization and analyzes the implications of this extension. Section 2.7 discusses the results of both the basic and extended models, and Section 2.8 concludes the chapter.

2.2. RELATED LITERATURE AND CONTRIBUTIONS

This chapter is related to the literatures on fertility choice, demographic transition, and the UGT. These literatures generally presume that people take reproductive decisions independent of social factors. This chapter challenges the individualistic approach to reproductive decision-making by introducing a social dimension, i.e., social norms. The inclusion of social norms to economic theory, as discussed by Burke and Young (2011), enriches theoretical predications that can be empirically tested.

The conventional theory assumes that rational agents are isolated from their social environment and make decisions solely on an economic basis. In contrast, a small body of theoretical literature argues that reproductive behavior of individuals do not depend only on economic factors as there are other social, cultural, or institutional forces influencing fertility (Mason, 1997). The works of Montgomery and Casterline (1996), Manski and Mayshar (2003), and Bernardi and Klärner (2014) discuss the non-negligible social dimension of fertility decisions and how its influence increases with the density of social relations, e.g., more market activity or increased social learning. Their discussions, to some extent, are based on the conflicting ideas of *homo economicus* and *homo sociologicus* and how private and social incentives jointly affect fertility. Moulasha and Rao (1999), Agadjanian (2001), Kohler, Behrman, and Watkins (2001), Iyer (2003), and Yeatman and Trinitapoli (2008) for underdeveloped or developing societies, and Bernardi (2003), Bernardi, Keim, and Von der Lippe (2007), and Hensvik and Nilsson (2010) for Western societies, provide evidence on how social interactions and culture affect fertility. The social influences on fertility are not only limited with the effects of social networks since legal institutions can also constrain fertility decisions. As Goldin and Katz (2002) discuss, the legal constraints on birth control significantly influence fertility, and the effects are stronger for younger adults. The goal of this chapter is to address the social influences on reproductive behavior through a theoretical framework and to show that an individualist rational-choice theory may really not be adequate to explain fertility choices, especially when social incentives are stronger.

This chapter, however, is not the first to form a theoretical model on social interactions and fertility. Akerlof (1997), Durlauf and Walker (2001), Kohler (2001), Bhattacharya and Chakraborty (2012), González-Bailón and Murphy (2013), and Spolaore and Wacziarg (2016) have formed micro-founded models where fertility is determined under social influences or interactions. This chapter contributes to this line of inquiry by introducing a model which captures the effects of social and economic incentives on fertility decisions. In order to do so, it induces a social norm constraint as in Montgomery and Casterline

(1996), which may or may not bind fertility in equilibrium.

The social influences on fertility are not only limited with the impact of socioeconomic factors, and a large literature studies the impacts of cultural heritage and religious norms and beliefs on reproduction. The early studies on the cultural transmission of fertility date back to Pearson, Lee, and Bramley-Moore's (1899) work that relates parents and their offspring's fertility choices. Later contributions, namely those of Leibenstein (1981), Hull (1983) Caldwell and Caldwell (1987), Caldwell, Orubuloye, and Caldwell (1992), and Bongaarts and Watkins (1996), have presented evidence that the cultural environment creates *habit formation* on fertility, especially in more traditional societies. These habits are intergenerationally transmitted.[13] In line with this literature, this chapter allows for historical persistence on fertility habits.

The chapter uses the typical formulation of the habit formation literature with endogenous growth, e.g., of Carroll, Overland, and Weil (1997, 2000), Fuhrer (2000), de la Croix (2001), Alvarez-Cuadrado et al. (2004), Ikefuji (2008), Gómez (2010), and de la Croix and Gosseries (2012). The model of this chapter adopts its basic features from de la Croix and Gosseries (2012) except the habit stock. The habit stock introduced is related to the consumption aspirations in de la Croix and Michel (1999) and de la Croix (2001). Specifically, the habit stock imposes a lower bound to the choice of each generation and evolves over time depending on the previous generation's decisions and the historical levels of the habit stock.

The literature on the impact of religious beliefs and norms is large enough to be addressed separately from that of the social norms. Janssen and Hauser (1981), Williams and Zimmer (1990), Adsera (2006), and Frejka and Westoff (2008) for Western societies, and G. W. Jones, Douglas, Caldwell, and D'Souza (1998), Munshi and Myaux (2006), Heaton (2011), and Gyimah, Adjei, and Takyi (2012) for underdeveloped economies show that religiosity positively affects fertility. The contribution of this chapter on fertility-religion nexus is through underlining the role of secularization. Analogous to the positive relationship between fertility and religiosity, Lesthaeghe (1977), van Poppel (1985), Lesthaeghe and Wilson (1986), Hacker (1999), van Bavel and Kok (2005), and Derosas and van Poppel (2006) have shown how secularization caused a fertility decline in Western societies. Baudin (2015), T. E. Murphy (2015), Spolaore and Wacziarg (2016), and de la Croix and Perrin (2018) have provided further evidence on how the initiation and diffusion of secularization affected the fertility of Western Europe from the 19th century onward. The analysis of this chapter stresses the role of secularization by showing that (i) strict or high

[13] See, e.g., Blau (1991), Gjerde and McCants (1995), Fernández and Fogli (2006, 2009) for empirical works on immigrants.

degrees of conservatism results in sustained high fertility and (ii) secularization is essential for a stabilized population size. The analysis of this chapter interprets secularization as the declining significance of religious norms in social life as in Strulik (2016).

A major contribution of this chapter is on the discussions related to the fertility decisions and demographic transition. One strand of the literature on fertility decisions, building on the works of Boldrin and Jones (2002) and Boldrin, De Nardi, and Jones (2005), asserts that parents see children as "investment goods" for old age. The models in this literature put the parents' utility as an argument in the utility function of the children, which, in turn, encourage parents base their fertility decisions on old age transfers. Consequently, this literature argues that the demographic transitions of today's developed economies followed increases in government-provided old-age pensions.

This chapter contributes to another strand of the literature on fertility decisions; the child Q-Q trade-off literature. The negative relation between fertility and education is well known and has been discussed by some seminal works such as those of G. S. Becker (1960, 1981), Willis (1973), Barro and Becker (1989), and K. M. Murphy, Simon, and Tamura (2008). A large body of literature, including but not limited to G. S. Becker et al. (1990), Azariadis and Drazen (1993), Kremer (1993), Galor and Weil (1996), and Tamura (1996), has underlined the role that the child Q-Q trade-off plays for development and growth. This chapter attempts to build a complementary explanation and narrative to the child Q-Q trade-off. The model formed here shows that social incentives, if they are strong enough, may prevent such a trade-off even if economic incentives favor otherwise. This result has important implications, especially for today's underdeveloped countries where high fertility and low education persist. The standard child Q-Q trade-off theory argues that high fertility with low education rates is an outcome of rational decision-making and low returns to education. This chapter, however, shows that social norms can prevent education investments in the case that education would have yielded high enough returns if social norms were not present. This result is particularly important for analyses of cross-country variations in education and labor quality.[14] Though it does not suggest that social norms *per se* can explain all the variations in human capital, that social norms force agents to allocate a significant part of their income on childbearing can have profound effects on human capital accumulation.

Consequently, an alternative approach to the child Q-Q trade-off has natural implications on and contributions to the development and unified growth literatures. Several poverty trap models have sought to explain the mechanisms that keep an economy trapped in

[14] See, e.g., Bils and Klenow (2000), Hendricks (2010, 2016), Córdoba and Ripoll (2013), and Manuelli and Seshadri (2014) for some notable empirical works.

a stagnation equilibrium; K. M. Murphy et al. (1989) on industrial demand spillovers, G. S. Becker et al. (1990) on the child Q-Q trade-off, Azariadis and Drazen (1990) on human capital externalities, and Matsuyama (1991) on increasing returns in manufacturing industry. This chapter provides a model where the presence of social norms creates multiple-equilibria where strict conservatism can result in prolonged stagnation. The poverty trap models, however, do not explore the mechanisms that explain the endogenous transition from Malthusian stagnation to perpetual growth. Some later contributions, e.g., Tamura (1996) on the role of increasing returns to human capital investment, Arifovic et al. (1997) on the role of adaptive learning, and Acemoglu and Zilibotti (1997) on the role of financial institutions that allow for risk diversification, have focused on the transition dynamics. However, these works have not addressed the endogenous occurrence of the demographic transition. This chapter contributes to this line of thought through underlining the role of secularization on the transition from stagnation to growth.

The unified growth literature, so far, has proposed models focusing on different factors; Galor and Weil (2000), C. I. Jones (2001), Galor and Moav (2002), and Galor (2005, 2011) on human capital, Kögel and Prskawetz (2001), Hansen and Prescott (2002), and Strulik and Weisdorf (2008) on productivity growth in agriculture and industry, Kalemli-Özcan (2002), Lagerlöf (2003), and Weisdorf (2004) on mortality, Doepke (2004) on child labor, Tamura (2002) on coordination costs, Connolly and Peretto (2003), Strulik, Prettner, and Prskawetz (2013), and Attar (2015) on R&D expenditures, and Strulik (2017) on the use of contraceptives. That a take-off from stagnation is inevitable through a fertility transition and resource mobilization is the common point of all these models. On the contrary, this chapter shows that once fertility habits are introduced into a unified growth framework and if the model economy's initial state is historically accurate, a fertility transition only occurs in the presence of secularization. Furthermore, the model shows that how secular a society is determines the duration of the stagnation period.

The analyses on traditions, religious norms, secularization, and development in this chapter are closely related to a few other studies, namely those of Strulik's (2016) and Prettner and Strulik's (2017). Strulik (2016) underlines the role that secularization has played for the sustained growth of contemporary developed economies. This chapter defines secularization similar to Strulik's (2016) definition, i.e., the diminishing role of religious norms in social life. However, this chapter differs from Strulik (2016) by defining the channels by which secularization affects the decision-making processes and economic development. Strulik (2016) argues that secularized individuals derive more pleasure from consumption and have further incentives to earn more and accumulate. Higher income levels make secular identity more appealing to following generations, generating a virtuous cycle between secularization and economic development. This chapter neither assumes a bicausal relationship between a secular identity and income nor relates secularization with consumption. It shows that when religious norms favor higher fertility, their strong influence on social life, i.e., via social norms, can constrain resource allocation and prevent development unless they are abandoned, e.g., through secularization. The approach of this model to social norms is similar to that of Prettner and Strulik's (2017). Prettner and Strulik (2017) associate social norms—or religious norms—with fertility through contraceptive usage and find multiple equilibria with either high fertility with stagnation or low fertility and economic growth. In their context, societies with norms that prevent contraceptive usage tend to get stuck to the low growth equilibrium and can only escape with the collective efforts of individuals. The results of both models (the model of this chapter and Prettner and Strulik's (2017)) are analogous, but this chapter, unlike Prettner and Strulik (2017), investigates the direct influence of social norms on fertility through a habit constraint. Moreover, this chapter offers an extension with secularization that allows the economy to converge to an asymptotic equilibrium where growth is perpetual and social norms are no longer binding.

2.3. THE MODEL ECONOMY

This section introduces the model environment (demographics, endowments, preferences, and technologies), market structures, and decision problems.

The model time t is discrete and has an infinite horizon. The economy is closed and produces a single consumption good using raw labor and skills. The average skill endowment of population is represented by human capital, i.e., a stock variable that expands through education investments.

There exist two overlapping generations in the model, adults and children. Fertility is chosen optimally by adults. Time is an input in reproduction.

The basic model consists of three endogenous state variables that evolve in time. These variables at t are

- the measure N_t of the adult population,
- the stock h_t of the human capital of adults, and
- the habit stock x_t of fertility that represents the social norms on reproductive behavior.

The values of these three variables at each subsequent period are determined through the choices of adults in period t; see Figure 5.

2.3.1 The Demographic Structure

Reproduction is asexual and completed at the beginning of each period. Both fertility and population are assumed to be real numbers for simplicity. In childhood, agents are passive; they have no resources and take no decisions. In adulthood, they reproduce, they work, and they take a decision towards the education of their children.

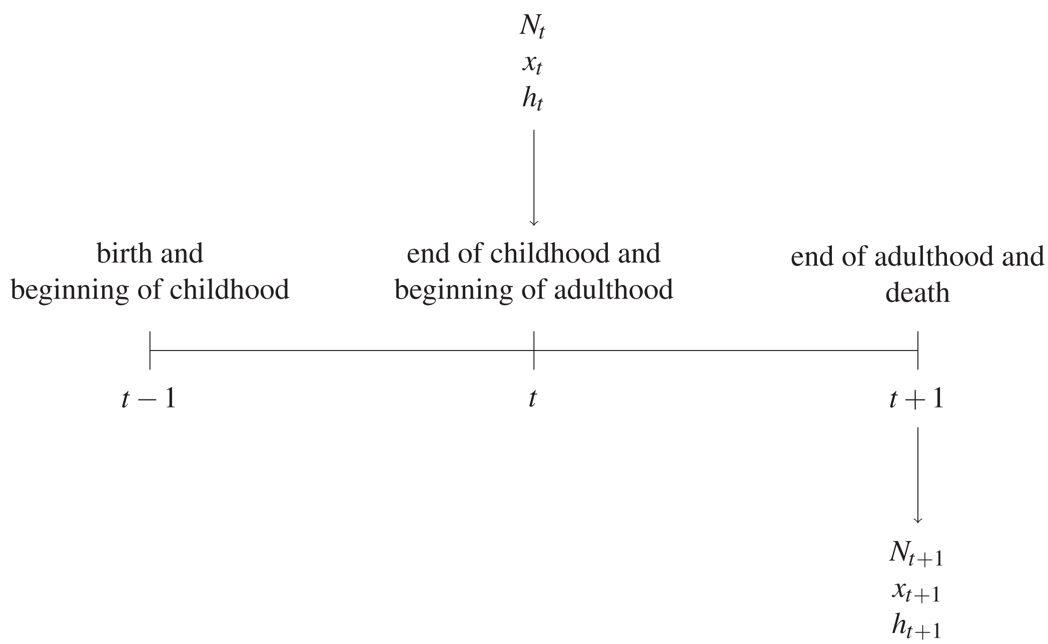

Figure 5: The Lifespan of Generation t and the Evolution of the State Variables
Note: Adult population of generation t is born at $t-1$. They live their childhood from $t-1$ to t. Their adulthood begins at t. Adults at t take N_t, x_t, and h_t as given at the beginning of t. Their decisions on fertility and the education of their children shape the state variables for the next period, i.e., at $t+1$.

Let $n_t \in \mathbb{R}_{++}$ denote the level of net fertility chosen by adults at the beginning of period t. Since adult individuals are identical, n_t represents the average fertility of generation t. The initial adult population $N_0 > 0$ is exogenously given and N_t's law of motion is simply

$$N_{t+1} = n_t N_t. \tag{2.1}$$

2.3.2 Endowments

The duration of each period is normalized to unity. Adults have one unit of time and their human capital endowments. They allocate their time endowment to labor supply $ł_t$ and childbearing ζ_t.

At t, the human capital endowment of each adult is denoted by h_t and is determined by the education investment e_{t-1} of their parents in the previous period. The human capital endowment h_0 of initial adults is exogenously given and normalized to unity.

2.3.3 Preferences

Adults derive their (lifetime) utility from their consumption (c_t), the number of their children (n_t), and the quality of their children (h_{t+1}). The utility function that represents these preferences is homothetic and strictly concave as in de la Croix and Gosseries (2012) but leisure is excluded since the present analysis does not focus on the labor-leisure choice. The utility function reads

$$U\left(c_t, n_t, h_{t+1}\right) = \ln\left(c_t\right) + \gamma \ln\left(n_t h_{t+1}\right), \tag{2.2}$$

where $\gamma > 0$ represents *parental altruism*. Parents gain utility from both the number, i.e., quantity, and the future consumption prospects, i.e., quality, of their children. The latter is known as the joy-of-giving property of preferences, i.e., impure altruism as in Andreoni (1989). Unlike the case in dynastic altruism, the parent's utility function does not contain their children's utility as an argument.

The model follows Montgomery and Casterline (1996) and introduces social norms on reproductive behavior. Similar to the consumption aspirations of de la Croix and Michel (1999) and de la Croix (2001), an agent must choose a level of fertility n_t under the restriction that it has a lower bound which represents the habit stock (x_t) of fertility, i.e.,

$$n_t \geq x_t. \tag{2.3}$$

A regularity assumption dictates that both n_t and x_t remain lower than the maximum fecundity of an agent ($\bar{x}$), i.e., the maximum number of children she can biologically have. Let $n_t, x_t < \bar{x}$ denote the fecundity constraint.

As in the case of continuous time models of Carroll et al. (1997, 2000), Alvarez-Cuadrado et al. (2004), Gurdgiev (2005), Ikefuji (2008), and Gómez (2010), and the discrete-time models of Abel (1990), Fuhrer (2000), and Diaz, Pijoan-Mas, and Rios-Rull (2003), the habit stock of the next period x_{t+1} is the weighted average of x_t and n_t as in

$$x_{t+1} = \psi x_t + (1-\psi) n_t, \tag{2.4}$$

where $\psi \in (0,1)$ is a fixed parameter that governs the role of historical persistence. Higher values of ψ reflect stronger degrees of influence of the past on the present.

2.3.4 Technologies

This subsection introduces the technologies within the model. These technologies are those of production, reproduction, and human capital formation.

2.3.4.1 Production Technology

The production technology is linear in raw labor augmented with human capital where labor suppliers are identical households. The total production of a firm j in the economy at t satisfies

$$y_{j,t} = \ell_{j,t} h_t. \tag{2.5}$$

2.3.4.2 Reproduction Technology

Adult individuals need to spend ζ_t amount of nursing time for each children where we have

$$\zeta_t = \begin{cases} \theta N_t^{\alpha} & if \quad N_t < \bar{N}, \\ \bar{\zeta} & otherwise. \end{cases} \tag{2.6}$$

Here, $\bar{N}$ is some sufficiently large population size such that ζ_t converges to $\bar{\zeta}$ if the population size exceeds $\bar{N}$.[15]

Childbearing cost, as in de la Croix and Gosseries (2012), is a function of the population size relative to the land. Land is fixed and implicitly taken into account through $\theta > 0$.[16]

[15] Assume that, even if $x_t = \bar{x}$ and $\zeta_t = \bar{\zeta}$, i.e., the society dictates the maximum possible nursing time from the domains of ζ_t and x_t, $\bar{\zeta}\bar{x} < 1$ so that the agents can still allocate time to labor supply. This is a trivial requirement for the existence of a SGE for all (ζ_t, x_t) pairs.

[16] The available land is accessible for all agents, i.e., there are no property rights on land.

The introduction of land per capita to the childbearing cost catches the additional costs of having smaller dwelling areas in child making process.[17] The curvature parameter $\alpha \in (0,1)$ reflects the importance of population density on childbearing cost. ζ_t is increasing and concave in N_t, with $\bar{\zeta} < 1$ being its upper bound. It is plausible to assume that, after the population size reaches a certain level, the nursing time required to spend on a single child does not change and remains constant for the higher levels of N_t.

2.3.4.3 Human Capital Formation

There are internal and external sources of human capital formation. Children get their internal education through living with their parents and acquiring their skills (h_t). They are also educated through formal schooling where e_t denotes the education expenditure for each child. Accordingly, h_{t+1} depends on h_t and e_t and satisfies

$$h_{t+1} = \tau (e_t + \sigma)^{\eta} h_t^{1-\eta}, \tag{2.7}$$

with

$$\sigma = \left(\frac{1}{\tau}\right)^{\frac{1}{\eta}}.$$

The parameter $\eta \in (0,1)$ denotes the weight of the education expenditure on human capital formation. Larger values of η imply greater returns to education. The scaling parameter $\tau > 0$ is large enough to sustain long-run economic growth through human capital accumulation.[18]

The parameter $\sigma > 0$ is a modified version of the initial productive skill endowment of children in G. S. Becker et al. (1990) and the informal education constant of Strulik et al. (2013). Specifically, it represents the implicit learning that children unintentionally acquire from their parents even if they do not receive formal education. The functioning of σ is to generate initial periods of stagnation with $e_t = 0$ where the human capital stock remains fixed. That is, when initial adults choose not to invest in human capital, i.e., $e_0 = 0$, the human capital stock in the next period is the same with that of the initial period, i.e.,

[17] See the early works of Goodsell (1937) and Thompson (1938) for the linkage between dwelling areas and childbearing costs.

[18] Specifically, the model economy requires

$$\tau > \left(\frac{1+\gamma}{\gamma\eta}\right)^{\eta}$$

to converge to an equilibrium where $e_t > 0$.

$h_0 = h_1 = 1$. The parental decision to invest only on the quantity of children is consistent with the "Malthusian epoch", i.e., relatively insignificant technological progress over a long period, as in Galor (2011). Therefore, by allowing agents to choose either zero or positive levels of education expenditure depending on the state vector, the model is able to capture an economy's long periods of stagnation and its transition to sustained growth. The latter is the main feature of unified growth models.

2.3.5 Market Structures

There are identical workers and firms.

Workers supply their work hours for firms and purchase the consumption good. They can either consume the good for their own satisfaction, c_t, or allocate it for the education of their children, $e_t n_t$.

There exists a unit mass of identical firms. There is only one type of consumption good in the economy, and each firm produces this good by employing effective labor $\ell_{j,t} h_t$.

Both labor and goods markets are perfectly competitive. The consumption good is the numéraire. Firms demand labor hours supplied by workers at wage w_t.

2.3.6 Decision Problems

This subsection demonstrates the optimization problems in the model economy. These problems are those of the representative firm's and the representative agent's.

2.3.6.1 The Firm's Problem

The representative firm j chooses the amount of labor to employ ($\ell_{j,t}$) to maximize the profit defined as in

$$\Pi_{j,t} = y_{j,t} - w_t \ell_{j,t}. \tag{2.8}$$

Substituting (2.5) in (2.8), the firm's problem reduces into

$$\max_{\ell_{j,t}} \quad \Pi_{j,t} = \ell_{j,t} h_t - w_t \ell_{j,t} \tag{2.9}$$

and its interior solution necessitates the unique equilibrium condition of

$$h_t = w_t. \tag{2.10}$$

2.3.6.2 The Worker's Problem

Given (2.5), (2.6), and (2.10), the representative worker maximizes (2.2) subject to the habit constraint (2.3), the budget constraint

$$c_t + n_t e_t = l_t h_t, \tag{2.11}$$

and the time constraint

$$l_t + \zeta_t n_t = 1. \tag{2.12}$$

Equivalently, after substituting (2.11) and (2.12) in (2.2), the worker's problem reduces into

$$\begin{aligned} \max_{n_t, e_t} \quad & \ln\left[(1-\zeta_t n_t)\, h_t - n_t e_t\right] + \gamma \ln(n_t) + \gamma\eta \ln(e_t + \sigma) + \rho_t \\ \text{subject to} \quad & x_t \leq n_t \end{aligned} \tag{2.13}$$

where

$$\rho_t = \gamma \ln(\tau) + \gamma(1-\eta)\ln(h_t)$$

is exogenously given.

2.3.7 Market Clearing Conditions

The following equations define the market clearing conditions for the goods and labor markets. For each market, the left-hand and right-hand sides denote the quantities supplies and demanded, respectively.

The goods market clearing condition is

$$\int_0^1 y_{j,t} \mathrm{d}j = N_t (c_t + e_t n_t) \tag{2.14}$$

and the labor market clears via

$$N_t l_t = \int_0^1 \ell_{j,t} \mathrm{d}j. \tag{2.15}$$

2.4. EQUILIBRIUM

This section has two parts. The first part defines the static equilibrium of the model. Then, it follows with the definition of the dynamic equilibrium.

2.4.1 Static General Equilibrium

Definition 2.1 *A SGE for $t \in \{0, 1, ...\}$ is a collection*

$$\{c_t, l_t, n_t, e_t, y_t, \ell_{j,t}, y_{j,t}\}$$

of quantities and a relative price w_t of labor such that, given the state vector $\mathbf{z}_t \equiv (\zeta_t, x_t, h_t)$,

- *(c_t, l_t, n_t, e_t) solves the worker's problem* (2.13)*,*
- *$\ell_{j,t}$ solves the firm's problem* (2.9)*,*
- *the goods market clears via* (2.14)*,*[19] *and*
- (2.3)*,* (2.5)*,* (2.10)*,* (2.11)*, and* (2.12) *are satisfied.*

Proposition 2.1 *A unique SGE of the model exists with $n_t \geq x_t$, $e_t \geq 0$ and $\ell_{j,t} > 0$. Depending on the state vector $\mathbf{z}_t$, the SGE features either*

- *Regime 1: $n_t = x_t$ and $e_t = 0$,*
- *Regime 2: $n_t > x_t$ and $e_t = 0$,*
- *Regime 3: $n_t = x_t$ and $e_t > 0$, or*
- *Regime 4: $n_t > x_t$ and $e_t > 0$.*

Proposition 2.1 shows that, for any given h_t, the regime that the model economy operates in depends on the position of $\zeta_t x_t$ with respect to several threshold levels. That is, the key variable of the model is the amount of necessary nursing time in the case of binding social

[19] The labor market clearing condition (2.15) is satisfied via Walras' Law.

norms. The threshold levels for $\zeta_t x_t$ are defined as

$$\begin{aligned}
\Gamma &\equiv \frac{\gamma}{1+\gamma}, \\
\Xi_t &\equiv \frac{\sigma x_t}{\eta h_t}, \\
\Theta_t &\equiv 1-\frac{\sigma x_t}{\gamma\eta h_t}, \\
\Phi_t &\equiv \frac{\gamma(1-\eta)}{1+\gamma}+\frac{\sigma x_t}{h_t}.
\end{aligned} \tag{2.16}$$

Corollary 2.1 *Education and fertility decisions depend on the threshold levels of $\zeta_t x_t$ such that*

$$e_t = e(\mathbf{z}_t) = \begin{cases} 0 & if \quad \zeta_t x_t \geq \Theta_t \quad and \quad \zeta_t x_t \geq \Gamma, \\ 0 & if \quad \zeta_t x_t \leq \Xi_t \quad and \quad \zeta_t x_t < \Gamma, \\ \frac{\gamma\eta(1-\zeta_t x_t)h_t}{(1+\gamma\eta)x_t} - \frac{\sigma}{1+\gamma\eta} & if \quad \zeta_t x_t < \Theta_t \quad and \quad \zeta_t x_t \geq \Phi_t, \\ \frac{\eta\zeta h_t-\sigma}{1-\eta} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \Phi_t, \end{cases} \tag{2.17}$$

and

$$n_t = n(\mathbf{z}_t) = \begin{cases} x_t & if \quad \zeta_t x_t \geq \Theta_t \quad and \quad \zeta_t x_t \geq \Gamma, \\ \frac{\gamma}{(1+\gamma)\zeta_t} & if \quad \zeta_t x_t \leq \Xi_t \quad and \quad \zeta_t x_t < \Gamma, \\ x_t & if \quad \zeta_t x_t < \Theta_t \quad and \quad \zeta_t x_t \geq \Phi_t, \\ \frac{\gamma(1-\eta)h_t}{(1+\gamma)(\zeta_t h_t-\sigma)} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \Phi_t. \end{cases} \tag{2.18}$$

Corollary 2.1 directly follows from the proof of Proposition 2.1. Since $\zeta_t x_t$ is the amount of necessary nursing time if the social norms on fertility are binding, it is related with the concept of "potential income" in Galor and Weil (2000). Here, $\zeta_t x_t$ determines the potential time that agents can allocate to labor supply. The conditions for each regime defined in Proposition 2.1 are summarized in Table 1.

The conditions are rather complicated because both e_t and n_t are endogenous and depend on separate threshold levels of $\zeta_t x_t$. Investigating these regimes through the benchmark cases where social norms are binding and non-binding is helpful to understand the logic of each regime.

Table 1: SGE Regimes

Regime	Conditions	Education	Fertility
1	$\zeta_t x_t \geq \Theta_t$ and $\zeta_t x_t \geq \Gamma$	$e_t = 0$	$n_t = x_t$
2	$\zeta_t x_t \leq \Xi_t$ and $\zeta_t x_t < \Gamma$	$e_t = 0$	$n_t > x_t$
3	$\zeta_t x_t < \Theta_t$ and $\zeta_t x_t \geq \Phi_t$	$e_t > 0$	$n_t = x_t$
4	$\zeta_t x_t > \Xi_t$ and $\zeta_t x_t < \Phi_t$	$e_t > 0$	$n_t > x_t$

2.4.1.1 Binding Social Norms

When the social norms are binding, i.e., $n_t = x_t$, the representative agent cannot substitute between fertility and education. The level of $\zeta_t x_t$ determines labor supply and income. The only trade-off that the adult agent encounters is the one where she determines how to spend her income, i.e., choosing between consumption and education expenditure.

The fact that children build some level of basic human capital even if they do not get formal education implies that the marginal utility derived from education expenditure does not go to infinity when education expenditure goes to zero. Therefore, whether children receive formal education at optimum depends on how large the level of income is. More specifically, the agent allocates $\zeta_t x_t$ amount of her time to childbearing and the remaining to labor supply. Since social norms determine the exact amount of time she can allocate to labor supply through x_t, the level of income is equal to $(1 - \zeta_t x_t)h_t$. Whether this income level would allow for positive education expenditure at optimum depends on $\zeta_t x_t$'s relative position to the threshold Θ_t. When $\zeta_t x_t$ is below the threshold level, her income is sufficiently large to promote human capital investment. That is, if $\zeta_t x_t < \Theta_t$, i.e., if her labor supply is sufficiently high, she earns enough income to allow for spending on education. On the contrary, if $\zeta_t x_t \geq \Theta_t$, i.e., her labor supply is sufficiently low, she does not earn enough income to spend on education.

The level of human capital creates an income effect that allows for positive education expenditure at optimum. The agent's income increases with her human capital. The threshold Θ_t becomes less stringent with higher levels of human capital, i.e., positive education expenditure becomes optimum for relatively small labor supply levels.

2.4.1.2 Non-Binding Social Norms

In the case that social norms are not binding, i.e., $n_t > x_t$, the agent faces the child Q-Q trade-off. Unlike the case under binding social norms, the agent prefers to invest in quantity over quality or *vice versa*. Now, the childbearing cost (i.e., the cost of having children) determines the agent's choices on the number and education of children.

Under non-binding social norms, if the unit childbearing cost in terms of nursing time, denoted by ζ_t, is sufficiently low to imply $\zeta_t x_t \leq \Xi_t$, investing in the quantity of children at the expense of education yields higher utility to the parent.[20] Parents choose not to educate their children due to the low cost of childbearing, i.e., the "price" of having a child being small. Likewise, the agent chooses to have fewer but educated children at the expense of having more if the unit childbearing cost is sufficiently high, i.e., $\zeta_t x_t > \Xi_t$. Since having children is too costly in this case, agents prefer to allocate their time more on labor supply and invest in the education of their children.

An important note is on the relative positions of threshold levels of $\zeta_t x_t$ and their values for a large h_t. Let $\tilde{x}_t$ denote a particular level of fertility habit stock defined as in

$$\tilde{x}_t \equiv \frac{\gamma \eta h_t}{(1+\gamma)\,\sigma}. \tag{2.19}$$

Lemma 2.1 *The relative positions of thresholds Γ, Ξ_t, Θ_t, and Φ_t change depending on whether x_t is smaller than $\tilde{x}_t$ or not. Specifically, we have*

- $x_t < \tilde{x}_t \Leftrightarrow \Xi_t < \Phi_t < \Gamma < \Theta_t$, *and*
- $x_t > \tilde{x}_t \Leftrightarrow \Theta_t < \Gamma < \Phi_t < \Xi_t$.

