THE BUSINESS CYCLE BEHAVIOR OF GINI COEFFICIENT OF THE INCOME DISTRIBUTION

by

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A thesis submitted in partial fulfillment of
the requirements for the degree of

Master of Arts in Economics

National University "Kyiv-Mohyla Academy"
Economics Education and Research Consortium
Master's Program in Economics

2004

Approved by ____
Ms.Svitlana Budagovska (Head of the State Examination Committee)

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Program Authorized
to Offer Degree Master's Program in Economics, NaUKMA

Date ____

National University "Kyiv-Mohyla Academy"

Abstract

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In this paper we describe a theoretical framework that allows us to address the business cycle behavior of the income distribution. Our analysis is built around a heterogeneous agents version of the standard neoclassical growth model. Heterogeneity is in two dimensions, initial endowment and non-acquired skills. We show that model admits a simple closed-form expression for the Gini coefficient of the income distribution. To be specific, at any point in time, the Gini coefficient of income distribution can be fully represented by a linear combination of its previous value, Gini coefficient of non-acquired skills and such macroeconomic aggregates as consumption, capital stock and efficient hours worked. We test the model's prediction by using panel data that covers 14 OECD countries for 1962-1991. We find that our model can explain about 60 per cent of the variation in the Gini coefficient within the countries.

LIST OF TABLES

ACKNOWLEDGMENTS

I want to express my sincere gratitude and appreciation to my advisor, Dr. Serguei Maliar, for his continuous encouragement of research and insightful supervision through the whole process of the thesis writing. I am also grateful to Dr. Tom Coupé for his patience and support thorough reviews and valuable comments. I am indebted to Dr. Sergey Slobodyan who inspired me to choose this research topic.

My warmest gratitude goes to my family and to all my friends for the support and understanding during these long, but challengeable two years. Special thanks go to Katerina Bornukova for her comments.

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Chapter 1

INTRODUCTION

In this paper, we describe a theorectical framework that allows to address the business cycle behavior of the Gini coefficient of the income distribution. Our framework is built around the model by Maliar, Maliar and Mora (2003). They study the business-cycle dynamics of the income and wealth distributions in the context of a heterogeneous-agent dynamic general equilibrium stochastic growth model. They show that, at any point in time, the wealth and income distribution in the economy can be represented by a linear combination of the skill distribution and the initial wealth distribution. We continue their analysis, concentrating on the behavior of the Gini coefficient.

We focus on the Gini coefficient as a measure of income inequality for two reasons: first of all Gini coefficient has a very simple expression and it is a summary measure of the Lorenz curve, which is a graphical representation of the inequality in the society. Secondly data available on the income inequality is mainly expressed in terms of Gini coefficient. That is why the Gini coefficient has been used in numerous empirical studies and policy researches.

There are many empirical papers that study the determinants of the inequalities. However, the existing papers are empirical and explanatory variables are selected on the bases of common sense Li, Squire and Zou (1998), Li and Zou (2002). For a survey of the empirical literature on the business cycle behavior of the income inequality see Parker (1999).

The paper done by Castaneda et al. (1998) also provides a theoretical framework for addressing the business cycle dynamics of the income distribution. However this paper is mostly concerned with the extent to which unemployment spells and cyclically moving factor shares account for the behavior of the income distribution by analyzing four heterogeneous household extensions of the neoclassical growth model. The paper uses simulations to study the properties of equilibrium, and obtains only numerical representation of the behavior of the income inequality.

The contribution of this paper is therefore twofold. First of all by using the expression for the income distribution we derive a closed-form expression for the Gini coefficient of the income distribution in the model. In addition we show that at any point of time, it can be represented by a linear combination of the previous value of Gini coefficient and Gini coefficient on non-acquired skills. Our findings are consistent with those obtained in Li, Squire and Zou (1998). They showed that the Gini coefficient has little variation within a country over time. Our model with assumption about equal distribution of non-acquired skills actually allows us to show that in our model the variation in Gini can be explained by innovations to aggregate variables.

Second, we conduct empirical analysis using obtained expression for Gini coefficient of the income distribution. For that purpose we use panel data that cover 14 OECD countries for the period 1962-1991. We find that our empirical model can explain about 90 per cent of the variation in the Gini coefficient in the data.

The structure of the work is as following: section 2 offers the literature review, where we provide short overview of the researches that are connected to our topic; section 3 describes the theoretical model of the business cycle income and wealth distribution behavior; section 4 provides the description of the data used in the empirical part of the paper; section 5 discusses the empirical results and finally, section 6 concludes.