$\tilde{x}_t$ is linear in h_t and goes to infinity when h_t goes to infinity. Since x_t remains below the maximum fecundity level $\bar{x}$, x_t always remains below $\tilde{x}_t$ when h_t goes to infinity. Furthermore, when h_t goes to infinity, the threshold levels Ξ_t and Θ_t converge to minimum and maximum levels of their domains where

$$h_t \to +\infty \Rightarrow \Xi_t \to 0 \quad \textit{and} \quad \Theta_t \to 1$$

which implies that $\zeta_t x_t$ always remain below Θ_t and above Ξ_t for $h_t \to +\infty$.

Figure 6 pictures the configurations defined in Lemma 2.1. The conditions for Regimes 3 and 4 cannot be satisfied when x_t is greater than $\tilde{x}_t$, i.e., Regimes 3 and 4 do not exist

[20] Note that both $\zeta_t x_t$ and the threshold Ξ_t are linear in x_t. Therefore, when social norms are not binding, the condition on whether to educate children or not does not depend on x_t.

for $x_t > \tilde{x}_t$. Lemma 2.1 also shows that when h_t goes to infinity, $\tilde{x}_t$ also goes to infinity, implying that x_t remains below $\tilde{x}_t$ for the remaining history. Furthermore, the thresholds Θ_t and Ξ_t converge to 1 and 0, respectively, when the level of human capital goes to infinity, indicating that $\zeta_t x_t$ cannot be above Θ_t or below Ξ_t. This suggests that Regimes 1 and 2 where education expenditure is zero do not exist for a sufficiently high level of human capital. The basic reason why Regimes 1 and 2 vanish is that higher levels of human capital generate higher levels of income given $\zeta_t x_t$.

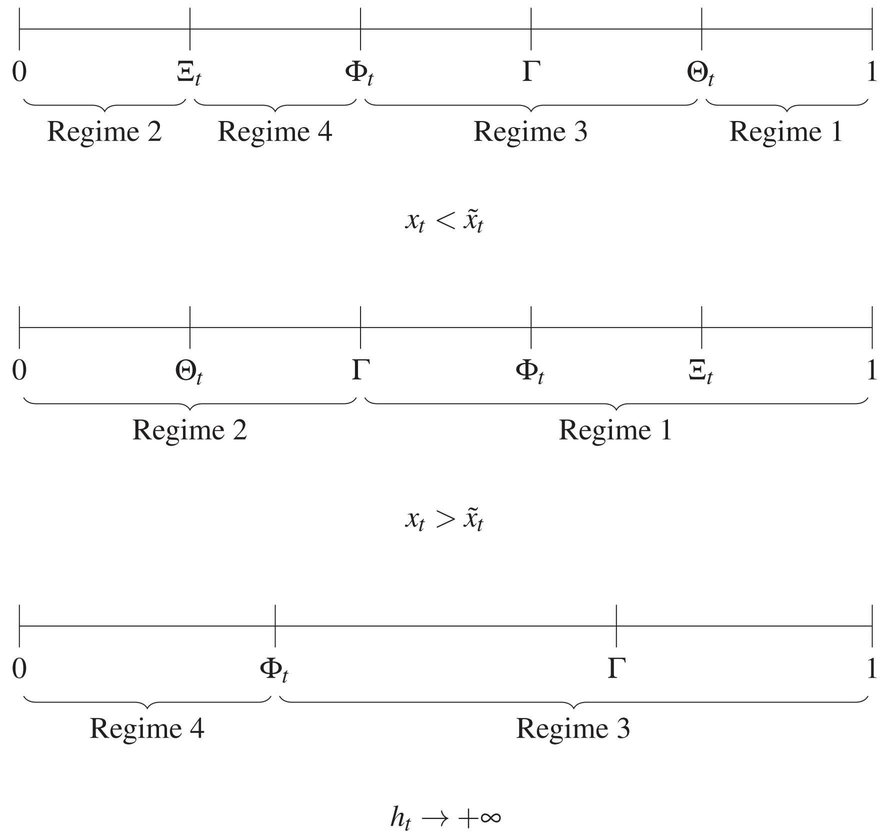

Figure 6: $\zeta_t x_t$ Intervals for Regimes 1, 2, 3 and 4

2.4.2 Dynamic General Equilibrium

The definition of a DGE necessitates to specify the evolution of the state vector $\mathbf{z}_t$. The laws of motion for x_t and h_t are (2.4) and (2.7), respectively. Deriving the law of motion for ζ_t requires iterating (2.6) as in

$$\zeta_{t+1} = \begin{cases} \theta N_{t+1}^{\alpha} & if \quad N_t < \bar{N}, \\ \bar{\zeta} & otherwise. \end{cases}$$

Substituting N_{t+1} with $n_t N_t$ from (2.1), the law of motion for ζ_t is obtained as

$$\zeta_{t+1} = \begin{cases} \theta N_t^{\alpha} n_t^{\alpha} & if \quad N_t n_t < \bar{N}, \\ \bar{\zeta} & otherwise. \end{cases} \tag{2.20}$$

Definition 2.2 *Given the vector of initial values, $\mathbf{z}_0 \in \mathbb{R}_+^3$, a DGE of the model economy for the entire history is a sequence of SGEs satisfying* (2.20)*,* (2.4)*, and* (2.7) *together with the sequences $\{\zeta_t, x_t, h_t\}_{t=1}^{+\infty}$.*

Proposition 2.2 *A DGE exists and is unique.*

2.5. RESULTS

This section has three parts. The first part shows the conditional dynamic systems under which the model operates. The second part demonstrates the steady-states, and the last part illustrates the economy's transition path towards either steady state when its initial state is historically accurate.

2.5.1 Conditional Dynamical Systems

This subsection shows the conditional dynamic systems under which the model operates under each regime. The future values $(\zeta_{t+1}, x_{t+1}, h_{t+1})$ of state variables depend on e_t and n_t that in turn depend on (ζ_t, x_t, h_t) in general; see Propositions 2.1 and 2.2. Thus, a general conditional dynamical system of (ζ_t, x_t) conditional on h_t determines the behavior of the model for each time period as in, e.g., Galor and Weil (2000), Galor and Moav (2002), and Attar (2015).

Lemma 2.2 *There exists a conditional dynamical system of (ζ_t, x_t) satisfying*

$$\frac{\zeta_{t+1}}{\zeta_t} = \begin{cases} n(\mathbf{z}_t)^{\alpha} & if \quad N_t < \bar{N} \\ \bar{\zeta} & otherwise \end{cases}, \text{ and} \tag{2.21}$$

$$\frac{x_{t+1}}{x_t} = \psi + (1-\psi)\frac{n(\mathbf{z}_t)}{x_t}. \tag{2.22}$$

Figures 7, 8, 9, and 10 capture the global dynamics of ζ_t and x_t on (ζ_t, x_t) plane for each regime.

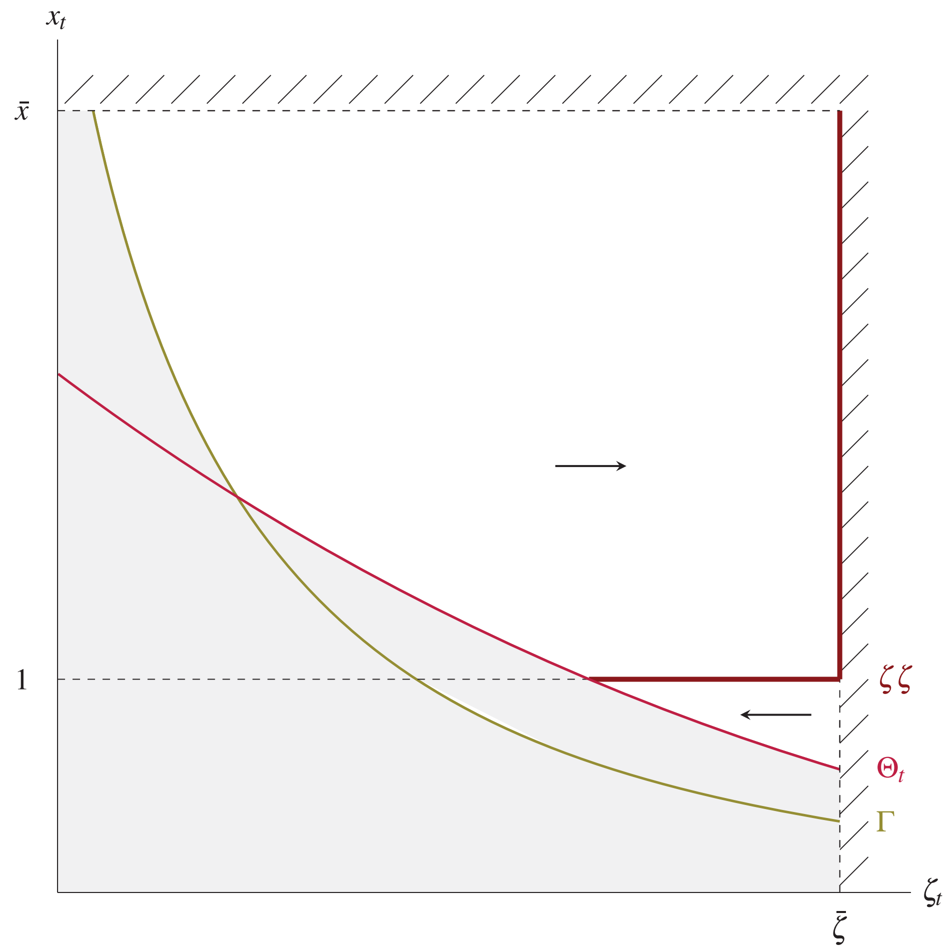

Figure 7: (ζ_t, x_t) Dynamics in Regime 1

Note: This figure pictures (ζ_t, x_t) dynamics for Regime 1 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 1. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 1 are excluded.

Now, define the xx-locus using (2.22) for given h_t as

$$xx = \{(\zeta_t, x_t) : x_{t+1} = x_t\}, \tag{2.23}$$

which, as follows from (2.20), satisfies

$$x_{t+1} = x_t \Leftrightarrow x_t = \begin{cases} (0, \bar{x}] & if \quad \zeta_t x_t \geq \Theta_t \quad and \quad \zeta_t x_t \geq \Gamma, \\ \frac{\gamma}{(1+\gamma)\zeta_t} & if \quad \zeta_t x_t \leq \Xi_t \quad and \quad \zeta_t x_t < \Gamma, \\ (0, \bar{x}] & if \quad \zeta_t x_t < \Theta_t \quad and \quad \zeta_t x_t \geq \Phi_t, \\ \frac{\gamma(1-\eta)h_t}{(1+\gamma)(\zeta_t h_t - \sigma)} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \Phi_t \end{cases} \tag{2.24}$$

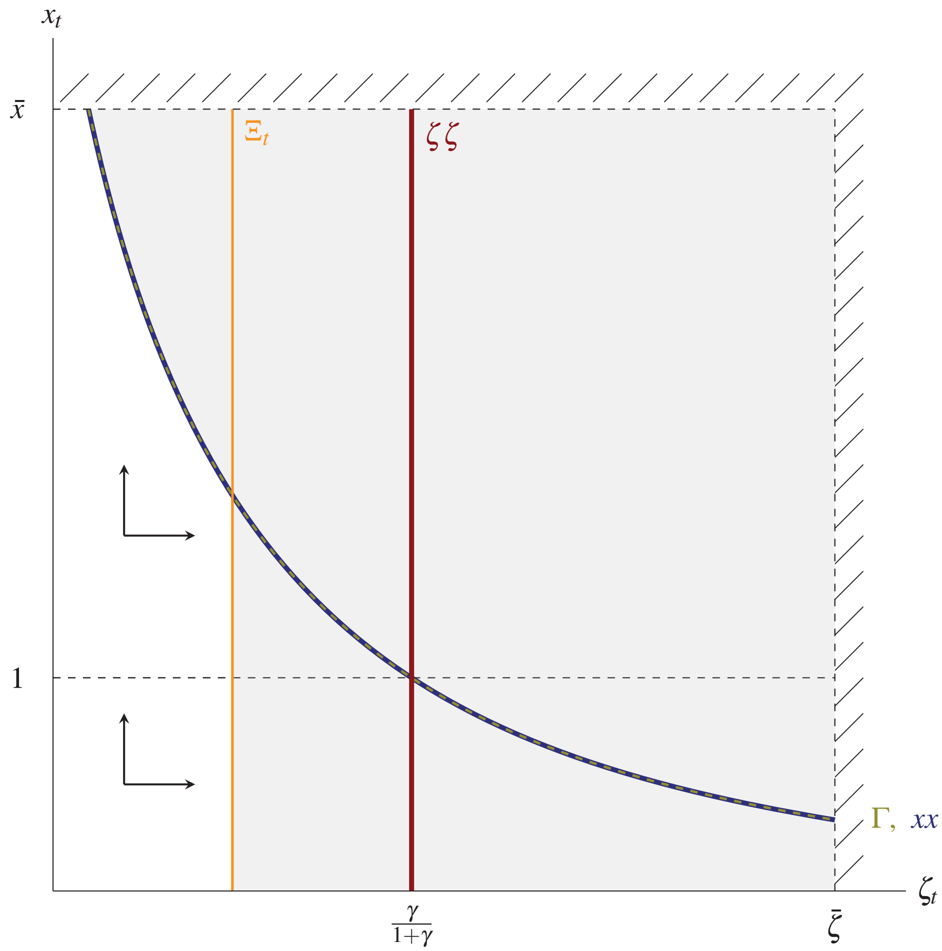

Figure 8: (ζ_t, x_t) Dynamics in Regime 2

Note: This figure pictures (ζ_t, x_t) dynamics for Regime 2 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 2. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 2 are excluded.

For Regimes 1 and 3, we simply have $x_{t+1} = x_t$. Regimes 2 and 4 are characterized by $n_t > x_t$ which, given (2.22), implies that x_t is increasing.[21]

Next, the $\zeta\zeta$-locus for given h_t is

$$\zeta\zeta = \{(\zeta_t, x_t) : \zeta_{t+1} = \zeta_t\}. \tag{2.25}$$

[21](2.4) shows that x_{t+1} is the weighted average of x_t and n_t. In Regimes 2 and 4, agents choose a level of n_t greater than x_t which means that x_{t+1} becomes the weighted average of x_t and a number that is greater than x_t. This trivially implies that x_{t+1} is greater than x_t.

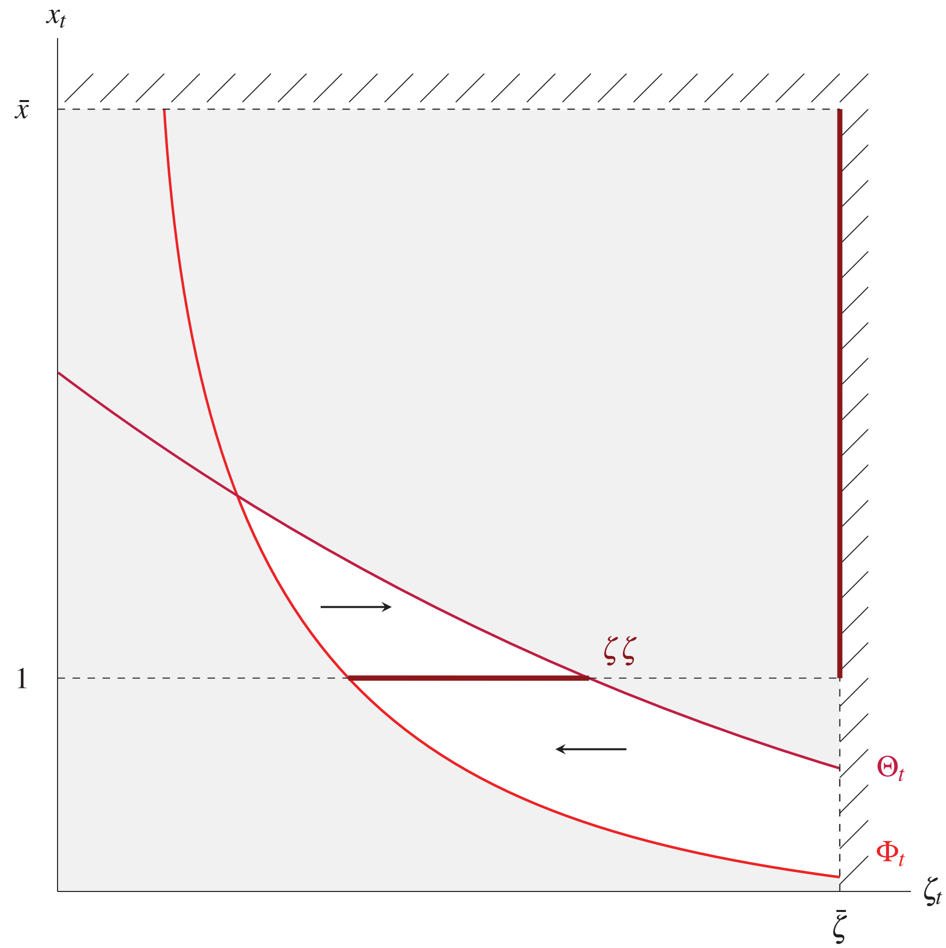

Figure 9: (ζ_t, x_t) Dynamics in Regime 3

Note: This figure pictures (ζ_t, x_t) dynamics for Regime 3 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 3. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 3 are excluded.

(2.21) shows that $\zeta_{t+1} = \zeta_t$ simply requires $n_t = 1$ for $N_{t+1} < \bar{N}$. $\zeta\zeta$ then becomes

$$\zeta_{t+1} = \zeta_t|_{N_t<\bar{N}} \Leftrightarrow \begin{cases} x_t = 1 & if \quad \zeta_t x_t \geq \Theta_t \quad and \quad \zeta_t x_t \geq \Gamma, \\ \zeta_t = \frac{\gamma}{1+\gamma} & if \quad \zeta_t x_t \leq \Xi_t \quad and \quad \zeta_t x_t < \Gamma, \\ x_t = 1 & if \quad \zeta_t x_t < \Theta_t \quad and \quad \zeta_t x_t \geq \Phi_t, \\ \zeta_t = \frac{\gamma(1-\eta)}{1+\gamma} + \frac{\sigma}{h_t} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \Phi_t \end{cases} \tag{2.26}$$

For $N_t \geq \bar{N}$, $\zeta\zeta$ is trivially $\zeta_t = \bar{\zeta}$ as the definition of ζ_t indicates that ζ_t remains constant when N_t is greater than $\bar{N}$. N_t can only reach $\bar{N}$ in Regimes 1 and 3 where $n_t = x_t \geq 1$, i.e., the population sustains fertility rates above the replacement level for the entire history and continues to grow. This results in an exploding population such that the population size

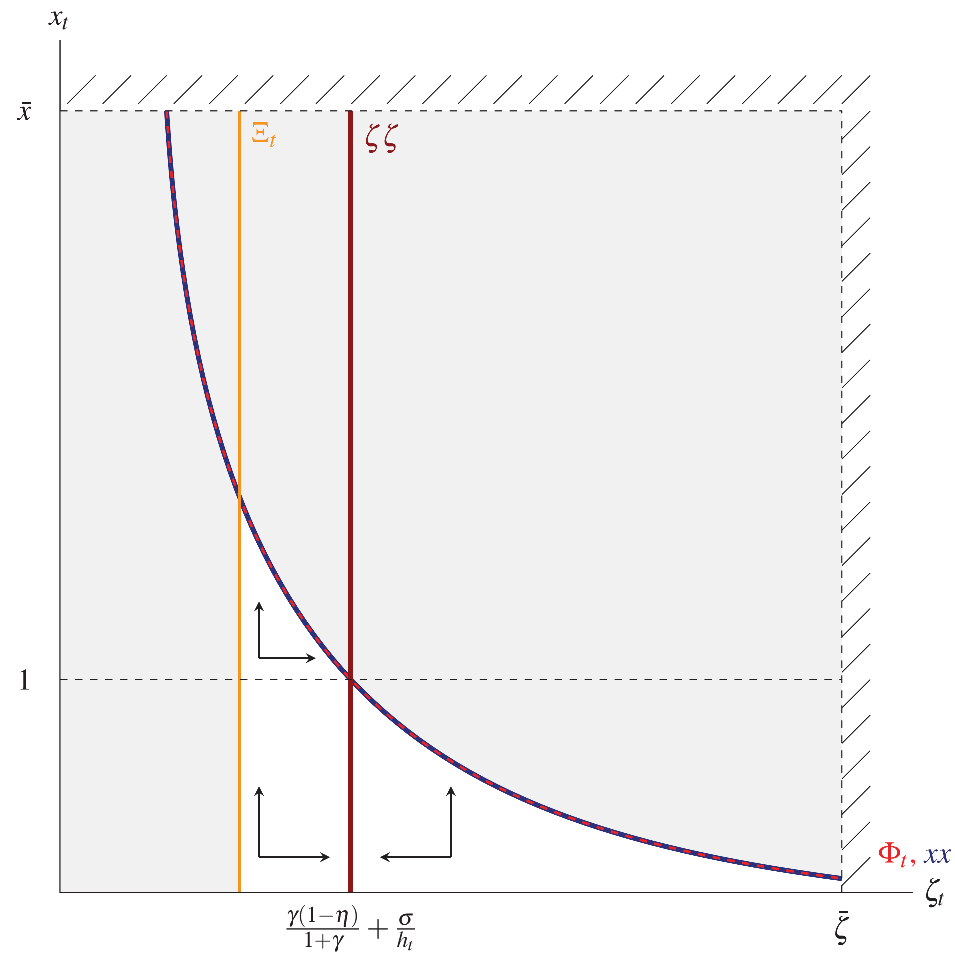

Figure 10: (ζ_t, x_t) Dynamics in Regime 4

Note: This figure pictures (ζ_t, x_t) dynamics for Regime 4 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 4. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 4 are excluded.

exceeds the threshold $\bar{N}$ and goes to infinity.

2.5.2 Steady-States and Growth

This subsection demonstrates that the model features multiple steady-state equilibria where (i) social norms are binding and positive education expenditure is not optimal, i.e., the economy does not grow and (ii) social norms are binding and education expenditure is optimal, i.e., the economy grows. The subsection also shows that, given $x_0 < 1$ and the economy is in Regime 4, the economy converges to a steady-state to which it would have converged in the absence of social norms and which yields the highest growth rate.

Let $G_t \equiv h_{t+1}/h_t \geq 1$ denote the gross growth rate of human capital h_t. The following analyses focus on human capital growth as it is the primary factor explaining growth of income per worker.[22]

Proposition 2.3 *Given a sufficiently high level of τ, the gross growth rate $G_t > 1$ satisfies*

$$G_t = \begin{cases} 1 & if \quad \zeta_t x_t \geq \Theta_t \quad and \quad \zeta_t x_t \geq \Gamma, \\ 1 & if \quad \zeta_t x_t \leq \Xi_t \quad and \quad \zeta_t x_t < \Gamma, \\ \tau\left\{\frac{\gamma\eta}{(1+\gamma\eta)x_t h_t}\left[(1-\zeta_t x_t)h_t + \sigma x_t\right]\right\}^{\eta} & if \quad \zeta_t x_t < \Theta_t \quad and \quad \zeta_t x_t \geq \Phi_t, \\ \tau\left[\frac{\eta}{(1-\eta)h_t}(\zeta_t h_t - \sigma)\right]^{\eta} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \Phi_t. \end{cases} \tag{2.27}$$

2.5.2.1 The High Fertility Trap with Binding Social Norms

Proposition 2.4 *The model economy features multiple steady-state equilibria in Regime 1 with $h^* \in [1, +\infty)$ and with $n^* = x^*$ and $e^* = 0$ such that*

- *$x^* = 1$ and $\zeta^* \in \left[1 - \frac{\sigma}{\gamma\eta h^*}, \bar{\zeta}\right]$, and*
- *$x^* \in (1, \bar{x}]$ and $\zeta^* = \bar{\zeta}$.*

The economy does not experience economic growth in these steady-states, i.e., $G^* = 1$.

Agents' choices on fertility are bound by social norms in any steady-state within Regime 1. They reproduce at a rate of x^*. (2.18) and (2.22) imply that population either does not grow or grows at a constant rate $x^* > 1$. Agents' earning abilities are limited because of a relatively high $\zeta^* x^*$ which prevents them from investing in education. Since $\zeta_t x_t$ does not decrease in Regime 1, agents can never have high enough income to afford a positive education expenditure. The economy cannot escape from a high fertility trap with binding social norms, agents do not educate the next generation, and the economy never experiences economic growth.

2.5.2.2 Development under Binding Norms

Proposition 2.5 *The model economy features multiple steady-states in Regime 3 with $h^* \to +\infty$ and with $n^* = x^*$ and $e^* \to +\infty$ such that*

- *$x^* = 1$ and $\zeta^* \in \left[\frac{\gamma(1-\eta)}{1+\gamma}, \bar{\zeta}\right]$, and*
- *$x^* \in (1, \bar{x}]$ and $\zeta^* = \bar{\zeta}$.*

[22] (2.11) shows that l_t and h_t determine the level of income. As $l_t \in (0,1)$ is a stationary variable, h_t is the prime determinant of economic growth.

The economy experiences economic growth with a constant G^* at the steady-state. G^* is decreasing in ζ_t and x_t with

$$\lim_{h_t \to +\infty} G_t \equiv G^* = \tau \left[\frac{\gamma\eta\,(1-\zeta^* x^*)}{1+\gamma\eta} \right]^{\eta}. \tag{2.28}$$

The steady-state in Regime 3 is characterized by agents investing in education even when social norms on fertility are binding. They reproduce at a rate of $x^* \geq 1$. If x^* is above the replacement level, the population continues to grow over time, exceeds $\bar{N}$, and ζ^* goes to $\bar{\zeta}$. If x^* is equal to the replacement level of unity, the population is stabilized at some $N^* < \bar{N}$. In either case, agents keep investing in education. As positive education investment implies that human capital grows over time, h_t goes to infinity with a constant gross growth rate $G^* > 1$.

G^* is decreasing in ζ^* and x^*. That is, G^* is higher when agents spend less time on childbearing due to either a smaller number of children they make x^* or a lower amount of time to spend on each child ζ^*.[23] G^* reaches its highest value in this steady-state where ζ^* is equal to its lower bound. Note that there exist an infinite number of steady-state growth rates in this regime.

2.5.2.3 High Growth under Non-Binding Norms

Proposition 2.6 *When the model economy is in Regime 4 with $x_0 < 1$, it converges to a unique growth steady-state with $h^* \to +\infty$ and with $n^* = 1$ and $e^* \to +\infty$ such that*

$$x^* = 1 \quad \text{and} \quad \zeta^* = \frac{\gamma(1-\eta)}{1+\gamma},$$

The economy experiences economic growth with a constant G^* at the steady-state that satisfies

$$\lim_{h_t \to +\infty} G_t \equiv G^* = \tau \left(\frac{\gamma\eta}{1+\gamma} \right)^{\eta}. \tag{2.29}$$

Proposition 2.6 shows that the economy converges to a steady-state with $x^* = 1$ if it starts in Regime 4 with $x_0 < 1$. This steady-state resides on a boundary point between Regimes 3 and 4. Furthermore, its unique ζ^* is the lower bound of the ζ^* of the steady-state in Regime 3.

[23] The lower values of x^* and ζ^* increase the time that agents can allocate to labor supply, i.e., increase their income. With higher levels of income, they can invest more resources on education which increases its growth rate.

Proposition 2.7 *The steady-state with*

$$x^* = 1 \quad and \quad \zeta^* = \frac{\gamma(1-\eta)}{1+\gamma}$$

is an equilibrium to which the model economy would have converged if the social norms were not present.

Proposition 2.7 shows that any steady-state but the one featured in Proposition 2.7 has a relatively low growth rate. If the economy is in either one of the other steady-states, agents' incomes are restricted with relatively high childbearing costs due to (i) high ζ^* implied by a large population and (ii) a high n^* implied by binding social norms.

2.5.3 The Historical Path of the Model Economy

This subsection illustrates the transition of an economy when its initial state is historically accurate. The economy can converge to two distinct steady-states, in which social norms are binding. Whether the economy experiences economic growth or not depends on the persistence of social norms. If the persistence of social norms, i.e., ψ is low, the economy converges to a steady-state in Regime 1 and never experiences economic growth. Otherwise, the economy converges to a steady-state in Regime 3, where it experiences perpetual growth under binding social norms.

Proposition 2.8 *Suppose that, at $t = 0$, the economy is in Regime 2, i.e., social norms are not binding. Also suppose that the size of population is sufficiently small, i.e., ζ_0 is sufficiently low, and that the social norm of fertility is above the replacement level, i.e., $x_0 > 1$. Then, the economy*

- *either enters and remains in Regime 1,*
- *or enters Regime 4 and then enters and remains in Regime 3.*

Remark 2.1 *Note that the assumptions in Proposition 2.8 are both historically accurate. First, considering the fact that the world population has expanded outstandingly during the last three centuries, and the modern human populations have emerged around 50,000 years earlier than today, it is reasonable to assume that the population size relative to the land was small in pre-historic societies.*

Second, considering the facts that (i) pre-historic societies did not have any contraceptive methods that prevent high fertility, (ii) were conservative relative to contemporary *societies, and (iii) most social and religious norms today promote high fertility and these norms originate from the pre-historic societies' social life, it is plausible to assume that these societies had fertility norms that dictate a fertility choice above the replacement level.*

Figures 11 and 12 picture the possible historical paths of the model economy given the initial conditions described in Proposition 2.8.

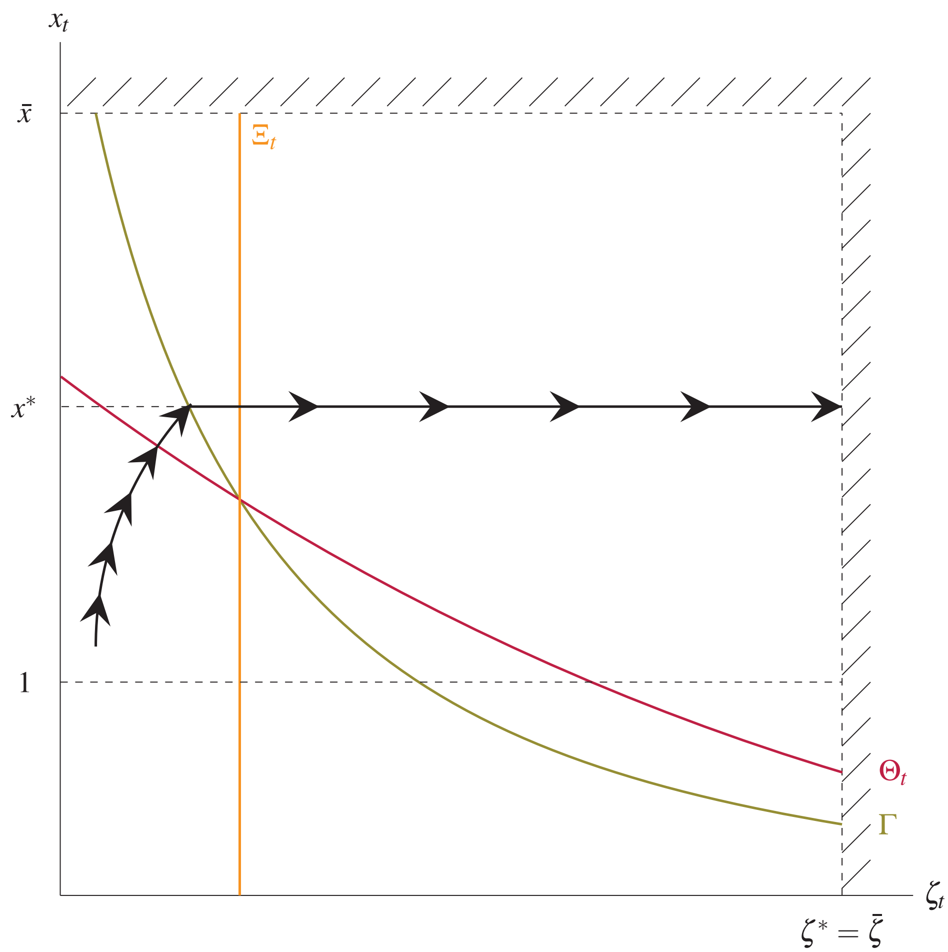

Figure 11: Convergence to the Steady-State in Regime 1
Note: This figure pictures the economy's convergence to a steady-state in Regime 1 under the assumptions that (i) the initial population size is at a historically low level and (ii) the initial social norms suggest a fertility choice above the replacement level. Given these conditions, the economy is initially in Regime 2, where optimum education expenditure is zero and fertility choice is above the fertility habit stock. If ψ, i.e., the historical persistence of social norms, is low, x_t increases at a faster pace than ζ_t. The economy eventually moves to Regime 1 where optimum education expenditure is zero and social norms are binding, and remains in Regime 1 forever with an ever-expanding population, without experiencing economic growth.

The population is historically small at the beginning of history. This implies that child-bearing is at a historically low cost as well. Conversely, fertility norms are relatively

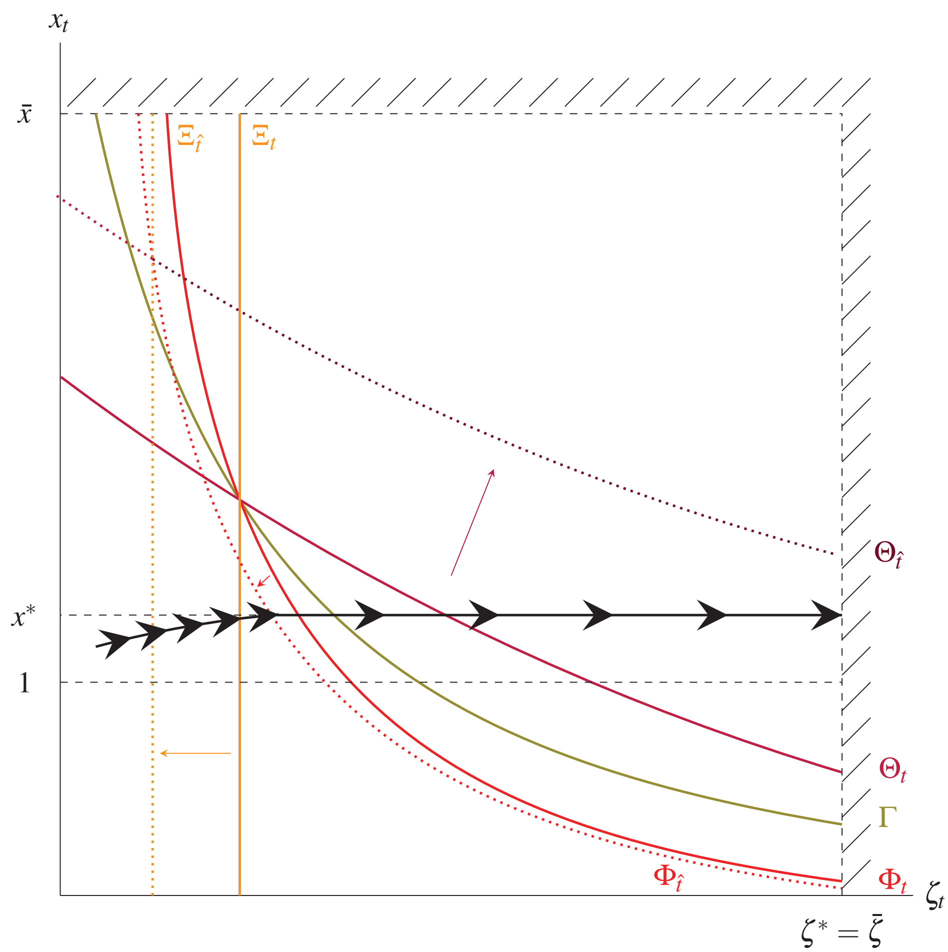

Figure 12: Convergence to the Steady-State in Regime 3

Note: This figure pictures the economy's convergence to a steady-state in Regime 3 under the assumptions that (i) the initial population size is at a historically low level and (ii) the initial social norms suggest a fertility choice above the replacement level. Given these conditions, the economy is initially in Regime 2, where optimum education expenditure is zero and fertility choice is above the fertility habit stock. If ψ, i.e., the historical persistence of social norms, is high, ζ_t increases at a faster pace than x_t, and the economy moves to Regime 4, where investment in education begins. Threshold levels Ξ_t and Φ_t decrease when agents start to accumulate human capital, while the threshold level Θ_t increases. The dotted lines represent the shifts in each threshold with an increasing human capital stock. Since x_t is non-decreasing and its initial value is above the replacement level, the population size and the childbearing cost continue to increase, and the economy eventually leaves Regime 4 at $\hat{t}$ and enters Regime 3 where education expenditure is positive and social norms are binding. Until the very end of the time, the economy remains in Regime 3 with positive education investment and an ever-expanding population.

high such that $x_0 > 1$, i.e., the society's allowed number of children that people can have is above the replacement level. Since the childbearing cost is too low, agents allocate a substantial portion of their time endowment to childbearing and have more children then the social minimum. In other words, despite the relatively high initial social norm stock, social norms are not binding. Agents are not concerned with educating their offspring because education does not yield high enough returns to compensate having fewer children. In other words, agents favor quantity over quality.

The initially low level of childbearing cost allows each generation to choose fertility above the social minimum and the population keeps growing. With each generation giving birth to a number of children above the social minimum, the next generation's fertility norm stock increases. Both the childbearing cost and the fertility norm stock are increasing and the society eventually leaves Regime 2 and enters either Regime 4 or Regime 1.

- The steady-state in Regime 1: If the historical persistence of social norms is low, each generations' influences on their descendants are strong. That is, the next generation's social norms are shaped more by their parents and less by their ancestors. This results in rapid increases in the social norm stock when the fertility rate is above the social minimum. Over time, the increase in the social norm of fertility (the habit stock) is relatively more than that of the childbearing cost. As a consequence, the minimum time that the society expects each agent to spend on childbearing becomes too high that agents no longer choose fertility above the social minimum and the economy enters Regime 1. Thereafter, fertility remains at a constant above the replacement rate for the remaining history and the population explodes. At the end of the history, the economy remains at a place where the human capital level has never changed and is the same as that of the initial period.
- The steady-state in Regime 3: With high historical persistence of social norms, the social norm stock mildly increases over time despite the relatively high fertility of each generation. Conversely, the increase in childbearing cost is relatively high. Childbearing cost of a single child increases over time despite the relatively stagnant fertility habit stock. Since the habit stock remains relatively stagnant, the economy does not initially enter to a regime where social norms are binding. At some point, the unit cost of childbearing becomes too high that agents choose to have fewer but educated children, and the economy enters Regime 4. The child Q-Q trade-off is initiated and agents start choosing lower fertility rates. However, the fertility rates are still above the social minimum that is greater than the replacement level and the population keeps growing. Ultimately, the total childbearing cost exceeds a threshold and the economy enters Regime 3. The fertility rate is no longer above the social minimum. Agents continue to educate their children but their labor supply remains limited due to their time spent on childbearing. The population keeps growing at a constant rate for the remaining history. Human capital also accumulates over time and is greater for each generation compared to their parents. At

Table 2: The Possible Historical Paths of the Model Economy

Transition Path	ψ	n^*	e^*	G^*
Regime 2 $\to$ Regime 1	Relatively Low	x^*	0	1
Regime 2 $\to$ Regime 4 $\to$ Regime 3	Relatively High	x^*	$+\infty$	$\tau\left[\frac{\gamma\eta\left(1-\bar{\xi}x^*\right)}{1+\gamma\eta}\right]^{\eta}$

the end of the history, investment in education continues and human capital stock increases without bound.

In conclusion, Proposition 2.8 shows that, if the initial state of the economy is historically accurate to represent the conditions of a pre-modern economy, the economy either follows a path throughout which a growth take-off never occurs or follows a path where the population explodes despite an increasing stock of human capital. See Table 2 for a summary of each path. Neither of these outcomes are realistic as the economy never experiences a demographic transition. These paths with steady-states in Regimes 1 and 3 are the outcome of strictly conservative agents who do not question the social norms. That x_t is non-decreasing over time prevents the agents from decreasing their fertility rates after a certain period. In reality, each generation questions the existing norms and may not blindly obey them if they are not compatible with their well-being. To capture moderately conservative agents, the next section introduces secularization to the model.

2.6. SOCIAL NORMS WITH SECULARIZATION

This section extends the model studied above with secularization. Let the social norms affecting fertility be religious norms as in Prettner and Strulik (2017) and Chabé-Ferret (2019). Let the social norm constraint of adults be

$$n_t \geq \xi x_t \tag{2.30}$$

where $\xi \in (0,1)$ represents each generations' obedience to social norms. Lower values of ξ imply that the society is more secular, i.e., less adhere to the social norms. The society still influences fertility choices. But unlike the basic model, each generation questions the social norms to some extent.

With the new social norm constraint, the worker's problem now becomes

$$\begin{aligned} \max_{n_t, e_t} \quad & \ln\left[(1-\zeta_t n_t)\, h_t - n_t e_t\right] + \gamma \ln(n_t) + \gamma\eta \ln(e_t + \sigma) + \rho_t \\ \text{subject to} \quad & \xi x_t \le n_t. \end{aligned} \tag{2.31}$$

2.6.1 Static General Equilibrium

The definition of the SGE for the extended model is similar to that of the basic model's, only with a different worker's problem which is (2.31).

Proposition 2.9 *There exists a unique SGE of the extended model with $n_t \ge \xi x_t$, $e_t \ge 0$ and $\ell_{j,t} > 0$. Depending on the given state vector $\mathbf{z}_t$, the SGE features four regimes as in Proposition 2.1.*

Proposition 2.9 shows that which regime the economy operates in depends on threshold levels of $\zeta_t x_t$ which are

$$\hat{\Gamma} \equiv \frac{\Gamma}{\xi}, \qquad \Xi_t, \qquad \hat{\Theta}_t \equiv \frac{\Theta_t}{\xi}, \qquad \hat{\Phi}_t \equiv \frac{\Phi}{\xi}. \tag{2.32}$$

2.6.2 Dynamic General Equilibrium

The DGE definition of the extended model is the same as that of the basic model.

Proposition 2.10 *A DGE of the extended model exists and is unique.*

2.6.3 Aggregate Dynamics and Asymptotic Equilibrium

The conditional dynamics of the extended model are the same with those of the basic model's. Figures 13, 14, 15, and 16 capture the dynamics of ζ_t and x_t for the extended model.

The xx-locus of the extended model is

$$x_{t+1} = x_t \Leftrightarrow x_t = \begin{cases} 0 & if \quad \zeta_t x_t \ge \hat{\Theta}_t \quad and \quad \zeta_t x_t \ge \hat{\Gamma}, \\ \frac{\gamma}{\xi(1+\gamma)\zeta_t} & if \quad \zeta_t x_t \le \Xi_t \quad and \quad \zeta_t x_t < \hat{\Gamma}, \\ 0 & if \quad \zeta_t x_t < \hat{\Theta}_t \quad and \quad \zeta_t x_t \ge \hat{\Phi}_t, \\ \frac{\gamma(1-\eta)h_t}{\xi(1+\gamma)(\zeta_t h_t - \sigma)} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \hat{\Phi}_t \end{cases} \tag{2.33}$$

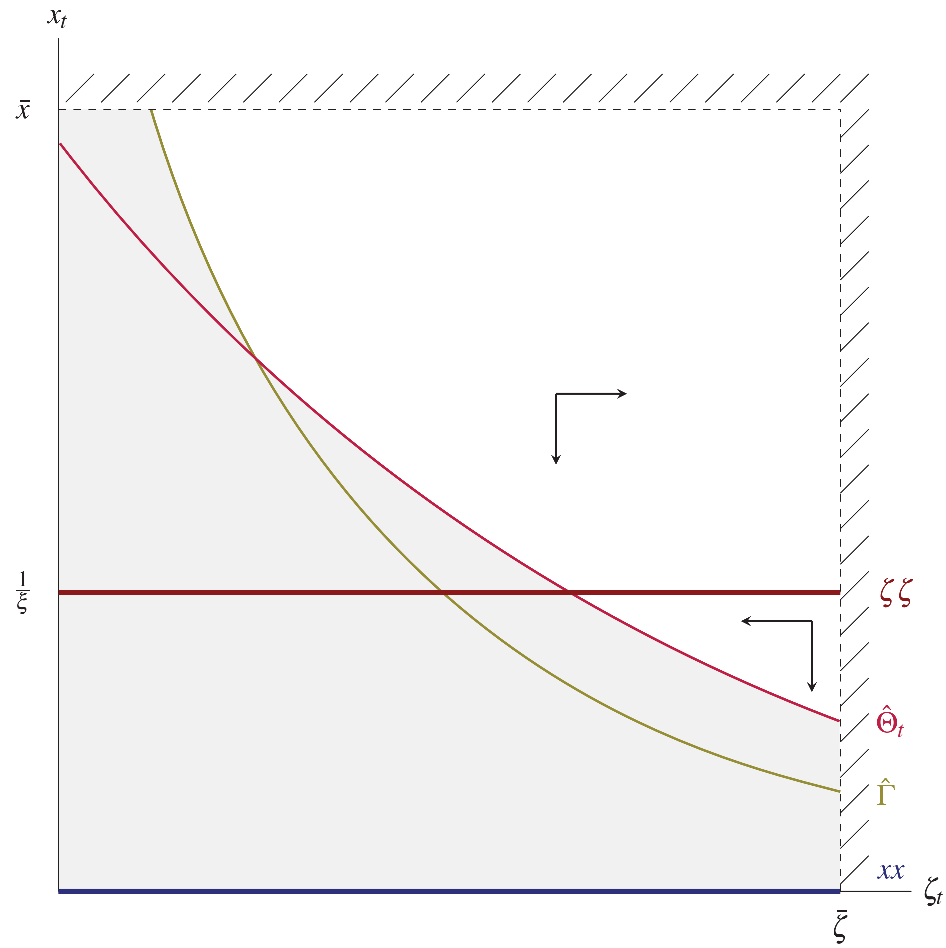

Figure 13: (ζ_t, x_t) Dynamics of the Extended Model in Regime 1

Note: This figure pictures (ζ_t, x_t) dynamics of the extended model for Regime 1 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 1. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 1 are excluded.

where x_t is increasing above and decreasing below. Note that $x_{t+1} = x_t$ in Regimes 1 and 3 requires the condition that $x_t = 0$. In regimes where the social norm constraint is binding, the condition that $x_{t+1} = x_t$ implies $x_t = \xi x_t$, which implies either $\xi = 1$ or $x_t = 0$. Since ξ is assumed to be smaller than 1, the only case where the social norm stock does not change is trivially $x_t = 0$. Proposition 2.9 and Lemma 2.2 show that x_t is decreasing for any positive value of x_t in these regimes.[24]

[24] Substituting $n_t = \xi x_t$ from Proposition 2.9 in (2.22) from Lemma 2.2 for each regime returns $x_{t+1}/x_t = \psi + (1-\psi)\xi < 1$, which shows that x_t is decreasing in these regimes.

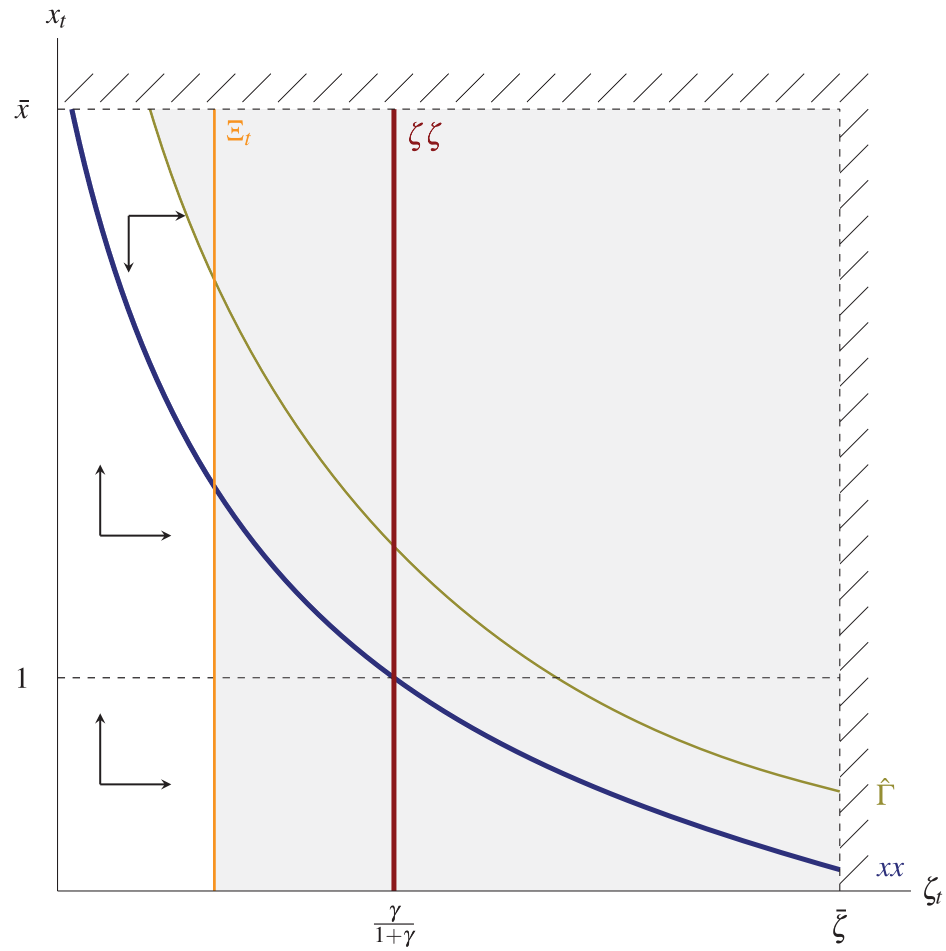

Figure 14: (ζ_t, x_t) Dynamics of the Extended Model in Regime 2

Note: This figure pictures (ζ_t, x_t) dynamics of the extended model for Regime 2 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 2. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 2 are excluded.

The $\zeta\zeta$ locus of the extended model reads

$$\zeta_{t+1} = \zeta_t|_{N_{t+1}<\bar{N}} \Leftrightarrow \begin{cases} x_t = \frac{1}{\xi} & if \quad \zeta_t x_t \geq \hat{\Theta}_t \quad and \quad \zeta_t x_t \geq \hat{\Gamma}, \\ \zeta_t = \frac{\gamma}{1+\gamma} & if \quad \zeta_t x_t \leq \Xi_t \quad and \quad \zeta_t x_t < \hat{\Gamma}, \\ x_t = \frac{1}{\xi} & if \quad \zeta_t x_t < \hat{\Theta}_t \quad and \quad \zeta_t x_t \geq \hat{\Phi}_t, \\ \zeta_t = \frac{\gamma(1-\eta)}{1+\gamma} + \frac{\sigma}{h_t} & if \quad \zeta_t x_t > \Xi_t \quad and \quad \zeta_t x_t < \hat{\Phi}_t \end{cases} \tag{2.34}$$

where ζ_t is increasing above and decreasing below. The population size could exceed $\bar{N}$ in Regimes 1 and 3 of the basic model because x_t was non-decreasing. In the extended model, $\xi < 1$ ensures that x_t decreases in these regimes until it reaches to its lower bound. Thus, the population size never exceeds $\bar{N}$ in the extended model, and ζ_t never reaches to

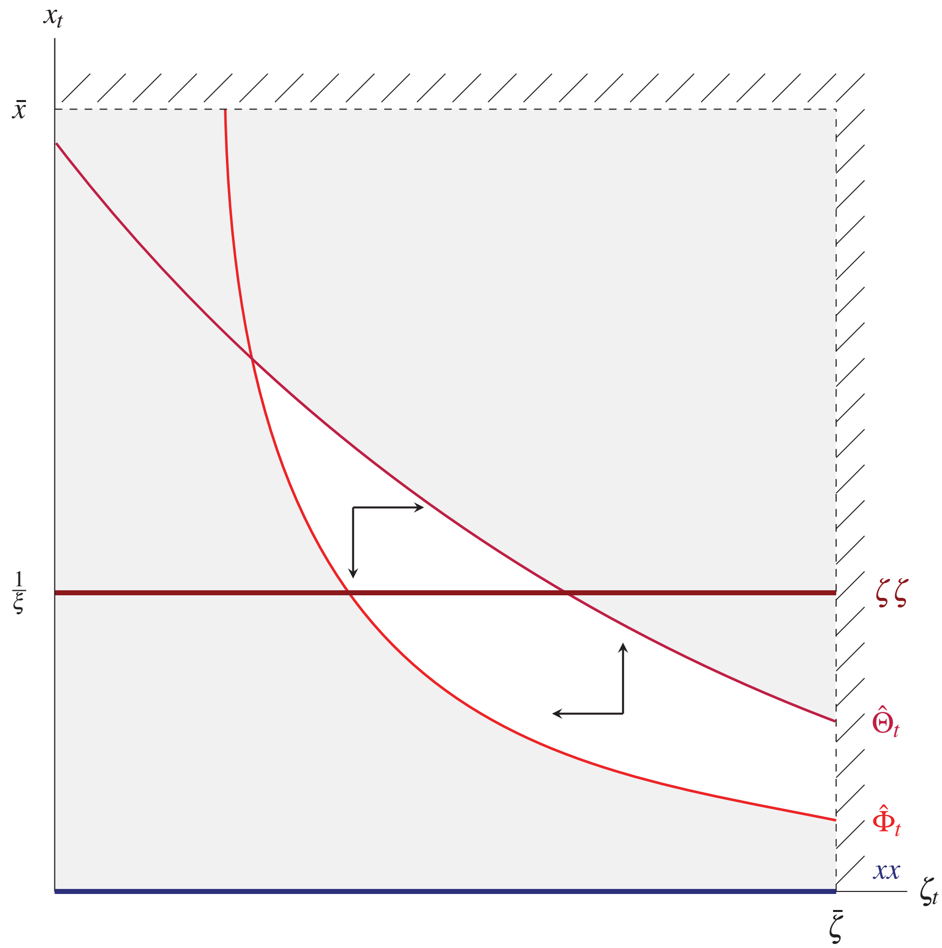

Figure 15: (ζ_t, x_t) Dynamics of the Extended Model in Regime 3

Note: This figure pictures (ζ_t, x_t) dynamics of the extended model for Regime 3 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 3. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 3 are excluded.

$\bar{\zeta}$. Therefore, a $\zeta\zeta$ locus does not exists for $N_{t+1} \geq \bar{N}$.

Proposition 2.11 *Suppose that the economy is initially in either Regime 1 or 2, i.e., $e_0 = 0$. Then, a $\tilde{t} > 0$ exists where $e_{\tilde{t}-1} = 0$ and $e_{\tilde{t}} > 0$: If the economy starts its evolution with investment in human capital not being optimal, the agents inevitably educate their offspring at some future period. Furthermore, independent of where it starts, the economy eventually enters Regime 4 where social norms are not binding.*

The definition of an asymptotic equilibrium is motivated by Proposition 2.11.

Definition 2.3 *The extended model features a unique asymptotic equilibrium in Regime*

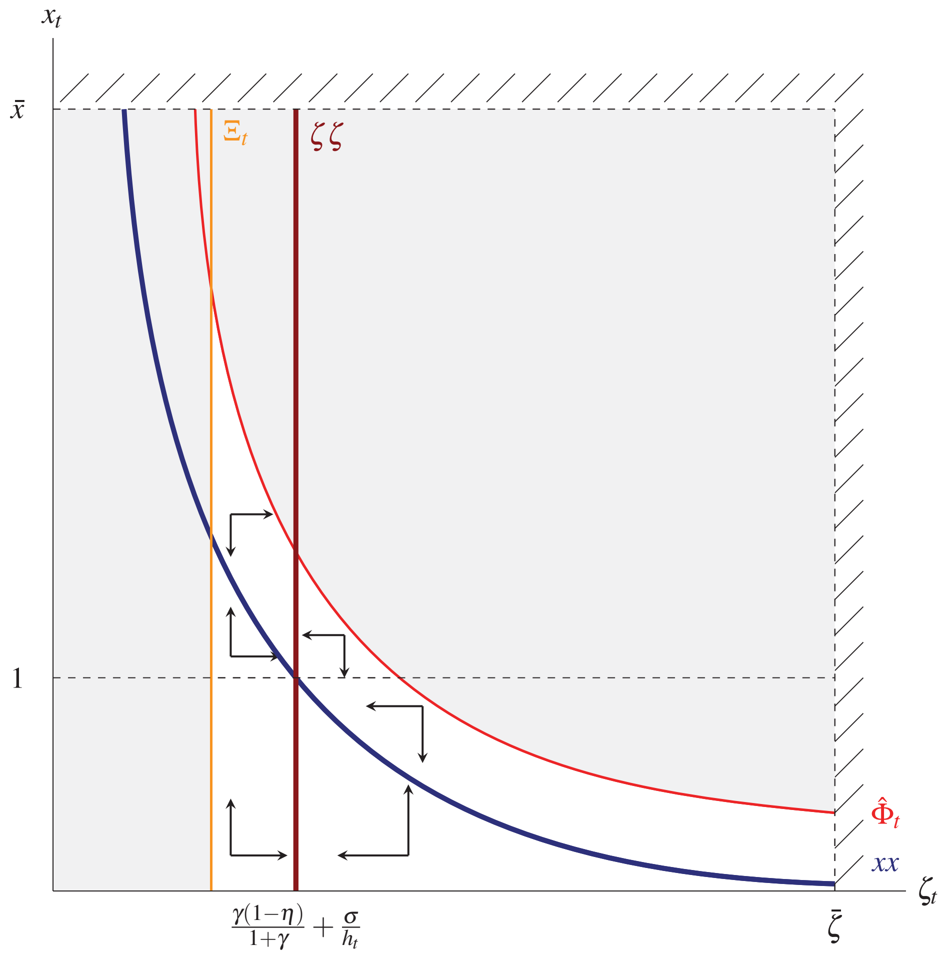

Figure 16: (ζ_t, x_t) Dynamics of the Extended Model in Regime 4
Note: This figure pictures (ζ_t, x_t) dynamics of the extended model for Regime 4 given $h_t < +\infty$. The unshaded area represent the ζ_t and x_t pairs for which the economy operates in Regime 4. The threshold levels of $\zeta_t x_t$ irrelevant for Regime 4 are excluded.

4 with

$$n_t \to n^* = 1, \quad e_t \to e^* \to +\infty \quad \textit{and} \quad G_t \to G^* = \tau\left(\frac{\gamma\eta}{1+\gamma}\right)^{\eta} > 1,$$

which is the limiting of the SGE with $t \to +\infty$.

The social norms are not binding at the asymptotic equilibrium and the adult population is stabilized at some

$$N^* = \left[\frac{\gamma(1-\eta)}{\theta(1+\gamma)}\right]^{\frac{1}{\alpha}} > 0 \tag{2.35}$$

which is solved from (2.1) and (2.34) with $n^* = 1$. With e^* being positive, Proposition

2.3 implies that human capital continues to grow over time with a $G^* > 1$. Hence, the asymptotic equilibrium features the perpetual growth of h_t, and equivalently w_t.

Proposition 2.12 *The (unique) asymptotic equilibrium is globally stable. In other words, the extended model's SGE ultimately converges to the asymptotic equilibrium for any* $\mathbf{z}_0 \in \mathbb{R}^3_+$.

Figure 17 pictures the regime transitions of the extended model, and captures the convergence to the Regime 4.

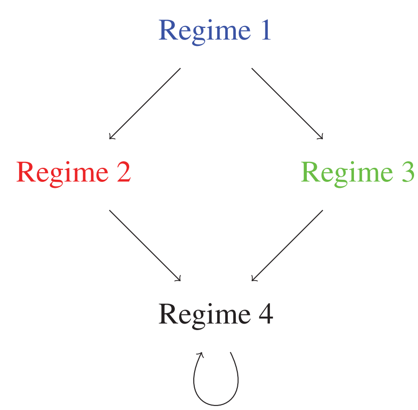

Figure 17: Regime Transitions in the Extended Model

2.6.4 The Historical Path of the Extended Model

Proposition 2.13 *Consider the extended model and suppose that ζ_0 is low, i.e., the population size is small and $x_0 > 1$.*

Suppose that the economy initially operates within Regime 2. The economy, then, enters Regime 4 at some $\hat{t} > 0$ and converges to the asymptotic equilibrium.

Suppose that the economy initially operates within Regime 1. The economy, then;

- *either enters Regime 2, then Regime 4 at some $\hat{t} > 0$, and converges to the asymptotic equilibrium,*
- *or enters Regime 3, then Regime 4 at some $\hat{t} > 0$, and converges to the asymptotic equilibrium.*

Figures 18 and 19 capture the economy's convergence to the asymptotic equilibrium when it initially starts in Regime 2. The economy, then, follows a path where it is never affected by the social norms. This is the case for the standard UGT literature, where the Q-Q trade-off begins when the unit childbearing cost is sufficiently high. The economy starts with an initially high fertility rate that gradually declines with a gradually increasing unit childbearing cost. When the childbearing cost is sufficiently high at $\hat{t}$, the returns to education relative to having children is high enough to initiate human capital investment at the expense of the number children. Afterwards, the economy converges to the asymptotic equilibrium where the education expenditure is positive, growth is perpetual and fertility rate is equal to the replacement level.