Chapter 2

LITERATURE REVIEW

The Gini coefficient or index is perhaps one of the most used indicators of social and economic conditions (for a comprehensive study of Gini coefficient see Kuan Xu(2004)). However, despite of the popularity there are very few papers that study the determinants of Gini coefficient of the income distribution and all of them are empirical. To offer a reader the idea of what was done in the literature related to the Gini coefficient we will divide this review into three logical sections. Thus in first section we will consider the empirical literature related to the Gini coefficient. There are two streams of literature: the first one uses the Gini coefficient among the explanatory variables, it is mainly presented by the empirical papers on growth. The second stream that tries to identify the major determinants of the Gini coefficient is closely related to our research. In the second section we will outline the main analytical studies of the modeling the long run behavior of the income distribution. And the third part will be devoted to papers that use neoclassical growth models to study the behavior of the income distribution.

2.1 Empirical literature

The literature that studies determinants of growth is numerous. The majority of these studies use Gini coefficient as one of the explanatory variables in the growth regression. However the question about the relationship is still controversial. Most of the recent empirical studies challenged the view that inequality enhances growth. The majority of them find a negative correlation between growth and inequality.

First evidence of the negative effect of inequality on growth was provided by Persson and Tabellini (1994). Their arguments were following: in the presence of the inequality poor agents will vote for the implementation of a redistribution policy, which in turn will disrupt the incentive for investment. Therefore if we assume that growth depends on accumulation we obtain a negative relationship between inequality and growth.

Initially they formulate a simple general-equilibrium model with heterogeneous agents, which also act as voters. The model's politico-economical equilibrium determines growth rate as a function of initial parameters. As a result the greater inequality leads to a lower level of growth. Next they test their model with two sets of data. The first is a historical panel of nine currently developed countries and the second contains postwar evidence for a broad cross section of countries. The equations were a reduced-form growth regression with per capita GDP growth as dependent variable and controls for initial GDP per capita and schooling. They found significant negative effect of inequality on growth. They estimated that a 0.007 increase in the income share held by the top 20% lowered the growth rate of per capita income by just under 0.5% - quite a significant effect.

Actually there is a great number of the models, which are based on political equilibrium: Perrotti (1993), Alesina and Rodric (1994), Benhabib and Rustichini (1991). All of them predict a negative impact of inequality on growth.

In recent years academic interest in assessment of main determinants of the inequality was renewed. It happened mainly due to a sharp increase in income inequality in the United States, United Kingdom, and other developed countries over the last two decades. Here we will focus on empirical papers that study Gini coefficient as a measure of the income inequality which is most relevant to our research. And then we will review the papers, which study the business cycle behavior of whole distribution and do not focus on specific measure such as Gini coefficient.

The first paper by Li, Squire and Zou (1998) tests the proposition that income inequality measured by the Gini coefficient is relatively stable within countries and varies significantly among the set of the countries. The analysis is conducted on the data set composed by Deininger and Squire (1996), which provides the measure the income inequalities. The authors find broad support for the both propositions.

Another important contribution of the paper is findings about the important determinants of the Gini coefficient. The paper suggests that there are variables, which do not vary much within countries and which can explain well the variation of the Gini coefficient within the countries. Indeed such variables as a measure of civil liberties and initial level of secondary education are important determinants of the Gini coefficient. The same suggestion was made about the variables that vary significantly among the countries and are connected to the second part of the proposition. They found that a measure of financial depth and the initial distribution of land explain well the variation of the Gini coefficient between the countries.

The second paper written by Li and Zou (2002) uses the same data set as in previous paper made by Deininger and Squire (1996) to explore the impact of inflation on the Gini coefficient of the income distribution and on the economic growth.

The authors use two different techniques: baseline OLS and IV to estimate the regression describing the relationship between Gini coefficient and inflation. The results obtained using these two methodologies are very similar and could be stated as following: an increase in the inflation rate or population growth will increase income inequality, whereas an increase in human capital stock, financial development, and government spending will reduce income inequality.

In contrast to papers that concentrate on the Gini coefficient there are many empirical researches that have been done to study business cycle behavior of the income distribution. Early work of this sort by Mendershausen (1946) and Kuznets (1953) established that U.S. inequality followed an anti-cyclical patterns in the interwar years: for example the upper income group makes strong relative gains during the Great Depression. However in the postwar period the results are mixed. There is a number of papers, which study disaggregated individual or family incomes, see Creamer (1956), Gramlich and Laren (1984), Slottje (1987), and Blank (1989). These works show that most types of household incomes are sensitive to the business cycles. Blank (1989), using Panel Study of Income Dynamics (PSID) on 1969-1981, found strong cyclical effects, with economic upturns reducing income inequality both between and within different demographic groups.

In addition to purely empirical literature, there was another kind of analysis, namely simulations with micro-data sets. This approach enables researchers to address the issue of the distributional effects of the business cycles. It was popular in 70th see Budd and Seiders(1971), Mirer (1973a, 1973b) and Minarik (1979). Thus for example Minarik (1979) observed that middle-class households were broadly unaffected by cyclical downturns, nevertheless the effect on richest group depends on how income is defined. In summary simulation studies tend to show that downturns are disequalizing, while upturns are equalizing. However, the simulation approach is partial equilibrium analysis and it was displaced by studies that focus on unemployment and inflation rates to proxy business cycle conditions.