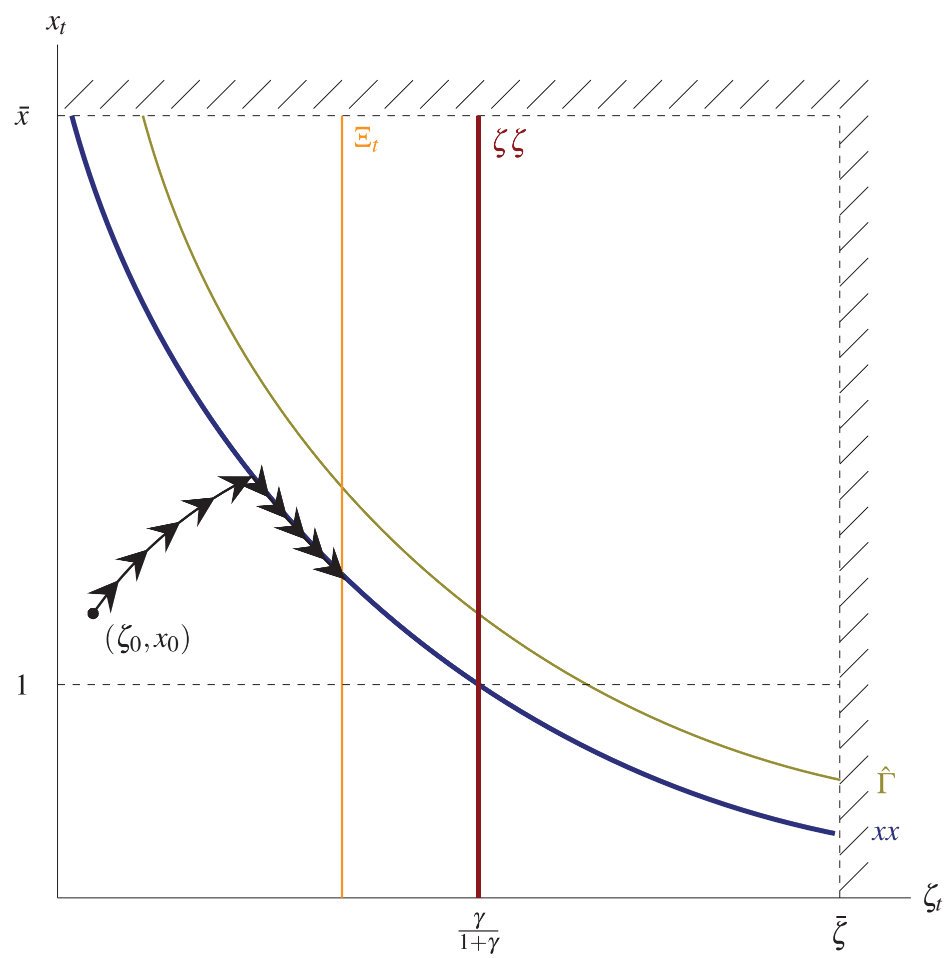

Figure 18: Extended Model's Path from Regime 2: Before $\hat{t}$

Note: This figure pictures the path of the model economy with secularization extension from $t = 0$ when the economy is initially in Regime 2 with $x_0 > 1$ before some $\hat{t} < +\infty$. When initially in Regime 2, the economy first moves towards xx. After it reaches xx, the economy moves alongside xx until it enters Regime 4 at some $\hat{t} < +\infty$.

There are two possible paths of the economy when it initially starts in Regime 1—the cases where the social norms influence reproductive behavior—with each path depending on the values of ψ and ξ, i.e., the historical persistence of social norms and the degree of secularization, respectively. Now, note that societies with relatively high ψ preserve

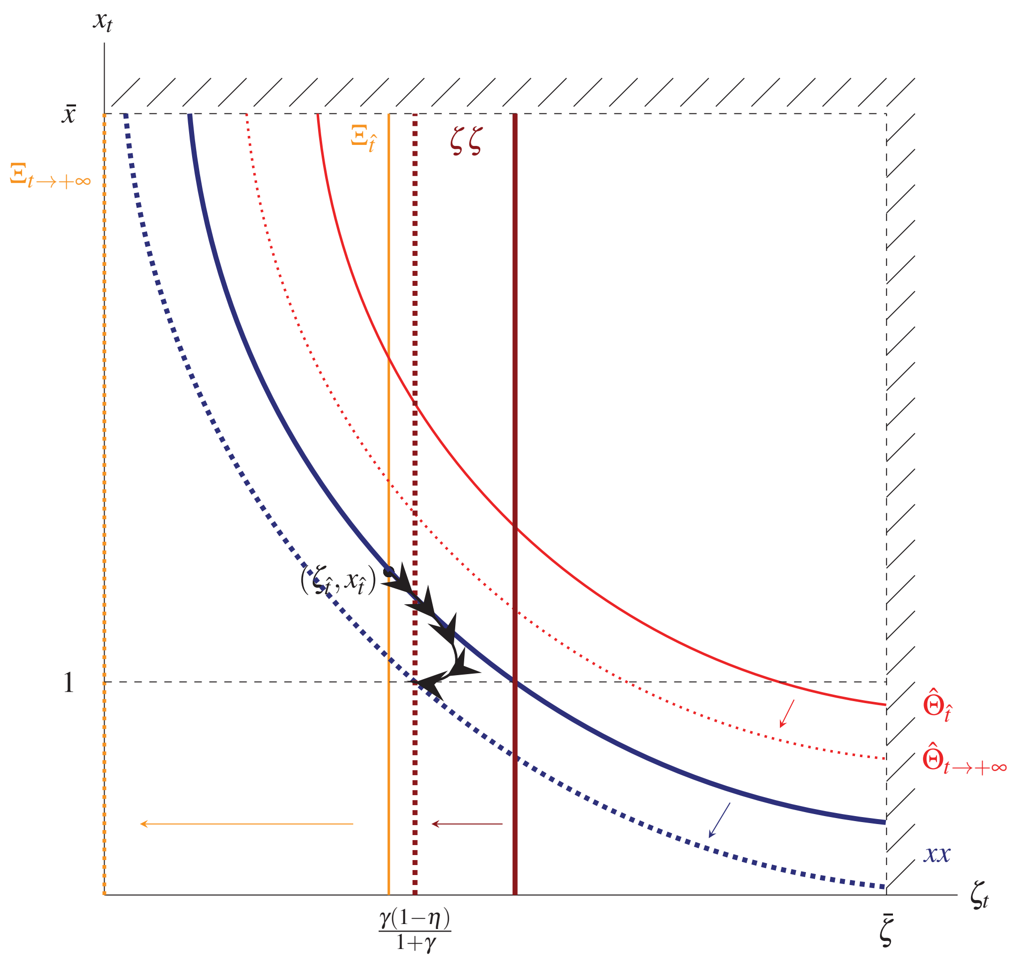

Figure 19: Extended Model's Path from Regime 2: After $\hat{t}$

Note: This figure pictures the path of the model economy with secularization extension after the economy enters to Regime 4 at some $\hat{t} < +\infty$. Since optimum education expenditure is positive in Regime 4, the human capital stock continues to increase over time and goes to infinity. The threshold levels of $\hat{\Theta}$ and Ξ, alongside the xx and $\zeta\zeta$ loci decrease with an increasing human capital stock. The dotted lines represent $\hat{\Theta}$, Ξ, xx and $\zeta\zeta$ when h_t goes to infinity. When in Regime 4, the economy converges to the asymptotic equilibrium in Regime 4 where the population is stabilized and economic growth is perpetual.

their social norms for generations. Hereafter, these societies are referred as "traditionalist societies" in which social norms have high historical persistence. Narratives for both paths are in order.

The initial population level N_0, therefore ζ_0, is at a historically low level. On the contrary, as a consequence of the social norms that value high fertility, $x_0 > 1$ is high such that the social norms are binding despite the historically low ζ_0. The reproductive behaviors of the initial generations are, then, determined by the social norms. However, each generation questions the social norms and does not completely obey them. That is, the society influences fertility decisions but does not completely determine the number of children each agent have.

At the initial stages of history, each generation choose not to educate their children because (i) the returns of education are not sufficiently high to promote human capital investment and (ii) their labor supply, therefore income, is limited and is not enough to support feasible levels of education expenditure that yields high enough returns relative to spending on consumption.

With each generation questioning the existing social norms, x_t decreases over time. The society may follow two distinct paths depending on its characteristics. These characteristics are determined by; how persistent their traditions are, i.e., how large ψ is, and how resistant to change they are, i.e., how large ξ is.

If the society is a relatively secular one with low persistence of traditions, it abandons the social norms that restrict the agents' preferences relatively fast. The economy eventually escapes from Regime 1 and enters Regime 2 where social norms still exist, but not strong enough to bind fertility choices. In time the evolution of fertility habits continue, but since they are shaped more by the preceding generations choices and less by its previous values, it evolves in accordance with the costs and benefits of having children. The economy follows the path of the one which initially starts in Regime 2, and eventually converges to the asymptotic equilibrium (see Figures 20 and 21).

If the society is characterized by high persistence of traditions, i.e., if it's a traditionalist society, and/or if it is resistant to change, it does not reach its balanced growth path as fast as the previous case. Each generation questions the social norms and x_t decreases over time, but the change is too slow that the economy remains in Regime 1 for a long time. However, even if the change is relatively small, the agents' incomes gradually increase over time. When their income is high enough, the agents start to educate their children and the economy enters Regime 3. But note that initiating human capital investment is not the outcome of the Q-Q trade-off because the number of children that each agent have is still influenced by the society. At this stage of development, agents only substitute between consumption and education.

At this stage of development, h_t starts to increase, but the increase is relatively small because the potential incomes of agents are still restricted by the social norms. Nevertheless, each generation continues to question social norms and both the income and education expenditure, therefore h_t grow at an accelerating rate over time. The economy ultimately enters Regime 4 at some $\hat{t}$ and converges to the asymptotic equilibrium (See Figures 22

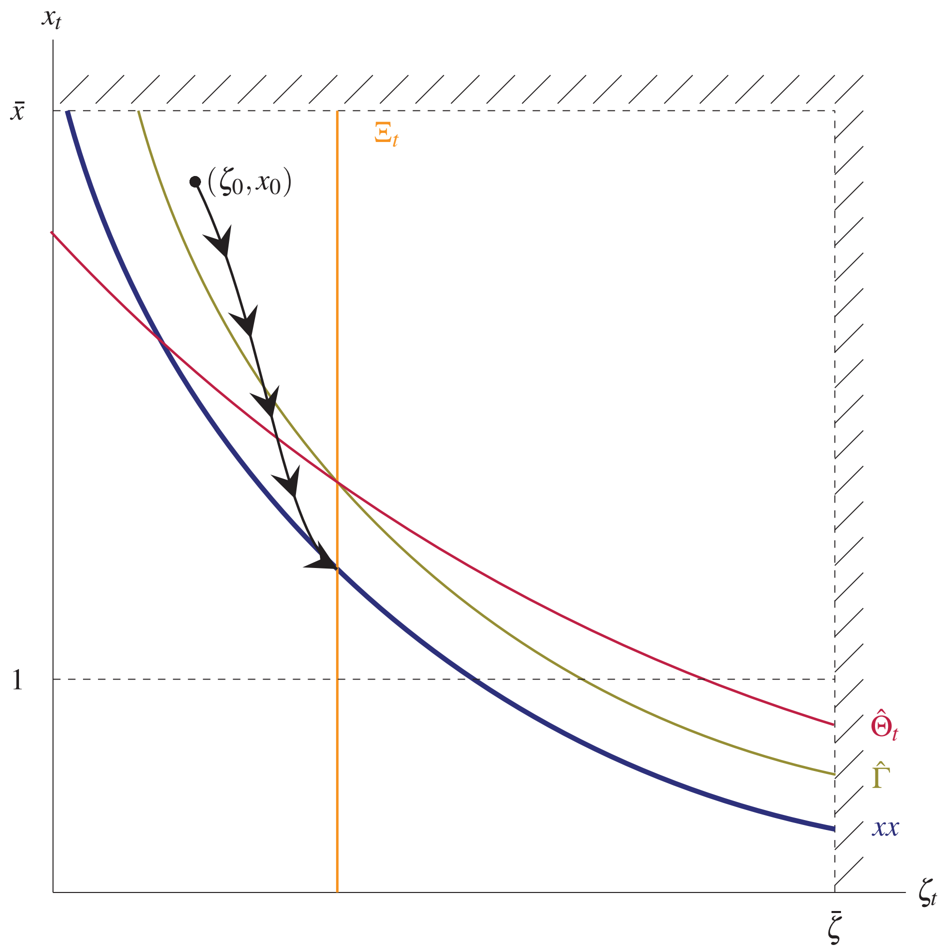

Figure 20: Extended Model's Path from Regime 1: Small ψ and ξ, Before $\hat{t}$
Note: This figure pictures the path of the model economy with secularization extension before some $\hat{t} < +\infty$, when the economy is initially in Regime 1 with $x_0 > 1$ under small ψ and ξ, i.e., with low historical persistence of social norms and a relatively secular society. With a secular and less-traditionalist population, the social norm stock quickly decreases so that the economy enters Regime 2 from Regime 1 at some $t < +\infty$. When in Regime 1, the state vector first converges to xx, and moves alongside it afterwards. The economy then enters Regime 4 at some $\hat{t} < +\infty$.

and 23).

In conclusion, when the economy's initial position is historically correct, the path that it follows replicate either the long-run path of the contemporary industrialized economies or the long-run path of underdeveloped economies. See Table 3 for a summary of the economies possible transition paths. When social norms are not strong or the society is relatively secular, the economy initiates human capital accumulation at a relatively early time and enters its balanced growth path. On the other hand, if fertility norms are initially strong, and the society is not secular enough, it can experience long periods of stagnation.

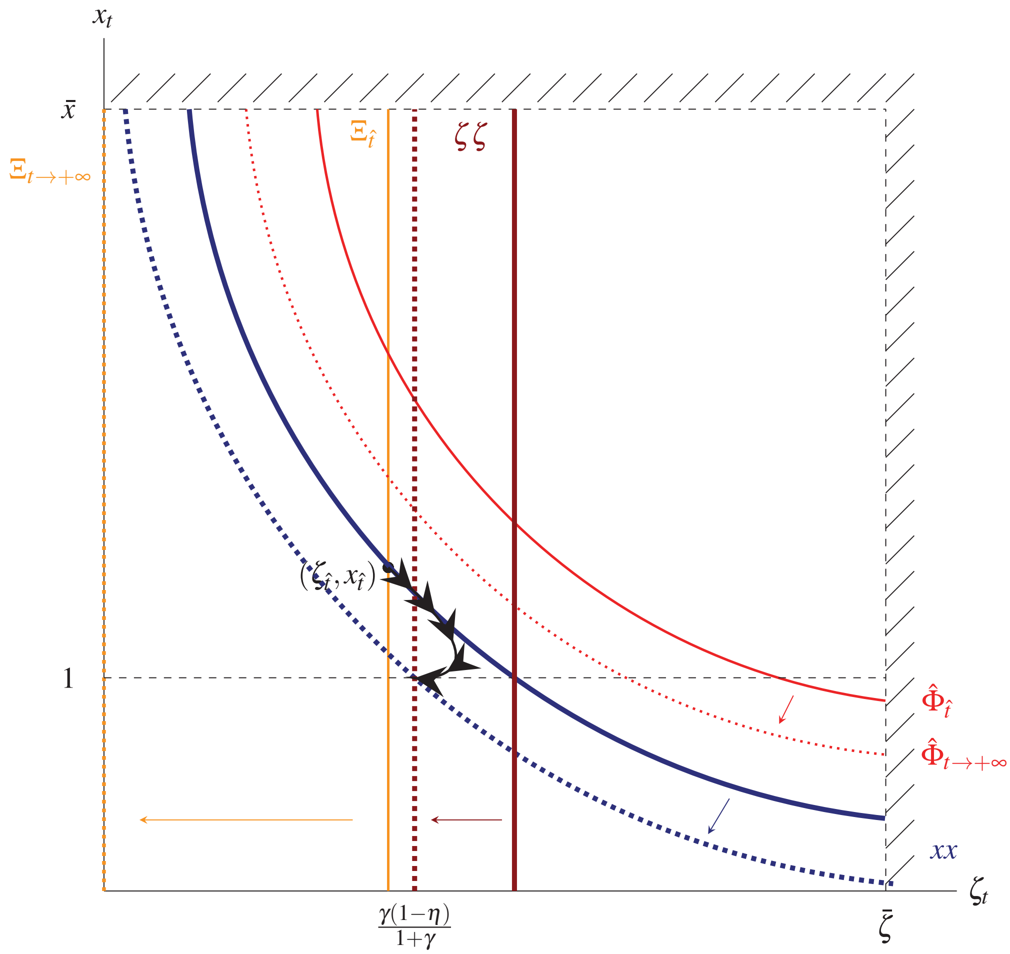

Figure 21: Extended Model's Path from Regime 1: Small ψ and ξ, After $\hat{t}$
Note: This figure pictures the path of the model economy with secularization extension after $\hat{t} < +\infty$, when the economy is initially in Regime 1 with $x_0 > 1$ under small ψ and ξ, i.e., with low historical persistence of social norms and a relatively secular society. The economy converges to the asymptotic equilibrium after it enters Regime 4. Since optimum education expenditure is positive in Regime 4, the human capital stock continues to increase over time and goes to infinity. The threshold levels of $\hat{\Theta}$ and Ξ, alongside the xx and $\zeta\zeta$ loci decrease with an increasing human capital stock. The dotted lines represent $\hat{\Theta}$, Ξ, xx and $\zeta\zeta$ when h_t goes to infinity. When in Regime 4, the economy converges to the asymptotic equilibrium in Regime 4 where the population is stabilized and economic growth is perpetual.

The economy eventually starts to accumulate human capital, but the timing is relatively late and the transition to its balanced growth equilibrium takes a relatively long time.

2.7. DISCUSSION

The effects of non-economic phenomena on economic behavior, such as those of habits, social and cultural norms, and religion, have been demonstrated in various theoretical and

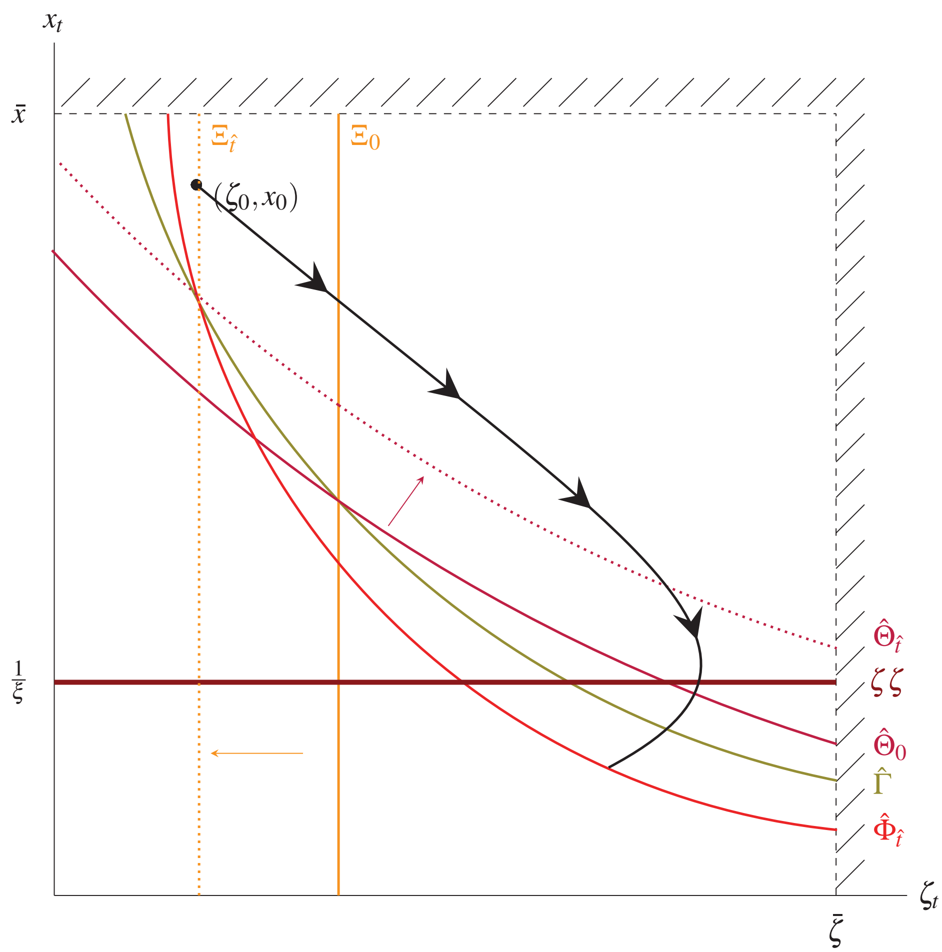

Figure 22: Extended Model's Path from Regime 1: Large ψ and ξ, Before $\hat{t}$

Note: This figure pictures the path of the model economy with secularization extension before some $\hat{t} < +\infty$, when the economy is initially in Regime 1 with $x_0 > 1$ under large ψ and ξ, i.e., with high historical persistence of social norms and a relatively conservative society. The social norm stock decreases when in Regime 1, but the decrease is relatively mild due to the traditionalist and conservative characteristics of the society, and the economy sustains relatively high fertility rates for a long time. Eventually, the economy escapes Regime 1 and enters Regime 3 (where optimum education expenditure is positive under binding social norms) at some $t < +\infty$, and human capital investment begins. The threshold level $\hat{\Theta}_t$ starts to increase and Ξ_t starts to decrease. The dotted lines represent the shifts in both threshold levels. The social norm stock continues to decline in this regime, and falls below $1/\xi$ at some point. Since social norms are binding in Regime 3, a social norm stock below $1/\xi$ implies that the population size and the childbearing cost decrease. The decrease in nursing time continues until the economy enters Regime 4 at some $\hat{t} < +\infty$.

empirical works. Guiso, Sapienza, and Zingales (2006), Fernández (2011), Spolaore and Wacziarg (2013), Alesina and Giuliano (2015), and Jackson, Rogers, and Zenou (2017) on social and cultural norms, Havranek, Rusnak, and Sokolova (2017) on habits, and Rubin (2017), S. O. Becker, Pfaff, and Rubin (2016), Cantoni, Dittmar, and Yuchtman (2018) and Kuran (2018) on religion are some recent studies. Such effects have important impli-

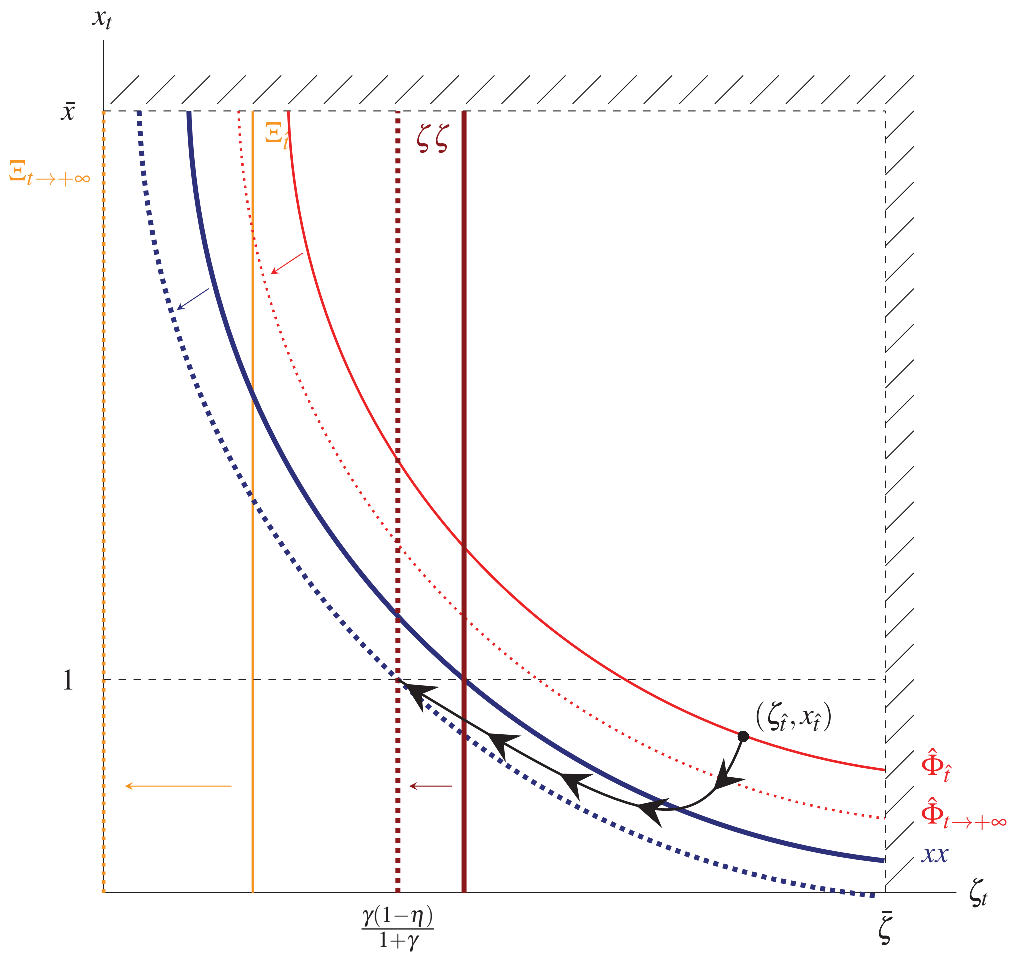

Figure 23: Extended Model's Path from Regime 1: Large ψ and ξ, After $\hat{t}$

Note: This figure pictures the path of the model economy with secularization extension after some $\hat{t} < +\infty$, when the economy is initially in Regime 1 with $x_0 > 1$ under large ψ and ξ, i.e., with high historical persistence of social norms and a relatively conservative society. The human capital stock continues to increase when in Regime 4, where positive education expenditure is optimum. After the economy enters Regime 4, it converges to the asymptotic equilibrium. With an increasing human capital stock, the threshold levels $\hat{\Theta}$ and Ξ, and the xx and $\zeta\zeta$ loci decrease over time. The dotted lines represent the shifts in each line when human capital stock goes to infinity. When in Regime 4, the economy converges to the asymptotic equilibrium where the population is stabilized, and economic growth is perpetual.

cations for the long-run growth path of a society. They are presumably more pronounced in less developed societies that are situated away from their balanced growth paths.

The basic model constructed in this chapter introduces social norms on fertility into a simple model of child Q-Q trade-off. Social norms dictate that fertility cannot be below some benchmark level determined by the evolution of habits. This evolution is shaped partially by the historical persistence and partially by the decisions of the previous generation. The model features multiple asymptotic equilibria with binding and non-binding social norms

Table 3: The Possible Historical Paths of the Extended Model

Transition Path	ψ and ξ	n^*	e^*	G^*
Regime 2 $\rightarrow$ Regime 4	Any	1	$+\infty$	$\tau\left(\frac{\gamma\eta}{1+\gamma}\right)^{\eta}$
Regime 1 $\rightarrow$ Regime 2 $\rightarrow$ Regime 4	Relatively Low	1	$+\infty$	$\tau\left(\frac{\gamma\eta}{1+\gamma}\right)^{\eta}$
Regime 1 $\rightarrow$ Regime 3 $\rightarrow$ Regime 4	Relatively High	1	$+\infty$	$\tau\left(\frac{\gamma\eta}{1+\gamma}\right)^{\eta}$

on fertility. The model is thus able to explain a set of outcomes consistent with both (i) prolonged stagnation with low education and high fertility, and (ii) economic growth with human capital accumulation accompanied by fertility decline.

An extension of this model assumes that religious norms shape the fertility constraints and introduces exogenous secularization in the form of the declining role of religious norms in social life via questioning the social norms. While social norms continue to influence fertility constraints, their influence is limited with how obedient each generation is. The extended model features a unique asymptotic equilibrium where the adult population is stabilized and economic growth is perpetual. How fast the economy converges to this equilibrium depends on the degree of secularization. The remaining part of this section discusses the implications of these main results.

2.7.1 Secularization and Modern Economic Growth

The UGT literature underlines the crucial role of a fertility transition for the take-off stage of an economy and its convergence to the BGP. This has encouraged economists to investigate the determinants of fertility, and several scholars have argued that the determinants of fertility decisions are not solely economic ones. The recent works of T. E. Murphy (2015) and Baudin (2015) demonstrate the role that religion has played in France's fertility transition. T. E. Murphy (2015) shows that the social environment has significantly influenced French fertility decisions in the nineteenth century. His findings indicate that fertility rates have been higher with more religiosity and France's fertility transition was parallel to its secularization. Furthermore, the social diffusion of religious norms from more secular areas to less secular ones via social interaction has accelerated the fertility decline. Baudin's (2015) findings provide support that religiosity's positive effect on fertility persist in today's France. These works illustrate the indirect effect of secularization on economic growth through affecting the fertility transition. Strulik (2016) and Prettner and Strulik (2017) further demonstrate that religious beliefs, when strong enough, cause high fertility and low education, therefore low or no economic growth.

In the model of this chapter, binding social norms prevent the economy from converging to a steady-state where the population is stabilized and growth is perpetual. Assuming that religious norms influence fertility, the effect is more pronounced when agents are strictly conservative, i.e., obey the religious norms without questioning them. However, the basic model shows that strict conservatism results in unrealistic outcomes when the initial state of the economy is historically correct with binding social norms and low population. The secularization extension suggests that even the slightest questioning of religious norms allows the economy to converge to a perpetual growth equilibrium with a stabilized adult population.

Though how large or small ξ is have no effect on the asymptotic equilibrium of the extended model, it has a significant role for the transition. The value of ξ, i.e., how secular the society is, affects the duration of the transition to the equilibrium. More secular societies complete their transition earlier while more conservative societies experience longer periods of stagnation. The extended model predicts that more secular societies complete their fertility transition and convergence to their BGP earlier. On the contrary, more conservative societies sustain high fertility and low education rates for longer periods. These results are analogous with those obtained by Prettner and Strulik (2017). In Prettner and Strulik's (2017) model, the usage of contraceptives represents religious beliefs. More religiosity implies less contraceptive usage which, in turn, implies high fertility and low education. They show that a society can only escape from a steady-state of stagnation by abandoning their traditional beliefs through collective actions.

The basic model of this chapter does not introduce secularization endogenously. Yet, an exogenous decline in x_t can be interpreted as the collective action to abandon religious norms as in Prettner and Strulik (2017). In the basic model of this chapter, obeying the existing norms without questioning them results in either a high fertility trap where human capital investment never starts, or an underdevelopment trap where growth is perpetual but relatively low.

Assume the economy is in either steady-state with $x^* \geq 1$. An exogenous decline in fertility norms such that $x_t < 1$ would decrease the population size, allow the economy to enter Regime 4, and eventually converge to the steady state described in Proposition 2.6. Both the basic and the extended models imply the need for abandonment of religious beliefs—in this case, fertility norms—to complete a fertility transition and attain higher living standards in terms of per capita income. The model does not capture the bicausal association of economic development and secularization (see, e.g., Strulik (2016)) but it still demonstrates the negative impact of conservatism on an economy.

2.7.2 Social Institutions and the Long-Run Path

The mainstream economics literature is largely built on models with isolated agents, treated as independent decision makers isolated from their social environment. This oversimplification has allowed economists to analyze complex structures such as decision-making processes regarding reproduction and education. However, models assuming away social effects may not be reliable in understanding the very long-run patterns of development since the evolution of culture may create non-trivial changes in social foundations of economic behavior. The rational agent model with an individualistic methodology can be used to analyze how an agent behaves under given circumstances, but it cannot explain why these given circumstances exist and how they evolve.

The model of this chapter demonstrates the possible long-run impacts of non-economic phenomena on economic outcomes. The habit stock of fertility introduces a social dimension to the individual decision-making process. Furthermore, the model captures the evolution and persistence of these habits and their effect on the economy's long-run growth and development path. The model predicts that the presence of habits can delay or stall the transition of an economy to its modern growth regime. A social norm on fertility restricts the earning abilities of agents through limiting their labor supply when the constraint is binding. The limited labor supply reduces the income of an agent for any t and naturally restricts the growth potential of human capital. In the extended model with secularization, binding fertility habits can cause long(er) periods of stagnation and delay the convergence to the asymptotic equilibrium.