As we can see from this section, the analysis of Gini coefficient determinants was empirical and did not have any theoretical framework. The papers considered suggest many variables that were not included in our research. However in this paper we try to capture the business cycle behavior of the Gini coefficient in the easiest possible setup of a neoclassical growth model, which explain well the variation in the Gini coefficient.

2.2 Modeling of the equilibrium Income distribution

To make our review of the literature complete we have to consider the main methods of modeling the evolution of the income distribution in the models with heterogenous agents. Most of them are constructed to find the steady state realization of the income distribution and do not allow for business-cycle dynamics. However, these studies help to recognize important factors, which are not included in our model and can be proposed as future extensions of our analysis.

In order to model joint dynamics of the wealth distribution and output most studies assume wealth heterogeneity among the agents. However making assumption about wealth heterogeneity by itself is not enough for modeling the influence of the inequality on growth. For example in framework of Solow-type capital accumulation model in the absence of credit-rationing capital will be distributed among agents in such a way that marginal returns will be equal. Thus in the absence of borrowing constraints allocation of the capital and equilibrium interest rate are independent from the initial wealth distribution, everybody will make the optimum investment, such that marginal return is equal to persistent interest rate. Rich agents will lend capital to poor agents in order to equalize marginal returns through the whole economy.

The papers introduce different mechanisms through which wealth heterogeneity influences the economic growth. One of such mechanisms is credit-rationing. There are many microeconomic foundations for the credit rationing, but majority based on low ability to monitor labor input (moral hazard), physical output, or individual ability (adverse selection). The major implication is that an agent can borrow up to the level, repayment of which is guaranteed by existing wealth (collateral). Thus some agents despite of their desire can not invest at the optimal level or are rationed at all from the investment activity in the presence of fixed size of investment.

In addition to the standard assumptions Aghion and Bolton (1997) take into account the mechanism of setting the equilibrium rate of return. In their economy each agent lives for one period and faces two choices. The first is to work on a "routine" activity, which requires no capital investment and has a fixed small payoff. A second option is to invest a fixed amount and become self-employed. The revenue of second activity is much higher, however there is a probability of becoming bankrupt $(1 - e)$, where e is agent's effort level. The resulting income is divided between consumption and bequests for one agent's offspring. Agents are assumed to have Leontieff preferences over consumption and bequests where there level of utility negatively depends on effort cost.

In the case of bankruptcy agent pays nothing to the bank, thus the banks choose an interest rate for each agent individually in order to maximize their expected payoff. In this framework banks charge higher interest rate from poorer agents, so repayment is positively related to amount that agent wants to borrow. Consequently agents who have to borrow to be able to invest choose effort level less than optimal because they have to make repayment to the bank. They found that under sufficiently high level of wealth accumulation there exists a unique invariant wealth distribution. Thus after some point in time the system will show constant level of inequality.

While Aghion and Bolton (1997) are mainly concerned about finding the conditions under which there is non-monotonic evolution towards a unique steady state, Piketty (1997) makes general analysis of the dual dynamics of the wealth distribution and interest rate in the framework of the Solow-type model with credit rationing. To emphasize the role of credit rationing Piketty also considers the Solow-type model with first-best credit. He assumes that while agents have opportunity to shirk, lenders can make sure at no cost that borrowers don't shirk with first-best credit. He shows that under this conditions the evolution of wealth is globally ergodic, and the distribution converges to unique invariant distribution with associated unique interest rate. Thus there is no trap and individuals can move between different long run wealth levels with positive probability in finite time. Introduction of the credit rationing changes the picture dramatically. Multiple stationary interest rates and wealth distributions can exist. The author proves that in the case of credit rationing under sufficiently small interest rate the stable state obtained with no rationing could prevail. However positive shocks to interest rate for a long time could be self-sustaining if they force out sufficiently many agents in the credit rationing region so that capital accumulation is depressed. However wealth accumulation process is ergodic at every steady state, but wealth mobility is lower with higher steady state interest rate.

Banerjee and Newman (1993) assume another source of equilibrium multiplicity through the modeling of the occupational choice of the agents. They studied dual dynamics of the wage rate and wealth distribution assuming that interest rate is given exogenously. In their model low wage depresses accumulation by the poor agents and in this way preserves high initial supply of the labor force. Model assumes four kinds of activity: idle (only put money to deposit), contract worker, self employed and entrepreneur who organize production and monitor hired contract workers, but which can not monitor more than certain number of people.

On the basis of payoffs they figure out the minimal salary at which agents will work, and maximum salary at which it is profitable to hire labor. Thus in economy one of the wage rates prevails: low wage if labor force is higher than entrepreneur demand or high wage in a case when demand is greater than supply. They obtain non-linear Markov process, which in general could hardly be traced. The brilliant idea of this paper, which makes the dynamics traceable, is dimensional reduction that simplifies analysis significantly. It becomes possible under the assumption that wage levels and levels of the wealth on which agents are credit rationed do not depend on any exogenous variable. It allows them to build system, each state of which can be identified by two parameters. Then they find transition matrix and transform it to two systems of linear differential equations. The main implication of this paper is the existence of multiple equilibria. Thus the exogenous initial wealth distribution can have qualitatively important implications for the long-run growth.

2.3 Income inequality in the framework of Neoclassical growth theory

Finally we come up to the third section of our literature review. In this section we will make a revision of the literature that uses different variants of the neoclassical growth model with heterogeneous agents as a framework for investigating the evolution of the income distribution during the business-cycles.

Caselli and Ventura (2000) paper introduces various sources of consumer heterogeneity in one-sector representative consumer growth models and develops tools to study the evolution of the distribution of consumption, assets, and incomes. This paper shows that growth models with representative consumer assumption can generate rich dynamics of the cross-sections of consumption, wealth and income. They consider a class of growth models with three sources of consumer heterogeneity: initial wealth, non-acquired skills and taste for consumption-smoothing. Despite this heterogeneity, the models in this class admit a representative consumer and, consequently, exhibit aggregate dynamics that are indistinguishable from those of the standard homogeneous-consumer models. They examine the behavior of consumers' relative consumption, wealth and income, and derive cross-sectional equations that show how these quantities (at any date) are related to both average variables and the consumer's individual characteristics.

Krusell and Smith (1998) explore the question of how movements in the distribution of the income and wealth affect the macro economy. The authors analyze this issue using a calibrated version of the stochastic growth model with partially uninsurable idiosyncratic risk and movements in the aggregate productivity. Under the assumption of existing capital market imperfections they show that the behavior of the macroeconomic aggregates can be almost perfectly described using only the mean of the wealth distribution. However they agree that under the assumption of the perfect markets, which was made in our model, there is no such relationship.

The paper done by Cataneda et al. (1997) is concerned with the income distribution business cycle dynamics. To address this issue they construct four heterogeneous household extensions of the stochastic neoclassical growth model. The models analyzed in this paper share the following features: first, they include two factors of production, labor and capital, and consequently, the agents have two income sources, labor income and capital income. Second, agents are subject to an exogenous stochastic process in their employment opportunities, and they work whenever they have the opportunity to do so. It is assumed that these processes are uninsured. Third, in all the models of economies analyzed in this paper, prices are fully endogenous. This fact and the competitive factor markets assumption imply that both the labor income and the capital income processes are endogenous to the model.

There are three main findings coming from this paper. Specifically, they found that separation of the population into five groups by types of the employment processes seemed to be enough to account for most aspects of the U.S. income distribution business cycle dynamics. The role played by cyclically moving factor shares is small. And the income distribution business cycle dynamics may be essentially independent from the significant part of the observed wealth concentration.

Thus as we have seen despite of the fact that large number of researches on the income inequality already have been done, there is still no paper that provides theoretical framework, which allows to find the analytical expression for the business cycle dynamics of the Gini coefficient.

Chapter 3

MODEL DESCRIPTION

The following model was developed by Lilia Maliar, Serguei Maliar and Juan Mora, see Maliar, Maliar and Mora(2003).

We consider a heterogeneous agents variant of the standard neoclassical stochastic growth model by Kydland and Prescott (1982). Time is discrete and the horizon is infinite, $t \in T$, where $T = \{0, 1, ...\}$ Economy consists of a representative production firm and a set of infinitely lived agents S.

3.1 The Firm

The representative firm owns the production technology, which is given by a constant returns to scale Cobb-Douglas function, $y_t = \theta_t k_t^{\alpha} h_t^{1-\alpha}$, where y_t is output; k_t and h_t are the aggregate inputs of capital and labor, respectively; $\alpha \in (0, 1)$; and θ_t is exogenous technology shock. The shock follows first order Markov process:

$$\log \theta_t = \rho \log \theta_{t-1} + \varepsilon_t \tag{3.1}$$

With a transitional probability given by:

$$Pr\{\theta_{t+1} = \theta | \theta_t = \theta\}_{\theta,\theta \in \Theta}, \tag{3.2}$$

where Θ denotes the set of all possible realizations of technology shocks. The profit-maximizing conditions of the firm imply that the real return on capital and labor inputs respectively, i.e. $r_t = \alpha\theta_t k_t^{\alpha-1} h_t^{1-\alpha}$ and $w_t = (1-\alpha)\theta_t k_t^{\alpha} h_t^{-\alpha}$.