The particular focus of this chapter is the socio-cultural dimension of reproductive behavior. In this respect, de la Croix and Delavallade's (2018) analysis is closely related to the main findings presented here. de la Croix and Delavallade (2018) investigate the effects of religions that give different weights to the roles of child making and rearing on long-run economic development. They classify religions as pro-child religions, i.e., putting "more weight on the number and quality of children", and pro-birth religions, i.e., putting "more weight solely on the number of the children" (de la Croix & Delavallade, 2018, p. 908). Their analysis shows that pro-child religions negatively affect growth at the initial stages of development via lower saving rates and lower labor supply levels. This closely relates to the Regime 1 of the model economy studied here where agents do not invest in education due to their limited labor supply. The other finding of de la Croix and Delavallade (2018) suggests that pro-birth countries depress growth via lower levels of investment in human capital. In the model economy of this chapter, this resembles Regime 3 where the economy experiences economic growth by $e_t > 0$ but with relatively low levels of education expenditure due to the binding social norms on fertility.

2.7.3 The Child Q-Q Trade-off with Social Norms

Social norms directly influence fertility preferences in the model. Therefore, whether a parent invests in the quantity or quality of her children does not solely depend on the returns to education. This is not a common feature of the child Q-Q trade-off literature since it is prevalently assumed that rational agents face this trade-off without any additional, particularly social, constraints. The presence of socio-cultural effects inevitably complicates the trade-off. A recent work of de la Croix and Perrin (2018) investigates whether the parsimonious rational choice theory can explain the fertility and education transition of the 19th century France. Their findings and the results presented here are analogous and both sets of results have important implications on the child Q-Q trade-off. de la Croix and Perrin (2018) shows that the parsimonious rational choice theory can only explain 38% of the variations in fertility while it is able to explain a relatively larger portion of variations in education. The fact that the rational choice mechanisms can only explain a considerably small portion of fertility changes shows that "even in the case of France, which is considered the pioneer in low fertility norms, socioeconomic conditions affect fertility" (de la Croix & Perrin, 2018, p. 240).

The model of this chapter has two noteworthy implications regarding the child Q-Q trade-off. First, substituting fertility and education cannot be achieved when social norms are binding. In Regimes 1 and 3, agents have x_t (or ξx_t) children regardless of their choice of education expenditure. Binding norms reduce the problem to choosing between consumption and education. An adult can substitute between n_t and e_t only when the social norm constraint is slack, i.e., in Regimes 2 and 4. These results are fully consistent with de la Croix and Perrin's (2018) finding that rational choice theory explains a relatively large part of the variations in education; even though fertility decisions are constrained by social norms, the effects of economic incentives on education decisions are still strong via the consumption-education trade-off in Regimes 1 and 3.

Second, binding social norms at t not only prevent generation t from substituting fertility with education but also make it harder for the next generation to do so. Under binding social norms, generation t chooses a fertility level above the one that they would have chosen in the absence of a social norm constraint; this is a trivial implication of $n_t \geq x_t$. A relatively high fertility level at t then results in a higher increase or a lower decrease in ζ_{t+1}, making the social norm constraint in $t+1$ more stringent. This would prevent or slow down a fertility transition especially in relatively traditional or conservative societies.

2.7.4 Underdevelopment

The basic model and its extension with secularization have implications regarding the global patterns of underdevelopment and low-growth equilibria. Consider Regime 3 where fertility norms are binding and education expenditure is positive. First, Proposition 2.3 shows that G_t in this regime is negatively related to ζ_t and x_t, as both variables negatively affect the optimal level of education expenditure. This implies that economies with (i) relatively large populations per land and (ii) relatively high fertility norms perform worse than their peers with opposite characteristics.

Second, a higher degree of historical persistence of fertility habits, i.e., higher ψ, and a higher degree of conservatism, i.e., higher ξ, increase the time that the model economy spends in Regimes 1 and 3 and can eventually cause prolonged periods with zero or low growth rates of human capital. This follows because the dynamics of ζ_t and x_t in Regimes 1 and 3 imply that higher values of ψ and ξ cause milder decreases in x_t. Additionally, higher levels of ξ cause higher increases (or lower decreases) in ζ_t within these regimes. There are, therefore, long-lasting effects of fertility norms for societies who are both conservative and traditionalist. ψ resembles the degree to which a society preserves its norms and traditions through generations, i.e., how traditionalist it is. Growth rates remain lower in these countries for relatively longer periods.

2.7.5 Female Labor Force Participation

Alesina and Giuliano (2010) demonstrate that female labor force participation rates are lower in societies with stronger family ties. Their basic explanation is that women take up a role to "stay at home and run the family" especially in large families. As an example, İlkkaracan (2012) shows that marriage is an important barrier for female labor force participation with married women having significantly less probability to work compared to their unmarried peers. Her findings illustrate the impact of the institutionalized patriarchal gender roles in Turkey with “male-breadwinner/female-homemaker families” (İlkkaracan, 2012, p. 14). Dildar’s (2015) work contributes to İlkkaracan’s (2012) findings by showing that female labor force participation rates and the prevalence of patriarchal norms (women being responsible for housework and childcare) are negatively related.

Gender roles, especially the ones related with work and fertility, are not only limited to the contemporary social norms and beliefs. Fernández, Fogli, and Olivetti (2004), Fernández (2007), and Fernández and Fogli (2009) empirically show that the cultural heritage and cultural transmission within the family have substantial influences on fertility and the labor force participation of women. A more recent study by Alesina, Giuliano, and Nunn (2013) investigates whether different approaches to women's role in the society have deep cultural origins and finds a strong correlation between the traditional agricultural practices and contemporary gender norms. They show that the effect of male-oriented production methods still persist and result in greater gender inequality where the women constitute a smaller portion of the labor market.

The model of this chapter can explain how cultural and social institutions determine women's role in several ways: First, especially in societies where women are seen responsible for childcare, in more traditional societies according to Alesina and Giuliano (2010), a high $\zeta_t x_t$ creates an obstacle for working women. Assuming that households in this model represent a married couple with both men and women sharing the time endowment, a sufficiently high $\zeta_t x_t$ forces the women to allocate all of their time on childbearing while the men work. The effect is weaker when either ζ_t or x_t is smaller where declines in x_t can be interpreted as the declining belief that "the natural place for women is within the home" (Alesina et al., 2013, p. 471).

Second, a high ψ can be interpreted as the persistence of patriarchal norms for longer periods which forces women to behave in a similar way that their ancestors did. With higher values of ψ, x_t changes relatively slowly and women do not participate in activities outside the domestic sphere for longer periods as in Alesina et al. (2013).

Finally, lower values of ξ would naturally imply a faster abandonment of initial patriarchal norms through secularization. Assume that fertility decisions, aside from the social norms constraint, are solely made by women. Assume further that $\xi_t = \xi(h_t)$ is initially close to one and a decreasing function of h_t. The assumption that ξ_t and h_t (hence, e_t) being negatively related is consistent with the findings of Gündüz-Hoşgör and Smits (2008) that education and female labor force participation, i.e., patriarchal norms, are negatively related in Turkey. This would imply that (i) a more traditional or conservative society can get stuck in Regime 1 for longer periods with no education where women are excluded from the market activities, and (ii) once growth in h_t is initiated, i.e. $e_t > 0$, the society starts to question patriarchal norms (ξ_t decreases) and female labor force participation accelerates.

2.7.6 Mortality

The simplest way to capture the role of mortality is to introduce a child mortality rate d_t and assume, as in Weisdorf (2004), that $d_t = d(y_t)$ is a decreasing function of y_t with

$\lim_{y_t \to 0} d_t = 1$ and $\lim_{y_t \to +\infty} d_t = 0$. For simplicity, suppose that net fertility can simply be written as $n_t = b_t(1 - d_t)$ where b_t is the total number of births. Also suppose that agents take d_t as given and choose b_t.

This extension would have important implication regarding the timing of the demographic transition. If the model economy enters Regime 3—positive education expenditure under binding social norms—before Regime 4—positive education expenditure under non-binding social norms—, the demographic path of the economy closely resembles the path of the Western European countries in the 19th century where fertility rates remain relatively high and stable (i.e., ξx_t) but mortality rates decline with increases in y_t.

The results following from this extension would also be in line with the experience of the majority of underdeveloped economies since more traditional, or religious societies would (i) experience relatively milder drops in mortality rates due to the persistence of fertility habits (i.e., high ψ) or strong religious norms (i.e., high ξ) and (ii) sustain relatively high and stable fertility rates for longer periods. This would strengthen the model's argument that relatively secular societies complete their demographic transition and converge to their balanced growth past relatively faster.

2.7.7 The Fertility Transition of Sub-Saharan Africa

According to Caldwell and Caldwell (1987), high fertility in sub-Saharan African originates from strong religious beliefs that demand high fertility for the continuation of the family lineage. In addition, the societal structure supported by religious norms weakens the link between reproductive behavior and the cost of having children. The works of Munshi and Myaux (2006), Heaton (2011), and Gyimah et al. (2012) provide further evidence on the influences of social and religious norms/structures on fertility in sub-Saharan Africa. The influences are mostly through the usage of contraceptive methods. Groth and May's (2017, Part 4) assertion that the cultural desire for a large family caused a slow fertility decline in sub-Saharan Africa is another explanation. The common point is that African socio-cultural structure has to be the starting point to study the demographic patterns in sub-Saharan Africa.

What is interesting here is that the findings of the existing literature on the strong ties of African fertility with social and religious norms and the persistence of these norms imply an uncommon explanation to the stalled (or slow) fertility transition in the region. These findings, together with the ones presented in this chapter and with those of Prettner and Strulik's (2017), suggest that sub-Saharan Africa may not have initiated a child Q-Q trade-off because they may not have faced such a trade-off at all. Consider Regimes 1 and 3 in the model of this chapter. These regimes represent the cases where a child Q-Q trade-off does not exist due to the binding social norms. Reproductive decisions are being determined by social norms, and agents cannot decline their fertility *regardless of the costs and benefits of having children or educating them*. With

- a high x_t, representing the high fertility demand originating from religious beliefs,
- a high ψ, representing the persistence of African culture and beliefs, and
- a high ξ, representing the resistance of African culture to change,

the sub-Saharan African region seems to be stuck in a state with high fertility and low or no education, despite the high costs of having children and relatively small habitable areas. As Yeatman and Trinitapoli (2008) show and Prettner and Strulik (2017) suggest, these economies can escape from this state by altering the social norms and religious beliefs that keep fertility rates high.

Religious and social norms, as shown by Caldwell and Caldwell (1987), are significant forces that influence the fertility pattern of sub-Saharan Africa. The standard child Q-Q trade-off literature predicts an increase in the education expenditure of children at the expense of their number. The social and religious constraints seem to be the forces that prevent this trade-off to operate. That is, sub-Saharan African countries may already be stuck in a high fertility and low growth equilibrium instead of being at the early stages of their fertility transitions with social and religious norms delaying or stalling the transition.

2.8. CONCLUDING REMARKS

Models in which agents are strictly isolated from the society provide economists with a convenient environment that simplifies the complex structure of the human decision-making processes. In most cases, the benefits of such simplifications outweigh the costs of assuming away the aspects of reality that change only slowly and from one generation to another. However, in areas where the decision-making processes have strong ties with non-economic motivations (e.g., social and cultural norms, religion, etc.), the results originating from the isolated rational-agent models may not be truly reliable.

Reproduction is a domain of inquiry where non-economic (socio-cultural) forces crucially influence the individual decision-making processes. A convincing case has recently been put forth by de la Croix and Perrin (2018) who demonstrate that a parsimonious rational-choice theory that assumes away non-economic dimensions can only explain a small fraction of variations in fertility. Other works, such as those of Leibenstein (1981), Hull (1983), Montgomery and Casterline (1996), Akerlof (1997), Manski and Mayshar (2003), Bernardi and Klärner (2014), and Ciliberto, Miller, Nielsen, and Simonsen (2016), support the argument that non-economic phenomena, especially culture and formal and informal institutions, have non-negligible effects on demographic change. Since fertility decisions affect living standards through factor accumulation decisions in the long run, understanding the patterns of demographic change in a satisfactory way is a critical task for growth and development economists.

The goal of this chapter is to analyze how individual decisions on fertility are formed and how they affect the (very) long-run patterns when social norms influence reproductive behavior. The chapter relaxes the isolated individual assumption by forming a habit constraint that stems from the social hierarchy as in Montgomery and Casterline (1996). The habit constraint resembles the consumption aspirations in de la Croix and Michel (1999) and de la Croix (2001) and imposes a lower bound on fertility for each generation. The results of the basic model can be summarized as follow:

- The model features multiple equilibria. When the initial state of equilibrium is historically accurate, i.e., a small size of population and binding social norms that dictate high fertility, the economy converges to a steady-state with either (i) high fertility and no growth or (ii) high fertility and low growth.
- If social norms are binding in equilibrium, a child Q-Q trade-off does not exist. This implies that parents cannot decrease the number of children to educate them. Furthermore, parents' potential incomes are restricted by relatively high childbearing costs, and this renders investing in human capital accumulation a non-optimal action.
- If the society is strictly conservative, i.e., if adult agents never question the existing social norms, the economy cannot converge to a modern growth equilibrium throughout which fertility declines.

The basic model of this chapter, on the other hand, does not provide a fully accurate representation of economic history. In reality, we have observed historical fertility transitions in the developed societies of today, despite their pre-modern social norms that dictate high fertility. The setup of the basic model does not allow for such a transition simply because of strict conservatism that leads agents to obey the existing fertility norms. Conversely, the transition from high to low fertility, as Baudin (2015) and T. E. Murphy (2015) show, has been through the secularization and abandonment of social norms that dictate high fertility. To capture the effects of such a secularization movement, this chapter also analyzes an extended model that includes a secularization parameter and allows each generation to question the existing social norms to some degree. The extended model predicts that, regardless of its initial position, an economy converges to an asymptotic equilibrium where social norms are not binding and growth is of modern type characterized by fertility declines. However, the transition to the equilibrium still depends on the historical persistence of social norms and the degree of secularization. Depending on the initial states, it may take a long time for relatively traditional and/or conservative societies to escape stagnation.

It should be noted that even the extended model ignores some aspects of reality. To begin with, the model assumes that all agents adhere to social norms and have the same preferences. In reality, however, the impacts of social norms (or social incentives) and economic rationale (or economic incentives) may vary among people. The differences in beliefs, tastes, and social identities inevitably lead to significant variations in observed preferences. In the context of this chapter, relatively secular individuals would prefer to not to obey social norms while conservative individuals would have stronger aspirations to follow traditions. As Postlewaite (2011) elaborates, determining an individual's social group exogenously and assuming that all individuals within the same group are identical causes a model to deviate away from picturing the reality in a successful way.

Second, to obtain closed-form solutions, the basic and extended models does not incorporate cultural diffusion. Assuming away the diffusion of preferences and beliefs within the society limits the usefulness of the analysis as demonstrated by Baudin (2010) and Bar-El, García-Muñoz, Neuman, and Tobol (2013) whose cultural diffusion models provide a more comprehensive understanding of fertility through direct and oblique socialization. An attempt to extend the models studied in this chapter with direct and oblique socialization has resulted in analytically intractable results that may be explored further only through the analysis of numerical solutions. This task is left for future.

SUMMARY AND CONCLUSION

> "[...] an adequate theory of economic conduct, even for statical purposes, cannot be drawn in terms of the individual simply—as is the case with the marginal-utility economics—because it cannot be drawn in terms of the underlying traits of human nature simply; since the response that goes to make up human conduct takes place under institutional norms and only under stimuli that have an institutional bearing; for the situation that provokes and inhibits action in any given case is itself in great part of institutional, cultural derivation."
>
> Veblen 1909, p. 629

In the last decades, the mainstream literature on growth and development has returned to its classical political economy foundations; the way by which the total output of the economy grows and how this growing output is distributed among the members of the society. Especially since the Great Recession, there has been a growing interest in understanding what factors mainly determine within-country income and wealth inequalities since growth does not necessarily trickle down to the wage earners. The distributions of economic aggregates are as important as their accumulation since both phenomena inevitably affect each other. The causality may run through the economic channels as in the case of less egalitarian income and wealth distributions preventing a larger portion of agents to invest in human capital under credit constraints as in Galor and Moav (2004). Or the causality may run through socio-political channels as in the case of social and political unrest caused by less egalitarian distributions repressing economic incentives as in Alesina and Rodrik (1994) or resulting in unsustainable consumer debt expansion as in Kumhof et al. (2015). The recent work of Berg, Ostry, Tsangarides, and Yakhshilikov (2018), Brueckner and Lederman (2018), and Huber and Mayoral (2019) follow the previous works on underlining how adversely inequality affects economic outcomes.

The growing attention given to income and wealth inequalities has led economists to focus on various sources of heterogeneity that shape distributions of income and wealth in the long run. The origins of inequality can be traced back to intergenerationally transmitted endowments or traits such as inherited wealth via bequests (e.g., as in Gale and Scholz (1994), Mulder et al. (2009)) or earning abilities via education (e.g., as in Castelló and Doménech (2002) and De Nardi (2004)). The primary sources affecting the wealth and income distributions in the long run are, therefore, closely related to how agents accumulate physical and human capital. The economic incentives behind each form of capital accumulation are established in the existing literature. What remains relatively unexplored is the role of social motives and norms. The boundaries of the conventional economic theory need to be extended to integrate the social sphere with individual decision-making in order to achieve a more satisfactory analysis of the accumulation processes.

The goal of this thesis is to address the aspects of human behavior that the existing literature largely assumes away: Decision makers in the real world are not strictly isolated from each other, and both their preferences and their choices are interdependent. Furthermore, the socially constructed factors that connect these real-world decision makers to each other are transmitted across generations, causing historical persistence in these factors. Surely, that social dimensions of human behavior exist and are not less significant than economic incentives have been acknowledged in the literature before, with Veblen (1898a, 1898b, 1899), Duesenberry (1949) and Leibenstein (1950) being the pioneers of this line of thought. However, the analytical simplicity of frameworks with isolated agents and the belief that economic incentives are strong enough to offset the effects of social incentives seem to have legitimized the exclusion of the social aspects. In this respect, this thesis aims at investigating the role of social motives and norms behind the typical decision-making processes. The thesis constructs two OLG GE models in Chapters 1 and 2 focusing on physical and human capital, respectively.

The first chapter of the thesis, entitled *Status Preferences, Wealth Inequality and Endogenous Growth*, aims at capturing the effects of social motives on growth and wealth inequality. The chapter introduces a discrete-time, heterogeneous agent, OLG GE model where agents are linked through *status-seeking motive* and social status is represented by their relative wealth. The social motive that is tied to the relative wealth affects (i) physical capital accumulation and growth, and (ii) the evolution of wealth inequality. The analysis in that chapter yields several distributional and welfare-related implications:

- Under the assumption that preferences are inherited in each dynasty and are i.i.d. among all dynasties, economic growth and wealth distribution are affected by the same set of factors. Higher average saving rate increases the balanced growth rate and leads to a more egalitarian steady-state distribution of detrended wealth, and higher elasticity of capital reduces the rate of economic growth and increases wealth inequality.

- The variations in preferences (both the bequest and status-seeking motives) explain the steady-state variance of the detrended wealth distribution and result in persistent inequality in the long run. Large variances of either one of the preference parameters can cause the variance of detrended wealth distribution to explode, creating a rationale to tax capital income and redistribute the revenue. Capital income taxation reduces wealth inequality without affecting the rate of economic growth.
- If the status-seeking motive is sufficiently strong, it generates negative externalities on welfare that offset the positive effects associated with growth. An extension of the model with a two-class society of leisure and working classes shows that, if the size of the working class is sufficiently large or if the average status-seeking motive of the leisure class is sufficiently strong, taxing capital income and redistributing the revenue optimize the utilitarian social welfare.

The second chapter of the thesis, entitled *Social Norms, Fertility, and Human Capital Accumulation*, focuses on how *fertility habits* in the form of *social norms* affect human capital accumulation. The chapter assumes that reproductive behavior of agents is based on both social and economic foundations. The chapter constructs a discrete-time, OLG GE model where social norms affect fertility decisions through a habit constraint that determines the minimum number of children each agent can have. The model allows for zero-growth in human capital and captures a transition from long periods of stagnation to an era of perpetual growth. Its results have several implications for the observed demographic trends and underdevelopment:

- Social norms, if binding, can prevent parents to substitute between fertility and education, thereby leading them to not to invest in education.
- If agents in an economy are strictly conservative, i.e., if they do not question existing social norms, the economy cannot escape stagnation. Secularization can ensure that the economy escapes from stagnation and transits to an asymptotic equilibrium where growth based on human capital accumulation is perpetual.
- How traditional and/or conservative a society is can explain its failure to experience a growth take-off. Even if the existing technology and childbearing costs form an economic motive to initiate a demographic transition, stronger social incentives can prevent people from decreasing fertility and result in slow economic growth with an expanding population.
- Slow or no secularization in societies with patriarchal norms can hinder female labor force participation and gender equality.

It has been roughly 250 years since Adam Smith wrote *The Wealth of Nations* and planted the seeds of economics as a social science, and it has been roughly 120 years since Thorstein Veblen wrote *The Theory of the Leisure Class* and emphasized the social influences on human behavior. However, economists have largely neglected the effects of the socio-political and socio-cultural environments on human behavior. More specifically, social motives and social norms have not become the central ingredients of canonical models of growth and development.

The last decades, on the other hand, have seen a *renaissance* in growth and development literatures. Theorists have incorporated income and wealth heterogeneity into formal macroeconomic models. They have developed endogenous growth and persistent poverty models. They have unified these two types of models to explain stagnation and growth of an economy in the very long run within a single framework. Social motives and social norms are now taken as essential aspects of economic outcomes concerning growth and welfare by an increasingly many economists. This thesis contributes to the ongoing recognition of economic agents as social beings by analyzing how social motives and social norms affect endogenous growth and inequality patterns in the long run.

REFERENCES

Abel, A. B. (1990). *Asset prices under habit formation and catching up with the Joneses* (Working Paper No. 3279). National Bureau of Economic Research. doi: 10.3386/w3279

Abel, A. B. (2007). *Optimal capital income taxation* (Working Paper No. 13354). National Bureau of Economic Research. doi: 10.3386/w13354

Acemoglu, D., Johnson, S., & Robinson, J. A. (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review*, *91*(5), 1369-1401. doi: 10.1257/aer.91.5.1369

Acemoglu, D., & Robinson, J. A. (2006). *Economic origins of dictatorship and democracy*. New York, New York: Cambridge University Press.

Acemoglu, D., & Robinson, J. A. (2012). *Why nations fail: The origins of power, prosperity, and poverty*. New York: Crown Publishing Group.

Acemoglu, D., & Ventura, J. (2002). The world income distribution. *Quarterly Journal of Economics*, *117*(2), 659–694. doi: 10.1162/003355302753650355

Acemoglu, D., & Zilibotti, F. (1997). Was Prometheus unbound by chance? risk, diversification, and growth. *Journal of Political Economy*, *105*(4), 709–751. doi: 10.1086/262091

Adsera, A. (2006). Marital fertility and religion in Spain, 1985 and 1999. *Population Studies*, *60*(2), 205–221. doi: 10.1080/00324720600684817

Agadjanian, V. (2001). Religion, social milieu, and the contraceptive revolution. *Population Studies*, *55*(2), 135–148. doi: 10.1080/00324720127691

Aghion, P., & Bolton, P. (1997). A theory of trickle-down growth and development. *Review of Economic Studies*, *64*(2), 151–172. doi: 10.2307/2971707

Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *Quarterly Journal of Economics*, *109*(3), 659–684. doi: 10.2307/2118417

Aiyagari, S. R. (1995). Optimal capital income taxation with incomplete markets, borrowing constraints, and constant discounting. *Journal of Political Economy*, *103*(6), 1158–1175. doi: 10.1086/601445

Akerlof, G. A. (1997). Social distance and social decisions. *Econometrica*, *65*(5), 1005–1027. doi: 10.2307/2171877

Akerlof, G. A., & Kranton, R. (2010). Identity economics. *Economists' Voice*, *7*(2). doi: 10.2202/1553-3832.1762

Akerlof, G. A., & Shiller, R. J. (2010). *Animal spirits: How human psychology drives the economy, and why it matters for global capitalism*. Princeton: Princeton University Press.

Alesina, A., & Giuliano, P. (2010). The power of the family. *Journal of Economic*

Growth, *15*(2), 93–125. doi: 10.1007/s10887-010-9052-z

Alesina, A., & Giuliano, P. (2015). Culture and institutions. *Journal of Economic Literature*, *53*(4), 898–944. doi: 10.1257/jel.53.4.898

Alesina, A., Giuliano, P., & Nunn, N. (2013). On the origins of gender roles: Women and the plough. *Quarterly Journal of Economics*, *128*(2), 469–530. doi: 10.1093/qje/qjt005

Alesina, A., & Perotti, R. (1996). Income distribution, political instability, and investment. *European Economic Review*, *40*(6), 1203–1228. doi: 10.1016/0014-2921(95)00030-5

Alesina, A., & Rodrik, D. (1994). Distributive politics and economic growth. *Quarterly Journal of Economics*, *109*(2), 465–490. doi: 10.2307/2118470

Alvaredo, F., Chancel, L., Piketty, T., Saez, E., & Zucman, G. (2018). *World inequality report 2018*. Retrieved from `https://wir2018.wid.world/files/download/wir2018-full-report-english.pdf`

Alvarez-Cuadrado, F. (2007). Envy, leisure, and restrictions on working hours. *Canadian Journal of Economics/Revue canadienne d'économique*, *40*(4), 1286–1310. doi: 10.1111/j.1365-2966.2007.00452.x

Alvarez-Cuadrado, F., & Long, N. V. (2012). Envy and inequality. *Scandinavian Journal of Economics*, *114*(3), 949–973. doi: 10.1111/j.1467-9442.2012.01714.x

Alvarez-Cuadrado, F., Monteiro, G., & Turnovsky, S. J. (2004). Habit formation, catching up with the Joneses, and economic growth. *Journal of Economic Growth*, *9*(1), 47–80. doi: 10.1023/B:JOEG.0000023016.26449.eb

Alvarez-Cuadrado, F., & van Long, N. (2011). The relative income hypothesis. *Journal of Economic Dynamics & Control*, *35*, 1489–1501. doi: 10.1016/j.jedc.2011.03.012

Andreoni, J. (1989). Giving with impure altruism: Applications to charity and Ricardian Equivalence. *Journal of Political Economy*, *97*(6), 1447–1458. doi: 10.1086/261662

Angelopoulos, K., Lazarakis, S., & Malley, J. R. (2017). *Wealth inequality and externalities from ex ante skill heterogeneity* (Working Paper No. 6572). Munich, Germany: CESifo. Retrieved from `https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3021688`

Arifovic, J., Bullard, J., & Duffy, J. (1997). The transition from stagnation to growth: An adaptive learning approach. *Journal of Economic Growth*, *2*(2), 185–209. doi: 10.1023/A:1009733218546

Arrow, K. J. (1962). The economic implications of learning by doing. *Review of Economic Studies*, *29*(3), 155–173. doi: 10.2307/2295952

Atkeson, A., Chari, V. V., & Kehoe, P. J. (1999). Taxing capital income: A bad idea. *Federal Reserve Bank of Minneapolis Quarterly Review*, *23*(3), 3–4. Retrieved from `https://www.minneapolisfed.org/research/quarterly-review/taxing-capital-income-a-bad-idea`

Atkinson, A. B. (2015). *Inequality: What can be done?* Cambridge, Massachusetts: Harvard University Press.

Atkinson, A. B., Piketty, T., & Saez, E. (2011). Top incomes in the long run of history. *Journal of Economic Literature*, *49*(1), 3–71. doi: 10.1257/jel.49.1.3

Atkinson, A. B., & Sandmo, A. (1980). Welfare implications of the taxation of savings. *Economic Journal*, *90*(359), 529–549. doi: 10.2307/2231925

Atkinson, A. B., & Stiglitz, J. E. (1976). The design of tax structure: Direct versus indirect taxation. *Journal of Public Economics*, *6*(1-2), 55–75. doi: 10.1016/0047-2727(76)90041-4

Attar, M. A. (2015). Entrepreneurship, knowledge, and the industrial revolution. *Economics: The Open-Access, Open-Assessment E-Journal*, *9*(2015-3), 1–55. doi: 10.5018/economics-ejournal.ja.2015-3

Azariadis, C., & Drazen, A. (1990). Threshold externalities in economic development. *Quarterly Journal of Economics*, *105*(2), 501–526. doi: 10.2307/2937797

Azariadis, C., & Drazen, A. (1993). Endogenous fertility in models of growth. *Revista de Análisis Economico*, *2*, 131–144. Retrieved from `https://www.rae-ear.org/index.php/rae/article/view/313`

Banerjee, A. V., & Newman, A. F. (1993). Occupational choice and the process of development. *Journal of Political Economy*, *101*(2), 274–298. doi: 10.1086/261876

Bar-El, R., García-Muñoz, T., Neuman, S., & Tobol, Y. (2013). The evolution of secularization: Cultural transmission, religion and fertility—theory, simulations and evidence. *Journal of Population Economics*, *26*(3), 1129–1174. doi: 10.1007/s00148-011-0401-9

Barro, R. J. (1999). *Inequality, growth, and investment* (Working Paper No. 7038). National Bureau of Economic Research. doi: 10.3386/w7038

Barro, R. J., & Becker, G. S. (1989). Fertility choice in a model of economic growth. *Econometrica*, *57*(2), 481–501. doi: 10.2307/1912563

Baudin, T. (2010). A role for cultural transmission in fertility transitions. *Macroeconomic Dynamics*, *14*(4), 454–481. doi: 10.1017/S1365100509090403

Baudin, T. (2015). Religion and fertility: The French connection. *Demographic Research*, *32*(13), 397–420. doi: 10.4054/DemRes.2015.32.13

Becker, G. S. (1960). An economic analysis of fertility. In *Demographic and economic change in developed countries* (pp. 209–240). Columbia University Press. Retrieved from `http://www.nber.org/chapters/c2387`

Becker, G. S. (1981). *A treatise on the family*. Cambridge, Massachusetts: Harvard University Press.

Becker, G. S., Murphy, K. M., & Tamura, R. (1990). Human capital, fertility, and economic growth. *Journal of Political Economy*, *98*(5, Part 2), S12–S37. doi: 10.1086/261723

Becker, S. O., Pfaff, S., & Rubin, J. (2016). Causes and consequences of the protestant reformation. *Explorations in Economic History*, *62*, 1–25. doi: 10.1016/j.eeh.2016.07.007

Benabou, R. (1996). Inequality and growth. *NBER Macroeconomics Annual*, *11*, 11–74. doi: 10.1086/654291

Benabou, R. (2000). Unequal societies: Income distribution and the social contract. *American Economic Review*, *90*(1), 96–129. doi: 10.1257/aer.90.1.96

Benhabib, J., Bisin, A., & Zhu, S. (2011). The distribution of wealth and fiscal policy in economies with finitely lived agents. *Econometrica*, *79*(1), 123–157. doi: 10.3982/ECTA8416

Berg, A., Ostry, J. D., Tsangarides, C. G., & Yakhshilikov, Y. (2018). Redistribution, inequality, and growth: New evidence. *Journal of Economic Growth*, *23*(3), 259–305. doi: 10.1007/s10887-017-9150-2

Bernardi, L. (2003). Channels of social influence on reproduction. *Population Research and Policy Review*, *22*(5-6), 427–555. doi: 10.1023/B:POPU.0000020892.15221.44

Bernardi, L., Keim, S., & Von der Lippe, H. (2007). Social influences on fertility: A comparative mixed methods study in Eastern and Western Germany. *Journal of Mixed Methods Research*, *1*(1), 23–47. doi: 10.1177/2345678906292238

Bernardi, L., & Klärner, A. (2014). Social networks and fertility. *Demographic Research*, *30*, 641–670. doi: 10.4054/DemRes.2014.30.22

Bertola, G. (1993). Factor shares and savings in endogenous growth. *American Economic Review*, *83*(5), 1184–1198. Retrieved from `https://www.jstor.org/stable/2117555`

Bertola, G. (2000). Macroeconomics of distribution and growth. In *Handbook of income distribution* (Vol. 1, pp. 477–540). Elsevier. doi: 10.1016/S1574-0056(00)80012-3

Bewley, T. (1986). Stationary monetary equilibrium with a continuum of independently fluctuating consumers. In *Contributions to mathematical economics in honor of gérard debreu* (Vol. 79). North-Holland.