3.2 The Agents

The agents are heterogenous in initial endowments and non-acquired skills. The skills of agent s reflects the number of efficiency hours e^s that correspond to one physical hour worked by agent. Note that the individual skills are assumed to be constant over time and across states of nature. For the convenience, we normalize the average level of skills to one, $\int_S e^s\, ds = 1$. The preferences of an agent s are given by the expected discounted of the period utility functions. The period utility function is defined over consumption, c_t^s, and leisure l_t^s, and is of the Constant Relative Risk Aversion (CRRA) type. The agent is endowed with one unit of time, so that $n_t^s = 1 - l_t^s$ represents his working hours. The problem solved by agent s is as follows:

$$\max_{\{c_t^s, n_t^s, k_{t+1}^s, m_{t+1}^s(\theta)\}} E_0 \sum_{t=0}^{\infty} \delta^t \frac{[(c_t^s)^{\mu}(1-n_t^s)^{1-\mu}]^{1-\eta} - 1}{1-\eta} \tag{3.3}$$

$$\text{s.t. } c_t^s + k_{t+1}^s + \int_{\Theta} p_t(\theta) m_{t+1}^s(\theta)\, d\theta = (1 - d + r_t)k_t^s + n_t^s e^s w_t + m_t^s(\theta_t), \tag{3.4}$$

where the initial endowment $[(1-d+r_0)k_0^s + m_0^s(\theta_0)] > 0$ is given. Here, E_t denotes the conditional expectation; k_{t+1}^s is the capital stock; $m_{t+1}^s(\theta)_{\theta\in\Theta}$ is the portfolio of state-contingent claims; $p_t(\theta)$ is the price of a claim that entitles the agent to the payment of one unit of consumption goods in period $t+1$ if state θ occurs; d is depreciation rate of capital; $\delta \in (0,1)$ is the discount factor; and finally, $\mu \in (0,1)$ and $\eta > 0$ are parameters of the utility function.

We define an individual's wealth, Z_t^s, as the value of his end of period asset portfolio, expressed in terms of current consumption goods:

$$Z_t^s \equiv k_{t+1}^s + \int_\Theta p_t(\theta) m_{t+1}^s(\theta)\, d\theta \tag{3.5}$$

A competitive equilibrium is defined as a sequence of contingency plans for the consumers allocation, for the firms allocation and for the prices. Such that given the prices, the sequence of plans for the consumer's allocation solves each agent's utility maximization problem (3.3),(3.5); the sequence of plans for the firm's allocation makes the rental price of each input equal to its marginal product; all markets clear:

$$k_t = \int_S k_t^s\, ds,\ h_t = \int_S n_t^s e^s\, ds,\ \int_S m_{t+1}^s(\theta)\, ds = 0; \tag{3.6}$$

and the economy resource constraints satisfied:

$$c_t + k_t = (1-d)k_t + \theta_t k_t^\alpha h_t^{1-\alpha} \tag{3.7}$$

3.3 Representative agent specification

If agents possess identical homothetic preferences and markets are complete, then there exist a representative consumer in the sense of Gorman (1953). Maliar and Maliar (2001) show that a representative consumer utility maximization problem, which corresponds to the above heterogeneous agents economy is

$$\max_{\{c_t,h_t,k_{t+1}\}_{t\in T}} E_0 \sum_{t=0}^{\infty} \delta^t \frac{[c_t^\mu (1-h_t)^{1-\mu}]^{1-\eta} - 1}{1-\eta} \tag{3.8}$$

$$\text{s.t. } c_t + k_{t+1} = (1-d)k_t + \theta_t k_t^\alpha h_t^(1-\alpha) \tag{3.9}$$

and consumption and working hours of agents, $\{c_t^s, n_t^s\}_{t\in T}^{s\in S}$, satisfy

$$c_t^s = c_t^s f^s,\ n_t^s = 1 - (1-h_t)\frac{f^s}{e^s}, \tag{3.10}$$

where $\{f^s\}^{s\in S}$ is a set of positive numbers with $\int_S f^s \, ds = 1$

and wealth of agents, $\{Z_t^s\}_{t\in T}^{s\in S}$, satisfies the recursive budget constraints,

$$Z_t^s = E_t \sum_{\tau=t+1}^{\infty} \delta^t \frac{u_1(c_\tau, h_\tau)}{u_1(c_t, h_t)} (c_\tau^s - n_\tau^s e^s w_\tau), \tag{3.11}$$

where $u_1(c_\tau, h_\tau) = c_\tau^{\mu(1-n)-1}(1-h_\tau)^{(1-\mu)(1-n)}$

Proof. See Maliar and Maliar (2001), Appendices A and B.