Bhattacharya, J., & Chakraborty, S. (2012). Fertility choice under child mortality and social norms. *Economics Letters*, *115*(3), 338–341. doi: 10.1016/j.econlet.2011.11.029

Bilancini, E., & D'Alessandro, S. (2012). Long-run welfare under externalities in consumption, leisure, and production: A case for happy degrowth vs. unhappy growth. *Ecological Economics*, *84*, 194–205. doi: 10.1016/j.ecolecon.2011.10.023

Bils, M., & Klenow, P. J. (2000). Does schooling cause growth? *American Economic Review*, *90*(5), 1160–1183. doi: 10.1257/aer.90.5.1160

Blau, F. D. (1991). *The fertility of immigrant women: Evidence from high fertility source countries* (Working Paper No. 3608). National Bureau of Economic Research. doi: 10.3386/w3608

Boldrin, M., De Nardi, M., & Jones, L. E. (2005). *Fertility and social security* (Working Paper No. 11146). National Bureau of Economic Research. doi: 10.3386/w11146

Boldrin, M., & Jones, L. E. (2002). Mortality, fertility, and saving in a Malthusian economy. *Review of Economic Dynamics*, *5*(4), 775–814. doi: 10.1006/redy.2002.0186

Bongaarts, J., & Watkins, S. C. (1996). Social interactions and contemporary fertility transitions. *Population and Development Review*, *22*(4), 639–682. doi: 10.2307/2137804

Brueckner, M., & Lederman, D. (2018). Inequality and economic growth: the role of initial income. *Journal of Economic Growth*, *23*(3), 341–366. doi: 10.1007/s10887-018-9156-4

Burke, M. A., & Young, H. P. (2011). Social norms. In *Handbook of social economics* (Vol. 1, pp. 311–338). Elsevier. doi: 10.1016/B978-0-444-53187-2.00008-5

Cagetti, M., & De Nardi, M. (2006). Entrepreneurship, frictions, and wealth. *Journal of Political Economy*, *114*(5), 835–870. doi: 10.1086/508032

Caldwell, J. C., & Caldwell, P. (1987). The cultural context of high fertility in sub-Saharan Africa. *Population and Development Review*, *13*(3), 409–437. doi: 10.2307/1973133

Caldwell, J. C., Orubuloye, I. O., & Caldwell, P. (1992). Fertility decline in Africa: A new type of transition? *Population and Development Review*, *18*(2), 211–242. doi: 10.2307/1973678

Cantoni, D., Dittmar, J., & Yuchtman, N. (2018). Religious competition and reallocation: the political economy of secularization in the protestant reformation. *Quarterly Journal of Economics*, *133*(4), 2037-2096. doi: 10.1093/qje/qjy011

Carroll, C. D. (1997). Buffer-stock saving and the life cycle/permanent income hypothesis. *Quarterly Journal of Economics*, *112*(1), 1–55. doi: 10.1162/003355397555109

Carroll, C. D., Overland, J., & Weil, D. N. (1997). Comparison utility in a growth model. *Journal of Economic Growth*, *2*(4), 339–367. doi: 10.1023/A:1009740920294

Carroll, C. D., Overland, J., & Weil, D. N. (2000). Saving and growth with habit formation. *American Economic Review*, *90*(3), 341–355. doi: 10.1257/aer.90.3.341

Cass, D. (1965). Optimum growth in an aggregative model of capital accumulation. *Review of Economic Studies*, *32*(3), 233–240. doi: 10.2307/2295827

Castaneda, A., Diaz-Gimenez, J., & Rios-Rull, J.-V. (2003). Accounting for the US earnings and wealth inequality. *Journal of Political Economy*, *111*(4), 818–857. doi: 10.1086/375382

Castelló, A., & Doménech, R. (2002). Human capital inequality and economic growth: Some new evidence. *Economic Journal*, *112*(478), C187–C200. doi: 10.1111/1468-0297.00024

Castelló, A., & Doménech, R. (2017). Status goods: Experimental evidence from platinum credit cards. *Quarterly Journal of Economics*, *133*(3), 1561–1595. doi: 10.1093/qje/qjx048

Chabé-Ferret, B. (2019). Adherence to cultural norms and economic incentives: Evidence from fertility timing decisions. *Journal of Economic Behavior & Organization*, *162*, 24–48. doi: 10.1016/j.jebo.2019.04.003

Chamley, C. (1986). Optimal taxation of capital income in general equilibrium with infinite lives. *Econometrica: Journal of the Econometric Society*, 607–622. doi: 10.2307/1911310

Charles, K. K., Hurst, E., & Roussanov, N. (2009). Conspicuous consumption and race. *Quarterly Journal of Economics*, *124*(2), 425–467. doi: 10.1162/qjec.2009.124.2.425

Christen, M., & Morgan, R. M. (2005). Keeping up with the Joneses: Analyzing the effect of income inequality on consumer borrowing. *Quantitative Marketing and Economics*, *3*(2), 145–173. doi: 10.1007/s11129-005-0351-1

Ciliberto, F., Miller, A. R., Nielsen, H. S., & Simonsen, M. (2016). Playing the fertility game at work: An equilibrium model of peer effects. *International Economic Review*, *57*(3), 827–856. doi: 10.1111/iere.12177

Clark, A. E., Frijters, P., & Shields, M. A. (2008). Relative income, happiness, and utility: An explanation for the Easterlin paradox and other puzzles. *Journal of Economic Literature*, *46*(1), 95–144. doi: 10.1257/jel.46.1.95

Clark, A. E., & Oswald, A. J. (1996). Satisfaction and comparison income. *Journal of Public Economics*, *61*(3), 359–381. doi: 10.1016/0047-2727(95)01564-7

Clemens, C., & Heinemann, M. (2015). Endogenous growth and wealth inequality under incomplete markets and idiosyncratic risk. *Journal of Macroeconomics*, *45*, 300–317. doi: 10.1016/j.jmacro.2015.05.008

Cole, H. L., Mailath, G. J., & Postlewaite, A. (1992). Social norms, savings behavior, and growth. *Journal of Political economy*, *100*(6), 1092–1125. doi: 10.1086/261855

Connolly, M., & Peretto, P. F. (2003). Industry and the family: Two engines of growth. *Journal of Economic Growth*, *8*(1), 115–148. doi: 10.1023/A:1022864901652

Córdoba, J. C., & Ripoll, M. (2013). What explains schooling differences across countries? *Journal of Monetary Economics*, *60*(2), 184–202. doi: 10.1016/j.jmoneco.2012.12.005

Cordoba, J. C., & Verdier, G. (2008). Inequality and growth: Some welfare calculations. *Journal of Economic Dynamics and Control*, *32*(6), 1812–1829. doi: 10.1016/j.jedc.2007.06.015

Corneo, G., & Jeanne, O. (1999). Pecuniary emulation, inequality and growth. *European Economic Review*, *43*(9), 1665–1678. doi: 10.1016/S0014-2921(98)00046-4

Corneo, G., & Jeanne, O. (2001). Status, the distribution of wealth, and growth. *Scandinavian Journal of Economics*, *103*(2), 283–293. doi: 10.1111/1467-9442.00245

Cynamon, B. Z., & Fazzari, S. M. (2015). Inequality, the great recession and slow recovery. *Cambridge Journal of Economics*, *40*(2), 373–399. doi: 10.1093/cje/bev016

de la Croix, D. (2001). Growth dynamics and education spending: The role of inherited tastes and abilities. *European Economic Review*, *45*(8), 1415–1438. doi: 10.1016/S0014-2921(00)00060-X

de la Croix, D., & Delavallade, C. (2018). Religions, fertility, and growth in South-East Asia. *International Economic Review*, *59*(2), 907–946. doi: 10.1111/iere.12291

de la Croix, D., & Doepke, M. (2003). Inequality and growth: Why differential fertility matters. *American Economic Review*, *93*(4), 1091–1113. doi: 10.1257/000282803769206214

de la Croix, D., & Gosseries, A. (2012). The natalist bias of pollution control. *Journal of Environmental Economics and Management*, *63*(2), 271–287. doi: 10.1016/j.jeem.2011.07.002

de la Croix, D., & Michel, P. (1999). Optimal growth when tastes are inherited. *Journal of Economic Dynamics and Control*, *23*(4), 519–537. doi: 10.1016/S0165-1889(98)00028-1

de la Croix, D., & Perrin, F. (2018). How far can economic incentives explain the French fertility and education transition? *European Economic Review*, *108*, 221–245. doi: 10.1016/j.euroecorev.2018.07.001

De Nardi, M. (2004). Wealth inequality and intergenerational links. *Review of Economic Studies*, *71*(3), 743–768. doi: 10.1111/j.1467-937X.2004.00302.x

Derosas, R., & van Poppel, F. (2006). *Religion and the decline of fertility in the western world*. Dordrecht, The Netherlands: Springer. doi: 10.1007/1-4020-5190-5

Diaz, A., Pijoan-Mas, J., & Rios-Rull, J.-V. (2003). Precautionary savings and wealth distribution under habit formation preferences. *Journal of Monetary Economics*, *50*(6), 1257–1291. doi: 10.1016/S0304-3932(03)00078-3

Dildar, Y. (2015). Patriarchal norms, religion, and female labor supply: Evidence from Turkey. *World Development*, *76*, 40–61. doi: 10.1016/j.worlddev.2015.06.010

Doepke, M. (2004). Accounting for fertility decline during the transition to growth. *Journal of Economic Growth*, *9*(3), 347–383. doi: 10.1023/B:JOEG.0000038935.84627.e4

Duernecker, G. (2007). *Growth effects of consumption jealousy in a two-sector model* (Working Paper No. 201). Vienna, Austria: Institute for Advanced Studies (IHS). Retrieved from `https://www.econstor.eu/handle/10419/72714`

Duesenberry, J. S. (1949). *Income, saving, and the theory of consumer behavior*. Harvard University Press.

Durlauf, S. N., & Walker, J. (2001). Social interactions and fertility transitions. In *Diffusion processes and fertility transition: Selected perspectives* (pp. 115–137). Washington, DC: National Academy Press.

Dutta, J., & Michel, P. (1998). The distribution of wealth with imperfect altruism. *Journal of Economic Theory*, *82*(2), 379–404. doi: 10.1006/jeth.1997.2442

Easterlin, R. A. (1974). Does economic growth improve the human lot? some empirical evidence. In *Nations and households in economic growth* (pp. 89–125). Elsevier. doi: 10.1016/B978-0-12-205050-3.50008-7

Easterlin, R. A. (1995). Will raising the incomes of all increase the happiness of all? *Journal of Economic Behavior & Organization*, *27*(1), 35–47. doi: 10.1016/0167-2681(95)00003-B

Eaton, B. C., & Eswaran, M. (2009). Well-being and affluence in the presence of a Veblen good. *Economic Journal*, *119*(539), 1088–1104. doi: 10.1111/j.1468-0297.2009.02255.x

Erosa, A., & Gervais, M. (2002). Optimal taxation in life-cycle economies. *Journal of Economic Theory*, *105*(2), 338–369. doi: 10.1006/jeth.2001.2877

Farhi, E., & Werning, I. (2010). Progressive estate taxation. *Quarterly Journal of Economics*, *125*(2), 635–673. doi: 10.1162/qjec.2010.125.2.635

Farhi, E., & Werning, I. (2013). Estate taxation with altruism heterogeneity. *American Economic Review*, *103*(3), 489–95. doi: 10.1257/aer.103.3.489

Fernández, R. (2011). Does culture matter? In *Handbook of social economics* (Vol. 1, pp. 481–510). Elsevier. doi: 10.1016/B978-0-444-53187-2.00011-5

Fernández, R., & Fogli, A. (2006). Fertility: The role of culture and family experience. *Journal of the European Economic Association*, *4*(2-3), 552–561. doi: 10.1162/jeea.2006.4.2-3.552

Fernández, R., & Fogli, A. (2009). Culture: An empirical investigation of beliefs, work, and fertility. *American Economic Journal: Macroeconomics*, *1*(1), 146–177. doi: 10.1257/mac.1.1.146

Fernández, R., Fogli, A., & Olivetti, C. (2004). Mothers and sons: Preference formation and female labor force dynamics. *Quarterly Journal of Economics*, *119*(4), 1249-1299. doi: 10.1162/0033553042476224

Fernholz, R. T. (2017). The distributional effects of progressive capital taxes. *Journal of Economic Policy Reform*, *20*(2), 99–112. doi: 10.1080/17487870.2017.1294074

Fernández, R. (2007). Women, work, and culture. *Journal of the European Economic Association*, *5*(2-3), 305-332. doi: 10.1162/jeea.2007.5.2-3.305

Fields, G. S. (2002). *Distribution and development: a new look at the developing world*. MIT press.

Fisher, W. H., & Hof, F. X. (2000). Relative consumption, economic growth, and taxation. *Journal of Economics*, *72*(3), 241–262. doi: 10.1007/BF01231266

Fisher, W. H., & Hof, F. X. (2008). The quest for status and endogenous labor supply: The relative wealth framework. *Journal of Economics*, *93*(2), 109–144. doi: 10

.1007/s00712-007-0297-8
Frank, R. H. (1985). The demand for unobservable and other nonpositional goods. *American Economic Review*, *75*(1), 101–116. Retrieved from https://www.jstor.org/stable/1812706
Frankel, M. (1962). The production function in allocation and growth: a synthesis. *American Economic Review*, *52*(5), 996–1022. Retrieved from https://www.jstor.org/stable/1812179
Frejka, T., & Westoff, C. F. (2008). Religion, religiousness and fertility in the US and in Europe. *European Journal of Population/Revue européenne de Démographie*, *24*(1), 5–31. doi: 10.1007/s10680-007-9121-y
Fuhrer, J. C. (2000). Habit formation in consumption and its implications for monetary-policy models. *American Economic Review*, *90*(3), 367–390. doi: 10.1257/aer.90.3.367
Futagami, K., & Shibata, A. (1998). Keeping one step ahead of the Joneses: Status, the distribution of wealth, and long run growth. *Journal of Economic Behavior & Organization*, *36*(1), 109–126. doi: 10.1016/S0167-2681(98)00072-9
Gabaix, X. (2009). Power laws in economics and finance. *Annual Review of Economics*, *1*(1), 255–294. doi: 10.1146/annurev.economics.050708.142940
Gale, W. G., & Scholz, J. K. (1994). Intergenerational transfers and the accumulation of wealth. *Journal of Economic Perspectives*, *8*(4), 145–160. doi: 10.1257/jep.8.4.145
Gali, J. (1994). Keeping up with the Joneses: Consumption externalities, portfolio choice, and asset prices. *Journal of Money, Credit and Banking*, *26*(1), 1–8. doi: 10.2307/2078030
Galor, O. (2005). From stagnation to growth: Unified growth theory. In *Handbook of economic growth* (Vol. 1, pp. 171–293). Elsevier. doi: 10.1016/S1574-0684(05)01004-X
Galor, O. (2010). The 2008 Lawrence R. Klein lecture—comparative economic development: Insights from unified growth theory. *International Economic Review*, *51*(1), 1–44. doi: 10.1111/j.1468-2354.2009.00569.x
Galor, O. (2011). *Unified growth theory*. Princeton, NJ: Princeton University Press.
Galor, O., & Moav, O. (2002). Natural selection and the origin of economic growth. *Quarterly Journal of Economics*, *117*(4), 1133–1191. doi: 10.1162/003355302320935007
Galor, O., & Moav, O. (2004). From physical to human capital accumulation: Inequality and the process of development. *Review of Economic Studies*, *71*(4), 1001–1026. doi: 10.1111/0034-6527.00312
Galor, O., & Weil, D. N. (1996). The gender gap, fertility, and growth. *American Economic Review*, *86*(3), 374–387. Retrieved from https://www.jstor.org/stable/2118202
Galor, O., & Weil, D. N. (2000). Population, technology, and growth: From Malthusian stagnation to the demographic transition and beyond. *American Economic Review*, *90*(4), 806–828. doi: 10.1257/aer.90.4.806
Galor, O., & Zeira, J. (1993). Income distribution and macroeconomics. *Review of Economic Studies*, *60*(1), 35–52. doi: 10.2307/2297811
Gjerde, J., & McCants, A. (1995). Fertility, marriage, and culture: Demographic pro-

cesses among Norwegian immigrants to the rural middle west. *Journal of Economic History*, *55*(4), 860–888. doi: 10.1017/S0022050700042194

Glomm, G., & Ravikumar, B. (1994). Growth-inequality trade-offs in a model with public sector r&d. *Canadian Journal of Economics*, 484–493. doi: 10.2307/135759

Gokhale, J., & Kotlikoff, L. J. (2002). Simulating the transmission of wealth inequality. *American Economic Review*, *92*(2), 265–269. doi: 10.1257/000282802320189375

Goldin, C., & Katz, L. F. (2002). The power of the pill: Oral contraceptives and women's career and marriage decisions. *Journal of Political Economy*, *110*(4), 730–770. doi: 10.1086/340778

Gómez, M. A. (2010). Endogenous growth, habit formation and convergence speed. *B.E. Journal of Macroeconomics*, *10*(1). doi: 10.2202/1935-1690.1971

González-Bailón, S., & Murphy, T. E. (2013). The effects of social interactions on fertility decline in nineteenth-century France: an agent-based simulation experiment. *Population Studies*, *67*(2), 135–155. doi: 10.1080/00324728.2013.774435

Goodfriend, M., & McDermott, J. (1995). Early development. *American Economic Review*, *85*(1), 116–133. Retrieved from https://www.jstor.org/stable/2117999

Goodsell, W. (1937). Housing and the birth rate in Sweden. *American Sociological Review*, *2*(6), 850–859. doi: 10.2307/2084364

Grossman, G. M., & Helpman, E. (2015). Globalization and growth. *American Economic Review*, *105*(5), 100–104. doi: 10.1257/aer.p20151068

Groth, H., & May, J. F. (2017). *Africa's population: In search of a demographic dividend*. Springer. doi: 10.1007/978-3-319-46889-1

Guiso, L., Sapienza, P., & Zingales, L. (2006). Does culture affect economic outcomes? *Journal of Economic Perspectives*, *20*(2), 23–48. doi: 10.1257/jep.20.2.23

Gündüz-Hoşgör, A., & Smits, J. (2008). Variation in labor market participation of married women in Turkey. *Women's Studies International Forum*, *31*(2), 104–117. doi: 10.1016/j.wsif.2008.03.003

Gupta, D. K. (1990). *The economics of political violence: The effect of political instability on economic growth*. Praeger New York.

Gurdgiev, C. (2005). *Habits in consumption, transactions learning and economic growth* (Working Paper No. TEP 2005/5). Trinity College Department of Economics. doi: 10.2139/ssrn.1105042

Gyimah, S. O., Adjei, J. K., & Takyi, B. K. (2012). Religion, contraception, and method choice of married women in Ghana. *Journal of Religion and Health*, *51*(4), 1359–1374. doi: 10.1007/s10943-011-9478-4

Hacker, J. D. (1999). Child naming, religion, and the decline of marital fertility in nineteenth-century America. *History of the Family*, *4*(3), 339–365. doi: 10.1016/S1081-602X(99)00019-6

Hansen, G. D., & İmrohoroğlu, A. (1992). The role of unemployment insurance in an economy with liquidity constraints and moral hazard. *Journal of Political Economy*, *100*(1), 118–142. doi: 10.1086/261809

Hansen, G. D., & Prescott, E. C. (2002). Malthus to Solow. *American Economic Review*, *92*(4), 1205–1217. doi: 10.1257/00028280260344731

Hanushek, E. A., & Woessmann, L. (2008). The role of cognitive skills in economic development. *Journal of Economic Literature*, *46*(3), 607–68. doi: 10.1257/jel.46

.3.607

Havranek, T., Rusnak, M., & Sokolova, A. (2017). Habit formation in consumption: a meta-analysis. *European Economic Review*, *95*, 142–167. doi: 10.1016/j.euroecorev.2017.03.009

Heaton, T. B. (2011). Does religion influence fertility in developing countries. *Population Research and Policy Review*, *30*(3), 449–465. doi: 10.1007/s11113-010-9196-8

Heffetz, O., & Frank, R. H. (2011). Preferences for status: Evidence and economic implications. In *Handbook of social economics* (Vol. 1, pp. 69–91). Elsevier. doi: 10.1016/B978-0-444-53187-2.00003-6

Heikkinen, T. (2015). (de) growth and welfare in an equilibrium model with heterogeneous consumers. *Ecological Economics*, *116*, 330–340. doi: 10.1016/j.ecolecon.2015.05.005

Hendricks, L. (2007). How important is discount rate heterogeneity for wealth inequality? *Journal of Economic Dynamics and Control*, *31*(9), 3042–3068. doi: 10.1016/j.jedc.2006.10.002

Hendricks, L. (2010). Cross-country variation in educational attainment: Structural change or within-industry skill upgrading? *Journal of Economic Growth*, *15*(3), 205–233. doi: 10.1007/s10887-010-9055-9

Hendricks, L. (2016). *Cross-country income gaps: The role of human capital.* Retrieved from http://lhendricks.org/econ821/growth/hc_sl.pdf

Hensvik, L., & Nilsson, P. (2010). *Businesses, buddies and babies: Social ties and fertility at work* (Working Paper No. 2010:9). Uppsala, Sweden: Institute for Labour Market Policy Evaluation. Retrieved from https://www.econstor.eu/handle/10419/45767

Huber, J. D., & Mayoral, L. (2019). Group inequality and the severity of civil conflict. *Journal of Economic Growth*, *24*(1), 1–41. doi: 10.1007/s10887-019-09162-6

Huggett, M. (1996). Wealth distribution in life-cycle economies. *Journal of Monetary Economics*, *38*(3), 469–494. doi: 10.1016/S0304-3932(96)01291-3

Hull, T. H. (1983). Cultural influences on fertility decision styles. In *Determinants of fertility in developing countries: Fertility regulation and institutional influences* (pp. 381–414). New York, NY: Academic Press.

Ikefuji, M. (2008). Habit formation in an endogenous growth model with pollution abatement activities. *Journal of Economics*, *94*(3), 241–259. doi: 10.1007/s00712-008-0015-1

İlkkaracan, İ. (2012). Why so few women in the labor market in Turkey? *Feminist Economics*, *18*(1), 1–37. doi: 10.1080/13545701.2011.649358

Ireland, N. J. (1994). On limiting the market for status signals. *Journal of Public Economics*, *53*(1), 91–110. doi: 10.1016/0047-2727(94)90015-9

Islam, N. (2003). What have we learnt from the convergence debate? *Journal of Economic Surveys*, *17*(3), 309–362. doi: 10.1111/1467-6419.00197

Iyer, S. (2003). Religion, reproduction and development in contemporary India. *Development*, *46*(4), 50–56. doi: 10.1177/1011637003046004008

Jackson, M. O., Rogers, B. W., & Zenou, Y. (2017). The economic consequences of social-network structure. *Journal of Economic Literature*, *55*(1), 49–95. doi: 10.1257/jel.20150694

Janssen, S. G., & Hauser, R. M. (1981). Religion, socialization, and fertility. *Demogra-*

phy, *18*(4), 511–528. doi: 10.2307/2060945

Jones, C., Midrigan, V., & Philippon, T. (2011). *Household leverage and the recession* (Working Paper No. 16965). National Bureau of Economic Research. doi: 10.3386/w16965

Jones, C. I. (2001). Was an industrial revolution inevitable? economic growth over the very long run. *Advances in Macroeconomics*, *1*(2). doi: 10.2202/1534-6013.1028

Jones, C. I. (2015). Pareto and Piketty: The macroeconomics of top income and wealth inequality. *Journal of Economic Perspectives*, *29*(1), 29–46. doi: 10.1257/jep.29.1.29

Jones, G. W., Douglas, R. M., Caldwell, J. C., & D'Souza, R. M. (1998). *The continuing demographic transition*. Oxford, UK: Clarendon Press.

Jones, L. E., Manuelli, R. E., & Stacchetti, E. (2000). *Technology and policy shocks in models of endogenous growth* (Working Paper No. 281). Minneapolis, Minnesota: Federal Reserve Bank of Minneapolis. Retrieved from `https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1223456`

Judd, K. L. (1985). Redistributive taxation in a simple perfect foresight model. *Journal of Public Economics*, *28*(1), 59–83. doi: 10.1016/0047-2727(85)90020-9

Kaldor, N. (1955). Alternative theories of distribution. *Review of Economic Studies*, *23*(2), 83–100. doi: 10.2307/2296292

Kaldor, N. (1961). Capital accumulation and economic growth. In *The theory of capital* (pp. 177–222). Springer.

Kalemli-Özcan, e. (2002). Does the mortality decline promote economic growth? *Journal of Economic Growth*, *7*(4), 411–439. doi: 10.1023/A:1020831902045

Kapteyn, A., van de Geer, S., van de Stadt, H., & Wansbeek, T. (1997). Interdependent preferences: an econometric analysis. *Journal of Applied Econometrics*, *12*(6), 665–686. doi: 10.1002/(SICI)1099-1255(199711/12)12:6<665::AID-JAE437>3.0.CO;2-U

Kapur, B. K. (2005). Can faster income growth reduce well-being? *Social Choice and Welfare*, *25*(1), 155–171. doi: 10.1007/s00355-005-0040-8

Kesten, H. (1973). Random difference equations and renewal theory for products of random matrices. *Acta Mathematica*, *131*(1), 207–248. doi: 10.1007/BF02392040

King, R. G., & Rebelo, S. (1990). Public policy and economic growth: Developing neoclassical implications. *Journal of Political Economy*, *98*(5, Part 2), S126–S150. doi: 10.1086/261727

Kögel, T., & Prskawetz, A. (2001). Agricultural productivity growth and escape from the Malthusian trap. *Journal of Economic Growth*, *6*(4), 337–357. doi: 10.1023/A:101274253

Kohler, H.-P. (2001). *Fertility and social interaction: An economic perspective*. Oxford, UK: Oxford University Press.

Kohler, H.-P., Behrman, J. R., & Watkins, S. C. (2001). The density of social networks and fertility decisions: Evidence from South Nyanza District, Kenya. *Demography*, *38*(1), 43–58. doi: 10.1353/dem.2001.0005

Koopmans, T. C. (1965). On the concept of optimal economic growth. In *The econometric approach to development planning.* North Holland.

Krebs, T. (2003a). Growth and welfare effects of business cycles in economies with idiosyncratic human capital risk. *Review of Economic Dynamics*, *6*(4), 846–868.

doi: 10.1016/S1094-2025(03)00030-9

Krebs, T. (2003b). Human capital risk and economic growth. *Quarterly Journal of Economics*, *118*(2), 709–744. doi: 10.1162/003355303321675491

Kremer, M. (1993). Population growth and technological change: One million BC to 1990. *Quarterly Journal of Economics*, *108*(3), 681–716. doi: 10.2307/2118405

Krusell, P., & Smith, A. A. (1998). Income and wealth heterogeneity in the macroeconomy. *Journal of Political Economy*, *106*(5), 867–896. doi: 10.1086/250034

Kumhof, M., Rancière, R., & Winant, P. (2015). Inequality, leverage, and crises. *American Economic Review*, *105*(3), 1217–45. doi: 10.1257/aer.20110683

Kuran, T. (2018). Islam and economic performance: Historical and contemporary links. *Journal of Economic Literature*, *56*(4), 1292–1359. doi: 10.1257/jel.20171243

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, *45*(1), 1–28. Retrieved from `https://www.jstor.org/stable/1811581`

Lagerlöf, N.-P. (2003). From Malthus to modern growth: Can epidemics explain the three regimes? *International Economic Review*, *44*(2), 755–777. doi: 10.1111/1468-2354.t01-1-00088

Laitner, J. (2001). Secular changes in wealth inequality and inheritance. *Economic Journal*, *111*(474), 691–721. doi: 10.1111/1468-0297.00656

Leibenstein, H. (1950). Bandwagon, snob, and Veblen effects in the theory of consumers' demand. *Quarterly Journal of Economics*, *64*(2), 183–207. doi: 10.2307/1882692

Leibenstein, H. (1981). Economic decision theory and human fertility behavior: A speculative essay. *Population and Development Review*, *7*(3), 381–400. doi: 10.2307/1972556

Lesthaeghe, R. J. (1977). *The decline of belgian fertility*. Princeton University Press.

Lesthaeghe, R. J., & Wilson, C. (1986). Modes of production, secularization, and the pace of the fertility decline in Western Europe, 1870–1930. In *The decline of fertility in europe.* Princeton, NJ: Princeton University Press.

Lindh, T., & Ohlsson, H. (1998). Self-employment and wealth inequality. *Review of Income and Wealth*, *44*(1), 25–41. doi: 10.1111/j.1475-4991.1998.tb00250.x

Liu, W.-F., & Turnovsky, S. J. (2005). Consumption externalities, production externalities, and long-run macroeconomic efficiency. *Journal of Public Economics*, *89*(5-6), 1097–1129. doi: 10.1016/j.jpubeco.2003.12.004

Lucas, R. E. J. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3–42. doi: 10.1016/0304-3932(88)90168-7

Luttmer, E. F. (2005). Neighbors as negatives: Relative earnings and well-being. *Quarterly Journal of Economics*, *120*(3), 963–1002. doi: 10.1093/qje/120.3.963

Mankiw, N. G. (2015). Yes, r> g. so what? *American Economic Review*, *105*(5), 43–47. doi: 10.1257/aer.p20151059

Manski, C. F., & Mayshar, J. (2003). Private incentives and social interactions: Fertility puzzles in Israel. *Journal of the European Economic Association*, *1*(1), 181–211. doi: 10.1162/154247603322256800

Manuelli, R. E., & Seshadri, A. (2014). Human capital and the wealth of nations. *American Economic Review*, *104*(9), 2736–62. doi: 10.1257/aer.104.9.2736

Mason, K. O. (1997). Explaining fertility transitions. *Demography*, *34*(4), 443–454. doi: 10.2307/3038299

Matsuyama, K. (1991). Increasing returns, industrialization, and indeterminacy of equilibrium. *Quarterly Journal of Economics*, *106*(2), 617–650. doi: 10.2307/2937949

Matsuyama, K. (2000). Endogenous inequality. *Review of Economic Studies*, *67*(4), 743–759. doi: 10.1111/1467-937X.00152

Matsuyama, K. (2004). Financial market globalization, symmetry-breaking, and endogenous inequality of nations. *Econometrica*, *72*(3), 853–884. doi: 10.1111/j.1468-0262.2004.00514.x

Matsuyama, K. (2011). Imperfect credit markets, household wealth distribution, and development. *Annual Review of Economics*, *3*(1), 339–362. doi: 10.1146/annurev-economics-111809-125054

McBride, M. (2001). Relative-income effects on subjective well-being in the cross-section. *Journal of Economic Behavior & Organization*, *45*(3), 251–278. doi: 10.1016/S0167-2681(01)00145-7

Menchik, P. L., & Jianakoplos, N. A. (1997). Black-white wealth inequality: is inheritance the reason? *Economic Inquiry*, *35*(2), 428–442. doi: 10.1111/j.1465-7295.1997.tb01920.x

Milanovic, B. (2016). *Global inequality: A new approach for the age of globalization*. Cambridge, Massachusetts: Harvard University Press.