Consequently, to find equilibrium in the heterogeneous agents economy (3.3)-(3.7), we shall first solve for the aggregate quantities from the representative consumer model (3.8) and then restore the individual quantities by using (3.9), (3.10). In the next section, we employ the representation (3.8) - (3.10) to derive some useful analytical results regarding the evolution of the income and wealth distributions in the model.

3.4 Business cycle dynamics of the Wealth and Income distributions

Our model can not explain long-run inequality trends observed in the data (it should not produce such trends by construction). However, the model is capable of generating non-trivial dynamics of the income and wealth distributions over the business cycles. We therefore focus on the business cycle movements of these distributions. We start by analyzing the model's implications for the wealth distribution dynamics. Consider the share of agent's s wealth within the total wealth,

$$z_t^s \equiv \frac{Z_t^s}{\int_S Z_t^s \, ds} = \frac{k_{t+1}^s + \int_\Theta p_t(\theta) m_{t+1^s(\theta)} \, d\theta}{k_{t+1}}. \tag{3.12}$$

The fact that follows from the market clearing condition for claims in (3.6). It turns out that there is a simple formula that characterizes the evolution of the wealth distribution in our economy. We specifically have the following for all t, $v \geq 0$, we have:

$$z_t^s = \xi_{t,v} z_v^s + (1 - \xi_{t,v}) e^s, \tag{3.13}$$

where $\xi_{t,v}$ is defined by

$$\xi_{t,v} \equiv \frac{k_{v+1} E_t \left[\sum\limits_{\tau=t+1}^{\infty} \delta^{\tau-t} \frac{u_1(c_\tau, h_\tau)}{u_1(c_t, h_t)} c_\tau \right]}{k_{t+1} E_v \left[\sum\limits_{\tau=v+1}^{\infty} \delta^{\tau-v} \frac{u_1(c_\tau, h_\tau)}{u_1(c_v, h_v)} c_\tau \right]} \tag{3.14}$$

Proof. See Appendix A in Maliar, Maliar and Mora (2003)

According to (3.13), the wealth distribution in a period t can be represented as a linear combination of the wealth distribution in any other period v and the skill distribution. The movements of the variable $\xi_{t,v}$ capture the entire effect of the aggregate dynamics on the wealth distribution. A straightforward implication of our analysis is that any wealth distribution can be supported in the steady state. Indeed, if the representative consumer economy (3.8) starts in the steady state, then we have that $\xi_{t,v} \equiv 1$ for all t, v and, therefore, the initial wealth distribution will be perpetuated, i.e., $z_t^s = z_0^s$ for all t and s. Another case in which the model has trivial implications with regard to the evolution of the wealth distribution is when the initial wealth distribution coincides with the skill distribution. In such a case, the wealth distribution will always be the same, independently of the movements of the variable $\xi_{t,v}$.

Let us analyze the dynamics of the wealth distribution in a general case. Fix $v = 0$ and denote $\xi_t = \xi_{t,0}$. Condition (3.13) implies

$$corr(z_t^s, y_t) = sign|z_0^s - e^s| corr(\xi_t, y_t) \tag{3.15}$$

,

When the utility function is logarithmic, expression (3.14) takes a simple form:

$$\xi_t = \frac{c_t/c_0}{k_{t+1}/k_1} \tag{3.16}$$

When economy in boom, both the consumption, c_t, and the capital, k_{t+1}, of the representative agent increase. However, given that the agent is risk-averse, the relative rise in consumption is lower than the increase in capital, so that ξ_t goes down. The fact that the variable ξ_t moves counter-cyclically implies that in our model, the agents s wealth share, z_t^s, increases (decreases) during expansions, if her initial wealth endowment is lower than her skills, $z_0^s < e^s$ (higher than her skills, $z_0^s > e^s$). Unfortunately, we cannot test this prediction of the model because, as we have said, there is no sufficient empirical evidence on the dynamics of the wealth distribution over the business cycle.

Now we will focus on the dynamics of the income distribution. We define the individuals income, Y_t^s , as the sum of the returns on her asset portfolio and her labor earnings expressed in terms of current consumption good,

$$Y_t^s \equiv r_t k_t^s + m_t^s(\theta_t) + n_t^s e^s w_t \tag{3.17}$$

It follows from definition (3.17) that the individual income depends on the composition of the agents asset portfolio, i.e., on how much capital and how many units of claims of each type $\theta \in \Theta$. were purchased by the agent in the previous period. In our economy the equilibrium composition of individual asset portfolio is not uniquely determined. As a result, there is indeterminacy in the individual income. This indeterminacy is due to the assumption of complete markets. In our economy, the agents are not concerned about how much income they receive in each period, but rather about how much income they receive over their life-time. Consequently, the agents are indifferent between any sequences of asset portfolios as long as they lead to the same expected life-time payoff. To overcome the problem of indeterminacy, we need to impose some additional restrictions on the composition of the agents portfolios. The restriction we use is that the state contingent claims are not traded so that only the capital stock is in operation. Since holding the portfolio, which is composed of the capital stock only, is optimal, such a restriction is consistent with our definition of equilibrium. Let y_t^s be the share of agents s income within the total income,

$$y_t^s \equiv \frac{Y_t^s}{\int_S Y_t^s \, ds} \tag{3.18}$$

Concerning the income distribution, we get the following result.

For all $t \geq 1$ and $v \geq 0$, we have

$$y_t^s = \vartheta_{t,v} z_v^s + (1 - \vartheta_{t,v}) e^s, \tag{3.19}$$

where $\vartheta_{t,v}$ is:

$$\vartheta_{t,v} = \alpha \xi_{t-1,v} + \frac{(1 - 1/h_t)(1-\alpha)\mu k_{v+1}}{E_v \left[\sum_{\tau=v+1}^{\infty} \delta^{\tau-v} \frac{u_1(c_\tau, h_\tau)}{u_1(c_v, h_v)} c_\tau \right]} \tag{3.20}$$

For proof see appendix A of Maliar, Maliar and Mora (2003)

Thus, similar to wealth distribution, the income distribution in our economy is given by a linear combination of the wealth distribution in some period v and the skill distribution. Again, only one aggregate variable, $\vartheta_{t,v}$, is needed to fully characterize the evolution of the income distribution.

Let us fix $v = 0$ and denote $\vartheta_t \equiv \vartheta_{t,v}$. Condition (3.19) yields the formula for the income distribution dynamics, which parallels the one previously obtained for the wealth distribution dynamics,

$$corr(y_t^s, y_t) = sign|z_0^s - e^s| corr(\vartheta_t, y_t) \tag{3.21}$$

The authors find that the variable ϑ_t moves counter-cyclically. However, $corr(\vartheta_t, y_t)$ is weaker than $corr(\xi_t, y_t)$.

A counter-cyclical behavior of ξ_t and ϑ_t implies that wealth and income inequality in our economy is counter-cyclical. Indeed, the weights of the initial wealth distribution, given by ξ_t and ϑ_t in (3.13) and (3.19), respectively, decrease during expansions and increase during recessions. The opposite is true for the weights of the skill distribution, $(1 - \xi_t)$ and $(1 - \vartheta_t)$. The (initial) wealth distribution in the data, however, is more unequal than the skill distribution. As a result, expansions (recessions) have an equalizing (disequalizing) effect on the income and wealth distributions.

The models prediction that income inequality is counter-cyclical agrees with the previous findings of Dimelis and Livada (1999), that the Gini and Theil coefficients of the U.S. income distribution are weakly counter-cyclical. The empirical evidence documented by Castaneda et al. (1998), indicates, however, that expansions have an ambiguous effect on income inequality. Specifically, inequality between the bottom and middle deciles goes down, while inequality between the middle and top deciles goes up. If the top-income group is excluded from the sample, the behavior of income inequality would be counter-cyclical, as predicted by our model.

3.5 Business cycle dynamics of the Gini coefficient

The paper by Maliar, Maliar and Mora (2003) studies the business cycle behavior of the income and wealth distributions and tests the conclusions using the coefficient of variation. In contrast our paper focuses on the behavior of the Gini coefficient as a measure of the inequality in society. The analytical expression for the business cycle behavior of the income distribution allows us to derive a closed-form expression for the Gini coefficient. To proceed we have to reexpress the income distribution in terms of its previous value. Recall that current income share of the agent could be expressed as follows:

$$y_t^s = \vartheta_{t,0} z_0^s - (1 - \vartheta_{t,0}) e^s \tag{3.22}$$

Using this expression we can derive a formula, which expresses the initial wealth distribution in terms of previous income distribution at time i and substitute it back to the (3.22). Thus we can reexpress the income distribution as a linear combination of its previous value and the distribution of non-acquired skills e^S:

$$y_t^s = \frac{\vartheta_{t,0}}{\vartheta_{i,0}} y_i^s - (1 - \frac{\vartheta_{t,0}}{\vartheta_{i,0}}) e^s \tag{3.23}$$

The standard definition of the Gini coefficient is as follows:

$$g_t = \frac{1}{2} - \frac{1}{\int_0^1 y_t^s \, ds} \int_0^1 \int_0^x y_t^s \, ds \, dx \tag{3.24}$$

In our case y_t^s represents share of the agent s in time equal t. That is why it is already normalized and we can rewrite the expression for the Gini coefficient as:

$$g_t = \frac{1}{2} - \int_0^1 \int_0^x y_t^s \, ds \, dx \tag{3.25}$$

The substitution of the expression for y_t^s in to (3.25) allows us to express Gini coefficient in current period using the past distribution of income. In our case we take the lagged value of the income distribution:

$$g_t = \frac{1}{2} - \int_0^1 \int_0^x \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} y_{t-1}^s + (1 - \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}}) e^s \, ds \, dx, \tag{3.26}$$