Mill, J. S. (1848). *Principles of political economy with some of their applications to social philosophy*. New York: 1965 ed. A.M. Kelly.

Montgomery, M. R., & Casterline, J. B. (1996). Social learning, social influence, and new models of fertility. *Population and Development Review*, *22*, 151–175. doi: 10.2307/2808010

Moulasha, K., & Rao, G. R. (1999). Religion-specific differentials in fertility and family planning. *Economic and Political Weekly*, *34*(42/43), 3047–3051. Retrieved from `https://www.jstor.org/stable/4408534`

Mulder, M. B., Bowles, S., Hertz, T., Bell, A., Beise, J., Clark, G., ... others (2009). Intergenerational wealth transmission and the dynamics of inequality in small-scale societies. *Science*, *326*(5953), 682–688. doi: 10.1126/science.1178336

Munshi, K., & Myaux, J. (2006). Social norms and the fertility transition. *Journal of Development Economics*, *80*(1), 1–38. doi: 10.1016/j.jdeveco.2005.01.002

Murphy, K. M., Shleifer, A., & Vishny, R. W. (1989). Industrialization and the big push. *Journal of Political Economy*, *97*(5), 1003–1026. doi: 10.1086/261641

Murphy, K. M., Simon, C., & Tamura, R. (2008). Fertility decline, baby boom, and economic growth. *Journal of Human Capital*, *2*(3), 262–302. doi: 10.1086/593052

Murphy, T. E. (2015). Old habits die hard (sometimes). *Journal of Economic Growth*, *20*(2), 177–222. doi: 10.1007/s10887-015-9111-6

Naumark, D. E., & Postlewaite, A. (1998). Relative income concerns and the rise in married women's employment. *Journal of Public Economics*, *70*(1), 157–183. doi: 10.1016/S0047-2727(98)00065-6

Newman, M. E. (2005). Power laws, pareto distributions and Zipf's law. *Contemporary Physics*, *46*(5), 323–351. doi: 10.1080/00107510500052444

Nirei, M., & Aoki, S. (2016). Pareto distribution of income in neoclassical growth models. *Review of Economic Dynamics*, *20*, 25–42. doi: 10.1016/j.red.2015.11.002

Pavoni, N., & Yazıcı, H. (2016a). Intergenerational disagreement and optimal taxation of parental transfers. *Review of Economic Studies*, *84*(3), 1264-1305. doi: 10.1093/

restud/rdw036
Pavoni, N., & Yazıcı, H. (2016b). Optimal life-cycle capital taxation under self-control problems. *Economic Journal*, *127*(602), 1188-1216. doi: 10.1111/ecoj.12323
Pearson, K., Lee, A., & Bramley-Moore, L. (1899). Mathematical contributions to the theory of evolution. vi. genetic (reproductive) selection: Inheritance of fertility in man, and of fecundity in thoroughbred racehorses. *Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a Mathematical or Physical Character*, *192*, 257–330. doi: 10.1098/rsta.1899.0006
Peng, B. (2008). Relative deprivation, wealth inequality and economic growth. *Journal of Economics*, *94*(3), 223–229. doi: 10.1007/s00712-008-0014-2
Peretto, P. F., & Seater, J. J. (2013). Factor-eliminating technical change. *Journal of Monetary Economics*, *60*(4), 459–473. doi: 10.1016/j.jmoneco.2013.01.005
Perotti, R. (1996). Growth, income distribution, and democracy: What the data say. *Journal of Economic Growth*, *1*(2), 149–187. doi: 10.1007/BF00138861
Persson, T., & Tabellini, G. (1992). Growth, distribution and politics. *European Economic Review*, *36*(2-3), 593–602. doi: 10.1016/0014-2921(92)90117-F
Persson, T., & Tabellini, G. (1994). Is inequality harmful for growth? *American Economic Review*, *84*(3), 600–621. Retrieved from https://www.jstor.org/stable/2118070
Pham, T. K. C. (2005). Economic growth and status-seeking through personal wealth. *European Journal of Political Economy*, *21*(2), 407–427. doi: 10.1016/j.ejpoleco.2004.10.001
Piketty, T. (2011). On the long-run evolution of inheritance: France 1820–2050. *Quarterly Journal of Economics*, *126*(3), 1071–1131. doi: 10.1093/qje/qjr020
Piketty, T., & Saez, E. (2013). A theory of optimal inheritance taxation. *Econometrica*, *81*(5), 1851–1886. doi: 10.3982/ECTA10712
Piketty, T., & Saez, E. (2014). Inequality in the long run. *Science*, *344*(6186), 838–843. doi: 10.1126/science.1251936
Piketty, T., & Zucman, G. (2015). Wealth and inheritance in the long run. In *Handbook of income distribution* (Vol. 2, pp. 1303–1368). Elsevier. doi: 10.1016/B978-0-444-59429-7.00016-9
Pollak, R. A. (1976). Interdependent preferences. *American Economic Review*, *66*(3), 309–320. Retrieved from https://www.jstor.org/stable/1828165
Postlewaite, A. (2011). Does culture matter? In *Social norms and preferences, chapter for the handbook for social economics edited by J. Benhabib, A. Bisin and M. Jackson* (Vol. 1, pp. 31–67). Elsevier. doi: 10.1016/B978-0-444-53187-2.00002-4
Prettner, K., & Strulik, H. (2017). It's a sin—contraceptive use, religious beliefs, and long-run economic development. *Review of Development Economics*, *21*(3), 543–566. doi: 10.1111/rode.12280
Quadrini, V. (1999). The importance of entrepreneurship for wealth concentration and mobility. *Review of Income and Wealth*, *45*(1), 1–19. doi: 10.1111/j.1475-4991.1999.tb00309.x
Quadrini, V. (2000). Entrepreneurship, saving, and social mobility. *Review of Economic Dynamics*, *3*(1), 1–40. doi: 10.1006/redy.1999.0077
Ramsey, F. P. (1928). A mathematical theory of saving. *Economic Journal*, *38*(152), 543–559. doi: 10.2307/2224098

Rauscher, M. (1997). *Protestant ethic, status seeking, and economic growth* (Working Paper No. 09). Rostock, Germany: University of Rostock, Institute of Economics.

Ravallion, M. (2016). Are the world's poorest being left behind? *Journal of Economic Growth*, *21*(2), 139–164. doi: 10.1007/s10887-016-9126-7

Ray, D., & Robson, A. (2012). Status, intertemporal choice, and risk-taking. *Econometrica*, *80*(4), 1505–1531. doi: 10.3982/ECTA9042

Robson, A. J. (1992). Status, the distribution of wealth, private and social attitudes to risk. *Econometrica*, 837–857. doi: 10.2307/2951568

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, *94*(5), 1002–1037. doi: 10.1086/261420

Rostow, W. W. (1959). The stages of economic growth. *Economic History Review*, *12*(1), 1–16. doi: 10.1111/j.1468-0289.1959.tb01829.x

Rubin, J. (2017). *Rulers, religion, and riches: Why the west got rich and the middle east did not*. Cambridge, UK: Cambridge University Press.

Smith, A. (1759). *The theory of moral sentiments*. Clarendon Press.

Smith, A. (1776). *An inquiry into the nature and causes of the wealth of nations*. W. Stahan & T. Cadell.

Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, *70*(1), 65–94. doi: 10.2307/1884513

Spolaore, E., & Wacziarg, R. (2013). How deep are the roots of economic development? *Journal of Eeconomic Literature*, *51*(2), 325–69. doi: 10.1257/jel.51.2.325

Spolaore, E., & Wacziarg, R. (2016). *Fertility and modernity* (Working Paper No. PWP-CCPR-2016-016). Los Angeles, CA: University of California, Los Angeles, The California Center for Population Research.

Stokey, N. L., Lucas, R. E. J., & Prescott, E. C. (1989). Recursive methods in economic dynamics. Cambridge, Massachusetts: Harvard University Press.

Straub, L., & Werning, I. (2014). *Positive long run capital taxation: Chamley-Judd revisited* (Working Paper No. 20441). National Bureau of Economic Research. doi: 10.3386/w20441

Strulik, H. (2016). Secularization and long-run economic growth. *Economic Inquiry*, *54*(1), 177–200. doi: 10.1111/ecin.12242

Strulik, H. (2017). Contraception and development: a unified growth theory. *International Economic Review*, *58*(2), 561–584. doi: 10.1111/iere.12227

Strulik, H., Prettner, K., & Prskawetz, A. (2013). The past and future of knowledge-based growth. *Journal of Economic Growth*, *18*(4), 411–437. doi: 10.1007/s10887-013-9098-9

Strulik, H., & Weisdorf, J. (2008). Population, food, and knowledge: a simple unified growth theory. *Journal of Economic Growth*, *13*(3), 195. doi: 10.1007/s10887-008-9033-7

Swan, T. W. (1956). Economic growth and capital accumulation. *Economic Record*, *32*(2), 334-361. doi: 10.1111/j.1475-4932.1956.tb00434.x

Tamai, T. (2015). Redistributive taxation, wealth distribution, and economic growth. *Journal of Economics*, *115*(2), 133–152. doi: 10.1007/s00712-014-0424-2

Tamura, R. (1996). From decay to growth: a demographic transition to economic growth. *Journal of Economic Dynamics and Control*, *20*(6-7), 1237–1261. doi: 10.1016/0165-1889(95)00898-5

Tamura, R. (2002). Human capital and the switch from agriculture to industry. *Journal of eEconomic Dynamics and Control*, *27*(2), 207–242. doi: 10.1016/S0165-1889(01)00032-X

Thompson, W. S. (1938). The effect of housing upon population growth. *Milbank Memorial Fund Quarterly*, *16*(4), 359–368. doi: 10.2307/3347951

Turnovsky, S. J., & Monteiro, G. (2007). Consumption externalities, production externalities, and efficient capital accumulation under time non-separable preferences. *European Economic Review*, *51*(2), 479–504. doi: 10.1016/j.euroecorev.2005.12.001

Uzawa, H. (1964). Optimal growth in a two-sector model of capital accumulation. *Review of Economic Studies*, *31*(1), 1–24. doi: 10.2307/2295932

van Bavel, J., & Kok, J. (2005). The role of religion in the Dutch fertility transition: Starting, spacing, and stopping in the heart of the Netherlands, 1845–1945. *Continuity and Change*, *20*(2), 247–263. doi: 10.1017/S0268416005005473

van Long, N., & Shimomura, K. (2004). Relative wealth, status-seeking, and catching-up. *Journal of Economic Behavior & Organization*, *53*(4), 529–542. doi: 10.1016/j.jebo.2002.11.003

van Poppel, F. W. A. (1985). Late fertility decline in the Netherlands: The influence of religious denomination, socioeconomic group and region. *European Journal of Population / Revue européenne de Démographie*, *1*(4), 347–373. doi: 10.1007/BF01797148

Veblen, T. (1898a). The instinct of workmanship and the irksomeness of labor. *American Journal of Sociology*, *4*(2), 187–201. Retrieved from `https://www.jstor.org/stable/2761796`

Veblen, T. (1898b). Why is economics not an evolutionary science? *Quarterly Journal of Economics*, *12*(4), 373-397. doi: 10.2307/1882952

Veblen, T. (1899). *The theory of the leisure class: An economic study of institutions*. The Macmillan Company.

Veblen, T. (1909). The limitations of marginal utility. *Journal of Political Economy*, *17*(9), 620–636. doi: 10.1086/251614

Wang, C., Wang, N., & Yang, J. (2016). Optimal consumption and savings with stochastic income and recursive utility. *Journal of Economic Theory*, *165*, 292–331. doi: 10.1016/j.jet.2016.04.002

Wang, N. (2003). Caballero meets Bewley: The permanent-income hypothesis in general equilibrium. *American Economic Review*, *93*(3), 927–936. doi: 10.1257/000282803322157179

Weber, M. (1905). *The protestant ethic and the spirit of capitalism*. Routledge.

Weisdorf, J. L. (2004). From stagnation to growth: Revisiting three historical regimes. *Journal of Population Economics*, *17*(3), 455–472. doi: 10.1007/s00148-004-0182-5

Weiss, Y., & Fershtman, C. (1998). Social status and economic performance: A survey. *European Economic Review*, *42*(3-5), 801–820. doi: 10.1016/S0014-2921(97)00137-2

Williams, L. B., & Zimmer, B. G. (1990). The changing influence of religion on US fertility: Evidence from Rhode Island. *Demography*, *27*(3), 475–481. doi: 10.2307/2061381

Willis, R. J. (1973). A new approach to the economic theory of fertility behavior. *Journal* *of Political Economy*, *81*(2, Part 2), S14–S64. doi: 10.1086/260152

Wolff, E., & Zacharias, A. (2007). The impact of wealth inequality on economic well-being. *Challenge*, *50*(4), 65–87. doi: 10.2753/0577-5132500405

Yeatman, S. E., & Trinitapoli, J. (2008). Beyond denomination: The relationship between religion and family planning in rural Malawi. *Demographic research*, *19*(55), 1851. doi: 10.4054/DemRes.2008.19.55

Yunker, J. (2014). Capital wealth taxation: Theory and application. *Review of Political Economy*, *26*(1), 85–110. doi: 10.1080/09538259.2013.874193

Zou, H. (1994). 'the spirit of capitalism'and long-run growth. *European Journal of Political Economy*, *10*(2), 279–293. doi: 10.1016/0176-2680(94)90020-5

APPENDIX 1

PROOFS OF CHAPTER 1

Proof of Proposition 1.1

The concavities of the household's problem (1.7) and the firm's problem (1.10) guarantee that the FOCs for these problems solve the problems and the solutions are unique.

Rearranging the FOC (1.11), and multiplying both sides with $X_t L_{j,t}$ yields

$$K_{j,t} = \left(\frac{r_t}{\alpha}\right)^{\left(\frac{1}{\alpha-1}\right)} X_t L_{j,t}. \tag{A.1.1}$$

Substituting $K_{j,t}$ in (1.15) gives

$$\int_0^1 a_{i,t} \mathrm{d}i = \int_0^1 \left(\frac{r_t}{\alpha}\right)^{\left(\frac{1}{\alpha-1}\right)} X_t L_{j,t} \mathrm{d}j \tag{A.1.2}$$

which, after substituting $\int_0^1 a_{i,t} \mathrm{d}i = A_t$ and (1.5) in can be written as

$$A_t = \left(\frac{r_t}{\alpha}\right)^{\left(\frac{1}{\alpha-1}\right)} \psi A_t \int_0^1 L_{j,t} \mathrm{d}j. \tag{A.1.3}$$

The labor market clearing condition (1.14) implies $\int_0^1 L_{j,t} \mathrm{d}j = 1$. Substituting the labor market clearing condition in (A.1.3) and rearranging terms return (1.16), where $r_t = r$ is the interest rate that clears the capital market for all $t \in \{0, 1, ...\}$. Dividing (A.1.1) by $X_t L_{j,t}$ and substituting (1.12) in returns

$$w_t = (1-\alpha) X_t \left(\frac{r_t}{\alpha}\right)^{\left(\frac{\alpha}{\alpha-1}\right)}. \tag{A.1.4}$$

Plugging r in (A.1.4) gives w_t as in (1.17) which satisfies the zero-profit condition for all $t \in \{0, 1, ...\}$. Substituting r and w_t in (1.8) returns (1.18). Finally, substituting $a_{i,t+1}$ in

(1.6) yields (1.19). Q.E.D.

Proof of Proposition 1.2

That there exists a unique solution to the SGE from Proposition 1.1 for any t and the law of motion (1.21) is a real-valued function prove a unique DGE for the entire history exists. Q.E.D.

Proof of Proposition 1.3

From (1.19), the aggregate consumption level c_t reads

$$\int_0^1 c_{i,t}\mathrm{d}i \equiv c_t = \int_0^1 \psi^{1-\alpha}(1-\lambda_i)\left[\alpha a_{i,t} + (1-\alpha)A_t\right]\mathrm{d}i \tag{A.1.5}$$

which, since λ_i and $a_{i,t}$ are independently distributed, reduces into

$$c_t = (1-\mu_\lambda)\,\psi^{1-\alpha}A_t. \tag{A.1.6}$$

From (1.13), (1.18) and (A.1.6), the aggregate output Y_t is given by

$$\int_0^1 Y_{j,t}\mathrm{d}j \equiv Y_t = \mu_\lambda \psi^{1-\alpha}A_t. \tag{A.1.7}$$

Iterating (A.1.6) and (A.1.7), dividing by themselves, and dividing (1.21) by A_t return

$$\frac{c_{t+1}}{c_t} = \frac{Y_{t+1}}{Y_t} = \frac{A_{t+1}}{A_t} = \mu_\lambda \psi^{1-\alpha} \equiv G_t \tag{A.1.8}$$

where G_t is the gross growth rate of c_t, Y_t and A_t. With G_t being time-independent the growth rates of c_t, Y_t and A_t are the same for the entire history. Thus, $G_t \equiv G^*$ and the economy is on a BGP for all $t = \{1,2,...\}$. Q.E.D.

Proof of Proposition 1.4

Taking the derivative of (1.23) and dividing both sides by A_t return

$$\frac{\partial u_{i,t}}{\partial A_t} = \frac{1-\alpha}{\alpha a_{i,t} + (1-\alpha)A_t} - \frac{\gamma_i}{A_t}. \tag{A.1.9}$$

$\partial u_{i,t}/\partial A_t > 0$ requires

$$\frac{\gamma_i}{A_t} > \frac{1-\alpha}{\alpha a_{i,t} + (1-\alpha) A_t}. \tag{A.1.10}$$

Multiplying both sides by A_t yields $\hat{\gamma}_{i,t}$ as in Proposition 1.4. Taking the derivative of $\hat{\gamma}_{i,t}$ with respect to $s_{i,t}$ returns

$$\frac{\partial \hat{\gamma}_{i,t}}{\partial s_{i,t}} = -\frac{\alpha (1-\alpha)}{(\alpha s_{i,t} + 1 - \alpha)^2} < 0. \tag{A.1.11}$$

Q.E.D.

Proof of Proposition 1.5

Utilizing the equation of motion (1.26), the status of an agent at its steady-state, s_i^* is solved via

$$s_i^* = \frac{\alpha \lambda_i}{\mu_\lambda} s_i^* + \frac{(1-\alpha)\lambda_i}{\mu_\lambda} \tag{A.1.12}$$

which, after rearranging terms, returns (1.27). Q.E.D.

Proof of Proposition 1.6

Utilizing the equation of motion (1.31), the expected value of $s_{i,t}$ at the steady-state, μ_s^* is solved via

$$\mu_s^* = \alpha \mu_s^* + 1 - \alpha, \tag{A.1.13}$$

which implies $\mu_s^* = 1$. The variance of $s_{i,t}$ at the steady-state, σ_s^{2*} is solved via the equation of motion (1.32) such that

$$\sigma_s^{2*} = \frac{\alpha^2 \left(\sigma_\lambda^2 + \mu_\lambda^2\right) \sigma_s^{2*}}{\mu_\lambda^2} + \frac{(\alpha \mu_s^* + 1 - \alpha)^2 \sigma_\lambda^2}{\mu_\lambda^2}. \tag{A.1.14}$$

Rearranging terms and plugging $\mu_s^* = 1$ in return σ_s^{2*} as in (1.36). Suppose that

$$\sigma_\lambda^2 = \frac{\left(1-\alpha^2\right)\mu_\lambda^2 + \varepsilon}{\alpha^2}$$

where $\varepsilon \geq 0$ and $\mu_{s,t} = \mu_s^* = 1$. (1.32) would then become

$$\sigma_{s,t+1}^2 = \frac{\alpha^2 \left[\frac{(1-\alpha^2)\mu_\lambda^2 + \varepsilon}{\alpha^2} + \mu_\lambda^2 \right] \sigma_{s,t}^2}{\mu_\lambda^2} + \frac{\left(1-\alpha^2\right)\mu_\lambda^2 + \varepsilon}{\alpha^2 \mu_\lambda^2}$$
$$= \left(1 + \frac{\varepsilon}{\mu_\lambda^2}\right) \sigma_{s,t}^2 + \frac{\left(1-\alpha^2\right)\mu_\lambda^2 + \varepsilon}{\alpha^2 \mu_\lambda^2} > \sigma_{s,t}^2 \quad \forall t. \quad \text{(A.1.15)}$$

Q.E.D.

Proof of Proposition 1.7

(1.15) clears the capital market and

$$\int_0^1 Y_{j,t} \mathrm{d}j = \int_0^1 c_{i,t} \mathrm{d}i + \int_1^\eta c_{\nu,t} \mathrm{d}\nu + \int_0^1 a_{i,t+1} \mathrm{d}i, and \quad \text{(A.1.16)}$$

$$\int_1^\eta 1 \mathrm{d}\nu = \int_0^1 L_{j,t} \mathrm{d}j \quad \text{(A.1.17)}$$

respectively clear the good and labor markets.

Since the working class does not face a maximization problem, there are two problems in the economy, namely those of the leisure class' problem (1.59) and the producer's problem (1.10). As in the proof of Proposition 1.1, the concavities of both problems guarantee that the FOCs solve the problems and the solutions are unique.

The procedure of the proof of Proposition 1.1, only with the exception of changing the labor market clearing condition to $\int_0^1 L_{j,t} \mathrm{d}j = \eta - 1$ solves the market clearing r_t and w_t as in (1.63) and (1.64) respectively. (1.65) is obtained by substituting r_t in the FOC of the leisure class' problem, which is

$$a_{i,t+1} = \lambda_i (1-\tau) r_t a_{i,t}, \quad \text{(A.1.18)}$$

and (1.66) is obtained by substituting (1.65) in (1.58).

(1.63) and (1.65) solve the aggregate capital stock at $t+1$ as

$$A_{t+1} = \mu_\lambda (1-\tau) \alpha \psi^{1-\alpha} (\eta - 1)^{1-\alpha} A_t. \quad \text{(A.1.19)}$$

Since there exists a unique solution to the SGE of this model for any t and the law of motion (A.1.19) is a real-valued function, assuming that $\lambda_i \in [\lambda_{\min}, \lambda_{\max}]$ such that $\lambda_{max} < 1$ and

$$\lambda_{\min} > \frac{1}{r(1-\tau)} = \frac{1}{\alpha\psi^{1-\alpha}(\eta-1)^{1-\alpha}(1-\tau)} \tag{A.1.20}$$

or equivalently

$$\psi > \frac{1}{[\alpha(1-\tau)\lambda_{\min}]^{\frac{1}{1-\alpha}}(\eta-1)} \tag{A.1.21}$$

imply that the asset stocks of the leisure class households are non-decreasing over time. This implies

$$\lim_{t\to+\infty} a_{i,t} > 0 \quad \forall i \in [0,1] \tag{A.1.22}$$

and a unique DGE exists for the entire history.

Finally, that a unique BGP exists can be shown by following the same procedure with that of the proof of Proposition 1.3. Dividing (A.1.19) by A_t returns G^* as in

$$G^* = \mu_\lambda(1-\tau)\alpha\psi^{1-\alpha}(\eta-1)^{1-\alpha}, \tag{A.1.23}$$

which does not depend on t, indicating that the economy is on a BGP for the entire history. Q.E.D.

Proof of Proposition 1.8

Substituting (1.63), (1.65) and (1.66) in (1.3) returns the total welfare of the leisure class

$$\int_0^1 u_{i,t}\mathrm{d}i = \left(1-\mu_\gamma\right)\ln(1-\tau) + \int_0^1 [\phi_i + \rho_i]\,\mathrm{d}i \tag{A.1.24}$$

where

$$\rho_{i,t} = (1-\gamma_i)\ln\left[\alpha(\eta-1)^{1-\alpha}\right] + \ln(a_{i,t}) + \ln(A_t).$$

Substituting (1.60), (1.62), (1.63) and (1.64) in (1.61) returns the total welfare of the working class

$$\int_1^\eta u_{\nu,t}\mathrm{d}\nu = \zeta_t + (\eta-1)\ln(1-\alpha+\tau\alpha) \tag{A.1.25}$$

where

$$\zeta_t = (\eta - 1)\ln\left[\psi^{1-\alpha}(\eta-1)^{-\alpha}A_t\right].$$

With (1.68), (A.1.24) and (A.1.25), the government's problem can be written as

$$\max_{\tau} \quad \left(1-\mu_\gamma\right)\ln(1-\tau) + (\eta-1)\ln(1-\alpha+\tau\alpha) + \zeta_t + \int_0^1 [\phi_i + \rho_i]\,\mathrm{d}i \tag{A.1.26}$$

subject to $\quad \tau \geq 0.$

The concavity of the problem indicates that the FOC returns the unique solution to the problem. The FOC is

$$\tau : \frac{\alpha(\eta-1)}{1-\alpha+\tau\alpha} - \frac{1-\mu_\gamma}{1-\tau} \leq 0, \quad \tau \geq 0, \quad \tau\left[\frac{\alpha(\eta-1)}{1-\alpha+\tau\alpha} - \frac{1-\mu_\gamma}{1-\tau}\right] = 0 \tag{A.1.27}$$

which solves τ as in (1.69). Q.E.D.

APPENDIX 2

PROOFS OF CHAPTER 2

Proof of Proposition 2.1

Start with the firm's problem. The quasi-concavity of the maximization problem guarantees that the FOC is necessary and sufficient for a maximum. Given (2.10), firms are indifferent in the amounts of labor to employ and the consumption goods to produce. For (2.14) and (2.15) to hold, they employ all the labor supplied by households and produce what the households demand.

Turning the attention to the household's problem, the concavity of the maximization problem again guarantees that the FOCs are necessary and sufficient for a maximum. The FOCs for (2.13) are

$$e_t : -\frac{n_t}{(1-\zeta_t n_t)h_t - e_t n_t} + \frac{\gamma\eta}{e_t+\sigma} \leq 0, \quad e_t \geq 0, \tag{B.2.1}$$

$$n_t : -\frac{\zeta_t h_t + e_t}{(1-\zeta_t n_t)h_t - e_t n_t} + \frac{\gamma}{n_t} + \lambda_t = 0, \tag{B.2.2}$$

$$\lambda_t : n_t - x_t \geq 0, \quad \lambda_t [n_t - x_t] = 0, \quad \lambda_t \geq 0. \tag{B.2.3}$$

There are four possible scenarios with $e_t \geq 0$ and $n_t \geq x_t$. First, solving the FOCs for $e_t = 0$ and $n_t = x_t$ yields

$$\frac{\gamma\eta}{\sigma} \leq \frac{x_t}{(1-\zeta_t x_t)\,h_t}, \qquad \lambda_t = \frac{\zeta_t x_t - \gamma + \gamma\zeta_t x_t}{x\,(1-\zeta_t x_t)}. \tag{B.2.4}$$

The former condition requires

$$\zeta_t x_t \geq 1 - \frac{\sigma x_t}{\gamma\eta h_t} \equiv \Theta_t \tag{B.2.5}$$

and $\lambda_t \geq 0$ returns

$$\zeta_t x_t \geq \frac{\gamma}{1+\gamma} \equiv \Gamma. \tag{B.2.6}$$

Combining (B.2.5) and (B.2.6) implies

$$e_t = 0 \wedge n_t = x_t \Leftrightarrow \zeta_t x_t \geq \Theta_t \wedge \zeta_t x_t \geq \Gamma. \tag{B.2.7}$$

Then, solving the FOCs for $e_t = 0$ and $n_t > x_t$ returns

$$\frac{n_t}{(1-\zeta_t x_t)} \geq \frac{\gamma\eta}{\sigma}, \qquad \frac{\gamma}{n_t} = \frac{\zeta_t h_t}{(1-\zeta_t x_t)}. \tag{B.2.8}$$

Rearranging terms in the latter condition gives n_t as in

$$n_t = \frac{\gamma}{(1+\gamma)\,\zeta_t}. \tag{B.2.9}$$

Substituting n_t in the other condition yields

$$\zeta_t \leq \frac{\sigma}{\eta h_t}. \tag{B.2.10}$$

Multiply both sides of (B.2.10) with x_t to obtain

$$\zeta_t x_t \leq \frac{\sigma x_t}{\eta h_t} \equiv \Xi_t. \tag{B.2.11}$$

$n_t > x_t$, (B.2.9) and (B.2.11) together indicate

$$n_t = \frac{\gamma}{(1+\gamma)\,\zeta_t} \wedge e_t = 0 \Leftrightarrow \zeta_t x_t < \Gamma \wedge \zeta_t x_t \leq \Xi_t. \tag{B.2.12}$$

Going forward, solving (B.2.1) for $e_t > 0$ and $n_t = x_t$ returns

$$\frac{\gamma\eta}{e_t+\sigma} = \frac{x_t}{(1-\zeta_t x_t)\,h_t - x_t e_t} \tag{B.2.13}$$

which, after rearranging the terms gives e_t as in

$$e_t = \frac{\gamma\eta\,(1-\zeta_t x_t)\,h_t - \sigma x_t}{(1+\gamma\eta)\,x_t}, \tag{B.2.14}$$

and $e_t > 0$ implies

$$\zeta_t x_t < \Theta_t. \tag{B.2.15}$$

Solving (B.2.2) for $e_t > 0$ and $n_t = x_t$ returns

$$\lambda_t = \frac{\zeta_t h_t + e_t}{(1-\zeta_t x_t)\, h_t - x_t e_t} - \frac{\gamma}{x_t}. \tag{B.2.16}$$

After substituting e_t from (B.2.14) in (B.2.16), $\lambda_t \geq 0$ requires

$$\zeta_t x_t \geq \frac{\gamma(1-\eta)}{1+\gamma} + \frac{\sigma x_t}{h_t} \equiv \Phi_t. \tag{B.2.17}$$

$n_t = x_t$, (B.2.14), (B.2.15) and (B.2.17) together imply

$$e_t = \frac{\gamma\eta\,(1-\zeta_t x_t)\, h_t - \sigma x_t}{(1+\gamma\eta)\, x_t} > 0 \wedge n_t = x_t \Leftrightarrow \zeta_t x_t < \Theta_t \wedge \zeta_t x_t \geq \Phi_t. \tag{B.2.18}$$

Finally, for $e_t > 0$ and $n_t > x_t$, solving (B.2.1) returns

$$e_t = \frac{\gamma\eta\,(1-\zeta_t n_t)\, h_t - \sigma x_t}{(1+\gamma\eta)\, n_t}, \tag{B.2.19}$$

and solving (B.2.2) returns

$$n_t = \frac{\gamma h_t}{(1+\gamma)\,(\zeta_t h_t + e_t)}. \tag{B.2.20}$$

Solving (B.2.19) and (B.2.20) for e_t and n_t gives both variables as in

$$e_t = \frac{\eta\,\zeta_t h_t - \sigma}{1-\eta}, \quad n_t = \frac{\gamma(1-\eta)\, h_t}{(1+\gamma)\,(\zeta_t h_t - \sigma)}. \tag{B.2.21}$$

From (B.2.21), $e_t > 0$ requires

$$\zeta_t > \frac{\sigma}{\eta h_t} \tag{B.2.22}$$

and $n_t > x_t$ requires

$$\zeta_t > \frac{\gamma(1-\eta)}{(1+\gamma)\, x_t} + \frac{\sigma x_t}{h_t}. \tag{B.2.23}$$

Multiplying both sides of both (B.2.22) and (B.2.23), and (B.2.21) together imply

$$e_t = \frac{\eta\zeta_t h_t - \sigma}{1-\eta} > 0 \wedge n_t = \frac{\gamma(1-\eta)h_t}{(1+\gamma)(\zeta_t h_t - \sigma)} > x_t \Leftrightarrow \zeta_t x_t > \Xi_t \wedge \zeta_t x_t < \Phi_t. \quad \text{(B.2.24)}$$

The combination of (B.2.7), (B.2.12), (B.2.18) and (B.2.24) shows the conditions for the results summarized in Proposition 2.1. Q.E.D.

Proof of Lemma 2.1

This proof has two parts. The first part covers the relative positions of threshold levels of $\zeta_t x_t$ and the second part covers the case where $h_t \to +\infty$.

Given ζ_t, h_t, and $x_t < \tilde{x}_t$, the relative positions of the four thresholds read

$$\Xi_t < \Phi_t, \quad \Phi_t < \Gamma, \quad \text{and} \quad \Gamma < \Theta_t.$$

The transitivity of binary relations in $\mathbb{R}$ implies that given ζ_t and h_t,

- $\Xi_t < \Phi_t < \Gamma < \Theta_t$ for $x_t < \tilde{x}_t$ and
- $\Theta_t < \Gamma < \Phi_t < \Xi_t$ for $x_t > \tilde{x}_t$.

All thresholds are equal to each other when $x_t = \tilde{x}_t$.

When h_t goes to infinity, $\tilde{x}_t$, Ξ_t and Θ_t are

$$\begin{aligned} \lim_{h_t \to +\infty} \tilde{x}_t &= \lim_{h_t \to +\infty} \frac{\gamma\eta}{(1+\gamma)\sigma} h_t \to +\infty, \\ \lim_{h_t \to +\infty} \Xi_t &= \lim_{h_t \to +\infty} \frac{\sigma x_t}{\eta h_t} = 0, \\ \lim_{h_t \to +\infty} \Theta_t &= \lim_{h_t \to +\infty} 1 - \frac{\sigma x_t}{\gamma\eta h_t} = 1 \end{aligned} \quad \text{(B.2.25)}$$

respectively. This implies that when h_t goes to infinity, (i) x_t remains below $\tilde{x}_t$ and (ii) Ξ_t and Θ_t are no more binding. Q.E.D.

Proof of Proposition 2.2

That there exists a unique solution to the SGE from Proposition 2.1 for any t and the laws of motion (2.4), (2.7), and (2.20) are real-valued functions prove that a unique DGE for the entire history exists. Q.E.D.

Proof of Lemma 2.2

Dividing (2.20) for $N_{t+1} < \bar{N}$ and (2.4) by ζ_t and x_t respectively returns conditional dynamics given in Lemma 2.2. Q.E.D.

Proof of Proposition 2.3

(2.7) and (2.17) solve G_t for each of the four regimes.

The initial education expenditure trivially results in $G_t > 1$. Suppose that the economy is in Regime 3 and let $G_t^{\text{Regime 3}}$ denote G_t in this regime. With $\partial G_t^{\text{Regime 3}} / \partial h_t < 0$, $G_t^{\text{Regime 3}}$ decreases in h_t. Given ζ_t and x_t, the lowest $G_t^{\text{Regime 3}}$ is obtained from

$$\lim_{h_t \to +\infty} G_t^{\text{Regime 3}} = \tau \left[\frac{\gamma\eta\,(1-\zeta_t x_t)}{1+\gamma\eta} \right]^{\eta},$$

which is greater than one for

$$\tau > \left[\frac{1+\gamma\eta}{\gamma\eta\,(1-\zeta_t x_t)} \right]^{\eta}. \tag{B.2.26}$$

G_t decreases in ζ_t and x_t with $G_t^{\text{Regime 3}} / \partial \zeta_t < 0$ and $G_t^{\text{Regime 3}} / \partial x_t < 0$. The proof of Lemma 2.1 shows that the economy requires at least $x < \tilde{x}$ to operate within Regime 3 and $\bar{\zeta}$ is the upper bound of ζ_t. Substituting these maximum values in (B.2.26) returns the strongest condition required for a sufficiently large τ as

$$\tau > \left[\frac{1+\gamma\eta}{\gamma\eta\,(1-\bar{\zeta}\tilde{x}_t)} \right]^{\eta}. \tag{B.2.27}$$

Now, suppose that the economy is in Regime 4 and let $G_t^{\text{Regime 4}}$ denote G_t in this regime. $G_t^{\text{Regime 4}}$ increases in h_t and ζ_t with $\partial G_t^{\text{Regime 4}} / \partial h_t > 0$ and $\partial G_t^{\text{Regime 4}} / \partial \zeta_t > 0$. The economy operates either below the $\zeta\zeta$ locus or above it. If the economy operates below $\zeta\zeta$, ζ_t increases over time, and $G_t^{\text{Regime 4}}$ remains greater than one. If the economy is above $\zeta\zeta$, ζ_t decreases over time. The lower bound of ζ_t in this regime is naturally equal to its value on $\zeta\zeta$. Substituting ζ_t from (2.26) in $G_t^{\text{Regime 4}}$ returns

$$G_t^{\text{Regime 4}} \Big|_{\zeta_t = \frac{\gamma(1-\eta)}{1+\gamma} + \frac{\sigma}{h_t}} = \tau \left(\frac{1+\gamma}{\gamma\eta} \right)^{\eta}, \tag{B.2.28}$$

which is above one for a sufficiently large τ as in

$$\tau > \left(\frac{1+\gamma}{\gamma\eta}\right)^{\eta}. \tag{B.2.29}$$

Q.E.D.

Proof of Proposition 2.4

The first part of the proof shows under which parameter values and state vectors that the economy remains in Regime 1, while the second part proves the existence of the steady-state equilibrium under certain parameter values.

First, let x_0, ζ_0 and h_0 be the initial state variables such that $\zeta_0 x_0 \geq \Gamma$ and $\zeta_0 x_0 \geq \Theta_0$, i.e., the economy is in Regime 1 where $n_t = x_t$ and $e_t = 0$.

(2.18) and (2.21) imply that ζ_1/ζ_0 is greater than 1 for $x_0 > 1$, equal to 1 for $x_0 > 1$, and less than 1 for $x_0 < 1$. (2.18) and (2.22) implies that $x_1 = x_0$.

As for the threshold levels of $\zeta_t x_t$ which the economy needs to satisfy in order to remain in Regime 1, Θ_t is increasing in h_t and decreasing in x_t, and Γ is a constant. That $e_t = 0$ in Regime 1 implies $h_t = h_{t+1}$. A constant h_t and a constant x_t jointly imply that Θ_t, thus both threshold levels, does not change when the economy is in Regime 1. The path of the economy depending on x_0 and the changes in ζ_t is as follows:

- ζ_t decreases over time for $x_0 < 1$. $x_{t+1}/x_t = 1$ and $\zeta_{t+1}/\zeta_t < 1$ imply $\zeta_{t+1}x_{t+1}/\zeta_t x_t < 1$. Thus, $\zeta_t x_t$ violates either $\zeta_t x_t \geq \Gamma$ or $\zeta_t x_t \geq \Theta_t$ at some t and the economy escapes from Regime 1.
- $x_0 = 1$ implies $\zeta_{t+1}/\zeta_t = 1$. Since variables in $\mathbf{z}_t$ do not change over time, $\zeta_t x_t$ violates neither threshold and the economy continues to operate in Regime 1 for the remaining history.
- $x_0 > 1$ implies $\zeta_{t+1}/\zeta_t > 1$. $x_{t+1}/x_t = 1$ and $\zeta_{t+1}/\zeta_t > 1$ imply $\zeta_{t+1}x_{t+1}/\zeta_t x_t > 1$. Since both conditions to operate in Regime 1 require $\zeta_t x_t$ to be greater than some threshold levels which remain constant over time, an increasing $\zeta_t x_t$ imply that the economy remains in Regime 1 forever.

Thus, given $\zeta_0 x_0 \geq \Gamma$ and $\zeta_0 x_0 \geq \Theta_0$, the economy remains in Regime 1 for the entire history for $x_0 \geq 1$.

Next, the intersection of the state vectors within Regime 1, xx locus, and $\zeta\zeta$ locus returns the state vectors under which the steady-state equilibrium exist. $x_{t+1}/x_t = 1$ for all state vetors within Regime 3 guarantees that any x_t such that $\zeta_t x_t \geq \Gamma$ and $\zeta_t x_t \geq \Theta_t$ is an element of xx.

As for $\zeta\zeta$: Taking the limit of ζ_{t+1} ζ_t with $t \to +\infty$ yields

$$\lim_{t\to+\infty} \frac{\zeta_{t+1}}{\zeta_t} = \lim_{t\to+\infty} x_0^{\alpha} = x_0^{\alpha}. \tag{B.2.30}$$

Consider $x_0 > 1$. N_t trivially increases over time, and reaches to $\bar{N}$ at some point. With $\zeta_{t+1} = \zeta_t = \bar{\zeta}$ for the remaining history, $\zeta^* = \bar{\zeta}$ is an element of $\zeta\zeta$. Therefore, there is a steady-state equilibrium in Regime 1 with state vector $\left(x^*, \bar{\zeta}, h^*\right)$ where $x^* \in (1, \bar{x}]$ and $h^* \in [1, +\infty)$.

$x_t = x_0 = 1$ imply $x_0^{\alpha} = 1$, which, together with (B.2.30) indicate that any $\zeta_0 = \zeta^*$ is an element of $\zeta\zeta$. The minimum value of ζ^* that satisfies the constraints for Regime 1 solves the minimum for the ζ^* set of the steady-state equilibrium. The proof of Lemma 2.1 shows that the more stringent constraint for Regime 1 depends on whether $x_0 = 1 < \tilde{x}_t$ or not.

- $\Theta_t > \Gamma$ for $1 < \tilde{x}_t$. Dividing Θ_t by $x_0 = 1$ returns the minimum ζ^* that lies within Regime 1. Therefore, there is a steady-state equilibrium in Regime 1 with the state vector $(1, \zeta^*, h^*)$ where $\zeta^* \in \left[1 - \frac{\sigma}{\gamma\eta h^*}, \bar{\zeta}\right]$ and $h^* \in [1, +\infty)$. The existence of the equilibrium requires at least one state vector to satisfy the constraints for Regime 1.
- $\Gamma > \Theta_t$ for $1 > \tilde{x}_t$. Dividing Γ by $x_0 = 1$ returns the minimum ζ^* that lies within Regime 1. Therefore, there is a steady-state equilibrium in Regime 1 with the state vector $(1, \zeta^*, h^*)$ where $\zeta^* \in \left[\frac{\gamma}{1+\gamma}, \bar{\zeta}\right]$ and $h^* \in [1, +\infty)$. The existence of the equilibrium requires at least one state vector to satisfy the constraints for Regime 1.

Q.E.D.

Proof of Proposition 2.5

This proof follows a similar path with that of the proof of Proposition 2.4.

Let x_0, ζ_0 and h_0 be the initial state variables such that $\zeta_0 x_0 < \Theta_0$ and $\zeta_0 x_0 \geq \Phi_0$, i.e., the economy is in Regime 3 where $n_t = x_t$ and $e_t > 0$. Both ζ_t and x_t have the same dynamics as in the Proof of Proposition 2.4.

As for the threshold levels of $\zeta_t x_t$ which the economy needs to satisfy in order to remain in Regime 3, Θ_t is increasing in h_t and decreasing in x_t, and Φ_t is decreasing in h_t and increasing in x_t. That $e_t > 0$ in Regime 3 implies $h_{t+1}/h_t > 1$ which is the case for all t as long as the economy operates in Regime 3, according to the proof of Proposition 2.3. $h_{t+1}/h_t > 1$ and a $x_{t+1}/x_t = 1$ jointly imply that Θ_t increases over time while Φ_t decreases.

- ζ_t decreases over time for $x_0 < 1$. $x_{t+1}/x_t = 1$ and $\zeta_{t+1}/\zeta_t < 1$ imply $\zeta_{t+1}x_{t+1}/\zeta_t x_t < 1$. Thus, $\zeta_t x_t$ violates $\zeta_t x_t \geq \Phi_t$ at some t and the economy moves to Regime 4 from Regime 3.
- $x_0 = 1$ implies $\zeta_{t+1}/\zeta_t = 1$. $\zeta_t x_t$ remains constant over time, it neither exceeds an increasing Θ_t not falls behind a decreasing Φ_t, and the economy remains in Regime 3 forever.
- $x_0 > 1$ implies $\zeta_{t+1}/\zeta_t > 1$. $x_{t+1}/x_t = 1$ and $\zeta_{t+1}/\zeta_t > 1$ imply $\zeta_{t+1}x_{t+1}/\zeta_t x_t > 1$. $\zeta_t x_t$ does not fall below Φ_t as long as it operates within Regime 3. However, whether it remains below Θ_t or not is uncertain, because both $\zeta_t x_t$ and Θ_t are increasing over time. Assume that the economy remains in Regime 3 for a sufficiently long time such that Θ_t, as in the proof of Lemma 2.1, converges to 1. Then, the economy remains in Regime 3 forever.

Thus, given $\zeta_0 x_0 < \Theta_t$ and $\zeta_0 x_0 \geq \Phi_0$, the economy remains in Regime 3 for the entire history for $x_0 \geq 1$.

Next, the intersection of the state vectors within Regime 3, xx locus, and $\zeta\zeta$ locus returns the state vectors under which a steady-state equilibrium exist. $x_{t+1}/x_t = 1$ for all state vetors within Regime 1 guarantees that any x_t such that $\zeta_t x_t < \Theta_t$ and $\zeta_t x_t \geq \Phi_t$ is an element of xx.

Suppose that $t \to +\infty$. The proof of Lemma 2.1 shows that $\Theta_t \to 1$. For given ζ_0, Φ_t becomes

$$\lim_{t\to+\infty} \Phi_t = \frac{\gamma(1-\eta)\,h_t}{(1+\gamma)\,(\zeta_0 h_t - \sigma)} = \frac{\gamma(1-\eta)}{(1+\gamma)\,\zeta_0}. \tag{B.2.31}$$

Assume that $x_0 > 1$. N_t increases over time, and reaches to $\bar{N}$ at some point. With $\zeta_{t+1} = \zeta_t = \bar{\zeta}$ for the remaining history, $\zeta^* = \bar{\zeta}$ is an element of $\zeta\zeta$. Therefore, there is a steady-state equilibrium in Regime 3 with state vector $\left(x^*, \bar{\zeta}, h^*\right)$ where $x^* \in (1, \bar{x}]$ and $h^* \to +\infty$.

As for $x_0 = 1$, the existence of a steady-state equilibrium requires a $\zeta_t x_t$ that satisfies $\zeta_t x_t \geq \Phi_t$ for all t. Solving $\lim_{t\to+\infty} \Phi_t = \zeta^*$ returns the minimum ζ^* that is an element of the steady-state. The state vector $(1, \zeta^*, h^*)$ such that $\zeta^* \in \left[\frac{\gamma(1-\eta)}{1+\gamma}, \bar{\zeta}\right]$, and $h^* \to +\infty$ is a steady-state equilibrium. Q.E.D.

Proof of Proposition 2.6

This proof seeks to demonstrate once the model economy enters Regime 4 with $x_0 < 1$, it converges to a unique steady-state for $t \to +\infty$.

(2.24) and (2.27) imply that

$$x_t = \frac{\gamma(1-\eta)\,h_t}{(1+\gamma)\,(\zeta_t h_t - \sigma)}, \quad \textit{and} \tag{B.2.32}$$

$$\zeta_t = \frac{\gamma(1-\eta)}{1+\gamma} + \frac{\sigma}{h_t} \tag{B.2.33}$$

are the xx and $\zeta\zeta$ loci in Regime 4 respectively. The optimum education expenditure is positive in Regime 4, and Lemma 2.1 shows that human capital is increasing with positive education expenditure. Taking the limits of $\zeta\zeta$ and xx for $t \to +\infty$ respectively return

$$\lim_{t\to+\infty} \zeta_t = \frac{\gamma(1-\eta)}{1+\gamma} + \frac{\sigma}{\lim\limits_{t\to+\infty} h_t} = \frac{\gamma(1-\eta)}{1+\gamma} = \zeta^*, \quad \textit{and} \tag{B.2.34}$$

$$\lim_{t\to+\infty} x_t = \frac{\gamma(1-\eta)\lim\limits_{t\to+\infty} h_t}{(1+\gamma)\left(\zeta_t \lim\limits_{t\to+\infty} h_t - \sigma\right)} = \frac{\gamma(1-\eta)}{(1+\gamma)\,\zeta^*} = x^*. \tag{B.2.35}$$

(B.2.34) and (B.2.35) solve the unique ζ^* and x^* when h_t goes to infinity as in

$$\zeta^* = \frac{\gamma(1-\eta)}{1+\gamma} \quad \text{and} \quad x^* = 1. \tag{B.2.36}$$

Assume that the economy enters Regime 4 with $x_0 \geq 1$. (2.22) shows that x_t increases in Regime 4 which, in this case, means that x_t diverges from $x^* = 1$. The proof of Lemma 2.1 shows that $\zeta_t x_t$ exceeds Φ_t but remains below Θ_t and the economy enters Regime 3. Therefore, the economy cannot converge to a steady-state in Regime 4 with $x_0 > 1$.

Now, assume that the economy enters Regime 4 with $x_0 < 1$ and $N_0 < \bar{N}$. The proof of Proposition 2.3 shows that h_t increases with e_t and goes to infinity for $t \to +\infty$.

Let $X^T \equiv (x_t, \zeta_t)$ be the vector that contains the elements x_t and ζ_t, and J be the Jacobian matrix governing the dynamical system of X . Also, let Δx_t and $\Delta\zeta_t$ be

$$\Delta x_t = x_t - x^* \tag{B.2.37}$$

and

$$\Delta\zeta_t = \zeta_t - \zeta^* \tag{B.2.38}$$

respectively, and $\Delta X^T \equiv (\Delta x_t, \Delta\zeta_t)$. Using a Taylor series expansion, the linear approximation of the system becomes

$$\Delta X_t = J\Delta X_{t-1} \tag{B.2.39}$$

Linearizing the system around the steady-state at $t \to +\infty$ and normalizing returns the explicit matrix expression

$$\begin{bmatrix} \Delta x_t \\ \Delta\zeta_t \end{bmatrix} = \begin{bmatrix} \psi & \frac{-(1-\psi)(1+\gamma)}{\gamma} \\ 0 & 1-\alpha \end{bmatrix} \begin{bmatrix} \Delta x_{t-1} \\ \Delta\zeta_{t-1} \end{bmatrix} \tag{B.2.40}$$

where the eigenvalues of the coefficient matrix, ψ and $1-\alpha$, satisfy $0 < \psi < 1$, $0 < 1-\alpha < 1$ and $\psi \neq 1-\alpha$, implying that the system is a stable node. Q.E.D.

Proof of Proposition 2.7

That the economy converges to the steady-state defined in Proposition 2.7 in Regime 4, which is characterized by non-binding social norms, guarantees that the economy would have converged to this steady-state if the fertility habit constraint was not introduced. The proof of Proposition 2.3 shows that $G_t^{\text{Regime 3}}$ is decreasing in both ζ_t and x_t. The steady-state in Proposition 2.7 is in Regime 3 and it has the lowest values for both x^* and ζ^*, which implies that it returns the highest G^* among all possible steady-state growth rates of the model economy. Q.E.D.

Proof of Proposition 2.8

Assume that the economy is initially in Regime 2 with $\zeta_0 x_0 < \Gamma$, $\zeta_0 x_0 \leq \Xi_t$, and $x_0 > 1$. These, alongside (2.4), (2.18), (2.21), and (2.22) imply $\zeta_{t+1}/\zeta_t > 1$, x_{t+1}/x_t $\zeta_{t+1}x_{t+1}/\zeta_t x_t > 1$. Since the condition to operate in Regime 2 requires $\zeta_t x_t$ to remain below two thresholds, it violates either condition at some t.

Note that the proof of Lemma 2.1 shows that $\Gamma < \Xi_t$ for $\tilde{x}_t < x_t$. (2.22) implies the growth of x_t depends on how large ψ is. For lower values of ψ, the growth of x_t is relatively high such that x_t exceeds $\tilde{x}_t$, and $\zeta_t x_t$ first exceeds the smaller threshold, Γ. The economy then enters Regime 1, and as the proof of Proposition 2.4 shows, remains in Regime 1 for the remaining history.

If, on the other hand, ψ is relatively large such that x_t does not exceed $\tilde{x}$ for a (very) long time, $\zeta_t x_t$ exceeds Ξ_t but remains below Φ_t and the economy enters Regime 4. However, with $x_t > 1$, as shown in the proof of Proposition 2.6, it eventually enters Regime 3 and operates in this regime for the remaining history. Q.E.D.

Proof of Proposition 2.9

Following the proof of Proposition 2.1 with substituting x_t with ξx_t solves the SGE of the extended model. The conditions for Regimes 1, 2, 3 and 4 become

$$\begin{aligned}
&e_t = 0 \wedge n_t = \xi x_t \Leftrightarrow \zeta_t x_t \geq \hat{\Theta}_t \wedge \zeta_t x_t \geq \hat{\Gamma}, \\
&e_t = 0 \wedge n_t = \frac{\gamma}{(1+\gamma)\,\zeta_t} > \xi x_t \Leftrightarrow \zeta_t x_t \leq \Xi_t \wedge \zeta_t x_t < \hat{\Gamma}, \\
&e_t = \frac{\gamma\eta\,(1-\xi\zeta_t)\,h_t - \xi\sigma x_t}{(1+\gamma\eta)\,x_t} > 0 \wedge n_t = \xi x_t \Leftrightarrow \zeta_t x_t < \bar{\Theta}_t \wedge \zeta_t x_t \geq \bar{\Phi}_t, \\
&e_t = \frac{\eta\zeta_t h_t - \sigma}{1-\eta} > 0 \wedge n_t = \frac{\gamma(1-\eta)\,h_t}{(1+\gamma)\,(\zeta_t h_t - \sigma)} > \xi x_t \Leftrightarrow \zeta_t x_t \geq \Xi_t \wedge \zeta_t x_t \geq \hat{\Phi}_t
\end{aligned} \tag{B.2.41}$$

respectively, where

$$\hat{\Gamma} \equiv \frac{\Gamma}{\xi}, \quad \hat{\Theta}_t \equiv \frac{\Theta_t}{\xi}, \quad \hat{\Phi}_t \equiv \frac{\Psi_t}{\xi}.$$

Q.E.D.

Proof of Proposition 2.10

That there exists a unique solution to the extended model's SGE from Proposition (2.9) for any t and the laws of motion (2.4), (2.7), and (2.20) are real-valued functions prove that a unique DGE of the extended model for the entire history exists. Q.E.D.

Proof of Proposition 2.11

This proof seeks to demonstrate that, when the economy is at an initial state with $e_0 = 0$ being optimum, education expenditure inevitably starts at some period $\tilde{t}$. The first part of the proof, as in the proof of Lemma 2.1, shows that the relative positions of the threshold levels of $\zeta_t x_t$ depend on whether x_t is above or below a threshold, $\xi \tilde{x}_t$. Utilizing the first part, the second part shows that the economy eventually enters a regime where positive education expenditure is optimum. The final part shows that the economy ultimately ends up in Regime 4 regardless of its initial state.

Substituting each x_t with ξx_t in the proof of Lemma 2.1 shows that, the relative positions of the threshold levels of $\zeta_t x_t$ defined in the proof of Proposition 2.9 depend on whether $x_t > \xi \tilde{x}_t$ or not. Figure 24 illustrates the relative positions of the threshold levels of $\zeta_t x_t$ for the extended model.

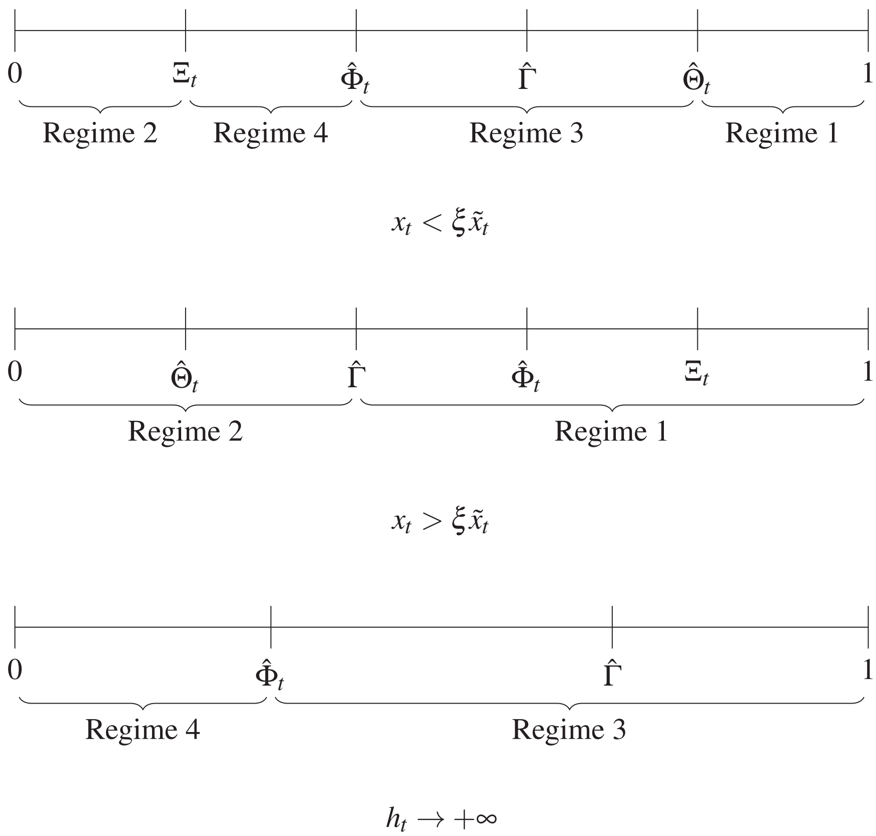

Figure 24: $\zeta_t x_t$ Intervals of the Extended Model for Regimes 1, 2, 3 and 4

Assume that the initial state of the economy is within Regime 2 and $x_0 > 1$. That x_t decrease above and increase below the xx-locus guarantee once the state vector reaches to the xx-locus, the state vector continues to move along it. $\zeta_{t+1}/\zeta_t > 1$ and $x_{t+1}/x_t = 1$ (when on the xx-locus) imply $\zeta_{t+1}x_{t+1}/\zeta_t x_t > 1$, thus the economy escapes the regime at some $\tilde{t}$. Note that since all points on the xx-locus lie below $\hat{\Gamma}$, and the state vector moves along the xx-locus, $\zeta_{\tilde{t}} x_{\tilde{t}}$ can only, and does, exceed $\Xi_{\tilde{t}}$ and the economy enters Regime 4.

Now, assume that the economy is initially in Regime 1 with $x_0 > 1$. Initially, $x_{t+1}/x_t < 1$ while $\zeta_{t+1}/\zeta_t > 1$ as a result of the increasing population size. That x_t has a lower bound of 0, and ζ_t has a positive upper bound guarantee that at some point, $\zeta_t x_t$ will start to decrease and violate either one of the conditions to operate in Regime 1. The economy can follow two paths from here, depending on ψ and ξ. For relatively high ψ and ξ, (2.4) and (2.30) show that $\mid x_{t+1}/x_t \mid$ is close to 1, i.e. the changes in x_t are relatively small such that the economy operates at relatively high x_t for a long time. Since $x_{t+1}/x_t < 1$, x_t eventually falls below $\xi \tilde{x}_t$, but when in Regime 1. With a decreasing $\zeta_t x_t$, the economy then enters to Regime 3 where education expenditure is positibe.

The second path of the economy is as follows: With relatively smaller ψ and ξ, $\mid x_{t+1}/x_t \mid$ is relatively small (i.e. x_t decreases rapidly) and x_t falls below $\xi \tilde{x}_t$ relatively quick, i.e., at relatively low levels of $\zeta_t x_t$. Figure 24 shows that in this case, the economy enters Regime 2. Then, it follows the steps that it would have followed if the initial state of the economy was in Regime 2.

Finally, assume that the economy is in Regime 3 at some t. This regime only exists for $x_t < \xi \tilde{x}_t$. Recall that $x_{t+1}/x_t < 1$. Also note that ζ_{t+1}/ζ_t is greater than 1 for $\xi x_t > 1$, equal to 1 for $\xi x_t = 1$, and smaller than 1 for $\xi x_t < 1$. Thus, with a declining x_t, it is trivial that the economy eventually escapes Regime 3 and enters Regime 4. Q.E.D.

Proof of Proposition 2.12

The unique equilibrium is in Regime 4 where xx and $\zeta\zeta$ intersect. Note that this Regime is where social norms are not binding on individuals' decisions, as in the Regime 4 of the basic model. Whether the individuals question social norms or not do not make any difference when in Regime 4. Therefore, the steady-state and the dynamics in Regime 4 of the extended model are the same as those of the basic model with the only difference being the effect of $x_t > 1$. Since x_t is not non-decreasing unlike the basic model, $x_t > 1$ does not cause any instability for the extended model. Hence, the unique equilibrium in Regime 4 is a stable node. Q.E.D.

Proof of Proposition 2.13

The proof of Proposition 2.11 shows the potential transitions among Regimes. When in Regime 1, the economy either moves to Regime 2 or 3. When in Regime 2 or 3, the economy moves to Regime 4. When in Regime 4, the economy remains there for the remaining history (see Figure 17). Thus, the equilibrium in Regime 4 is asymptotically globally stable. Q.E.D.

APPENDIX 3

ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
MASTER'S THESIS ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ECONOMICS DEPARTMENT

Date: 07/06/2019

Thesis Title: Habits, Status Preferences, and Optimal Economic Growth

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Name Surname: Sencer KARADEMİR
Student No: N15221500
Department: Economics
Program: Economics Master's Programme

ADVISOR APPROVAL

APPROVED.

Asst. Prof. Dr. Mustafa Aykut ATTAR

APPENDIX 4

ETHICS BOARD WAIVER FORM

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
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GRADUATE SCHOOL OF SOCIAL SCIENCES
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Date: 10/06/2019

Thesis Title: Habits, Status Preferences, and Optimal Economic Growth

My thesis work related to the title above:

1. Does not perform experimentation on animals or people.
2. Does not necessitate the use of biological material (blood, urine, biological fluids and samples, etc.).
3. Does not involve any interference of the body's integrity.
4. Is not based on observational and descriptive research (survey, interview, measures/scales, data scanning, system-model development).

I declare, I have carefully read Hacettepe University's Ethics Regulations and the Commission's Guidelines, and in order to proceed with my thesis according to these regulations I do not have to get permission from the Ethics Board/Commission for anything; in any infringement of the regulations I accept all legal responsibility and I declare that all the information I have provided is true.

I respectfully submit this for approval.

Date and Signature
10/06/2019

Name Surname: Sencer KARADEMİR
Student No: N15221500
Department: Economics
Program: Economics Master's Programme
Status: ☒ MA ☐ Ph.D. ☐ Combined MA/ Ph.D.

ADVISER COMMENTS AND APPROVAL

Approved.

Asst. Prof. Dr. Mustafa Aykut ATTAR