One can note that first term of left hand side of (3.26) can be reexpressed in terms of lagged value of the Gini coefficient:

$$g_t = \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} g_{t-1} + (1 - \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}})(\frac{1}{2} - \int_0^1 \int_0^x e^s \, ds \, dx), \tag{3.27}$$

Note that $\frac{1}{2} - \int_0^1 \int_0^x e^s \, ds \, dx$ is Gini coefficient of non-acquired skills, specifically we get:

$$g_t = \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} g_{t-1} + (1 - \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}}) g^e, \tag{3.28}$$

Consider the weights in our expression. In the case of general form of utility function the expression for $\vartheta_{t,0}$ depends on whole sequence of future consumption and working hours of the agent. In order to get simple analytical expression we assume commonly used logarithmic utility function:

$$U = log(c_t) + \beta log(1 - h_t) \tag{3.29}$$

Recall that expression for $\vartheta_{t,v}$ is given by the (3.20). If we substitute (3.29) and take derivative of utility function with respect to consumption and substitute (3.16) the expression (3.20), when $v = 0$ simplifies to:

$$\vartheta_{t,0} = \alpha \frac{c_{t-1} k_1}{c_0 k_t} + \frac{(1 - \frac{1}{h_t})(1 - \alpha)\mu k_1}{E_0 \left[\sum_{\tau=1}^{\infty} \delta^\tau c_0 \right]} \tag{3.30}$$

In the maximization problem agents make decision on the consumption c_v at the period v. Thus $E_v(c_v) = c_v$ and we can omit the expectation sign. After calculating the sum of the infinite arithmetical progression in the denominator we get:

$$\vartheta_{t,0} = \alpha \frac{k_1}{c_0} \left[\frac{c_{t-1}}{k_t} + \frac{(1 - \frac{1}{h_t})(1 - \alpha)(1 - \delta)\mu}{\delta} \right] \tag{3.31}$$

Thus we derive analytical expression for Gini coefficient in any period and showed that it is a linear combination of the any previous value of Gini and Gini coefficient of non-acquired skills.

$$g_t = \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} g_{t-1} + (1 - \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}}) g^e, \tag{3.32}$$

where

$$\frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} = \frac{\frac{c_{t-1}}{k_t} + \gamma(1 - \frac{1}{h_t})}{\frac{c_{t-2}}{k_{t-1}} + \gamma(1 - \frac{1}{h_{t-1}})} \tag{3.33}$$

and

$$\gamma = \frac{(1-\alpha)(1-\delta)\mu}{\alpha\delta} \tag{3.34}$$

Now we can analyze the dynamics of the Gini coefficient of income distribution in a manner similar to the previous analysis for income and wealth distributions. In the case of expansion, both the consumption, c_t, and the capital, k_{t+1}, of the representative agent increase. However, as we mention before, given that the agent is risk-averse, the relative rise in consumption is lower than the increase in capital. This implies that in our model, the weight of previous value of Gini coefficient, increases (decreases) during expansions, if her initial wealth endowment is lower than her skills, $z_0^s < e^s$ (higher than her skills, $z_0^s > e^s$). Thus we can conclude that Gini coefficient of the income distribution moves counter-cyclical. During the expansion society becomes more equal as weight of Gini coefficient of skills rises, and in recession we observe inverse picture, inequality starts to rise as weight of previous Gini becomes greater than one.

Chapter 4

DATA DESCRIPTION

For the estimation I use unbalanced panel that covers 14 OECD [1] countries for the 1962-1991. The choice of OECD countries was made due to two reasons. The series on Gini coefficient are typically short even for developed countries. The second and the main reason is that one of the underling assumption in our theoretical model is complete capital markets, which is only the case for developed countries.

The data for the empirical analysis are taken from

- Penn World Tables, version 6.1,
- dataset on inequality assembled by Deinenger and Squire (1996),

The set of variables I use in my empirical estimation includes:

1. Gini coefficient coming from the newly assembled data set by Deininger and Squire (1996), which improves greatly the quality of the available data on the income inequality. However we have to mention that panel constructed using this data set is highly unbalanced. Problem becomes especially severe if we note, that we should have the Gini coefficient in two sequential periods in order to be used in our regression.

[1] The set includes following countries: Australia, Canada, Finland, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, and United States.

2. Series on the consumption is coming from Penn World Table, version 6.1. Aggregate consumption is expressed in the prices of local currency of 1996 year. It contains information on consumption series for 1950-2000 on all OECD countries.

3. Physical capital stock variable is constructed using the perpetual inventory method [2]. The initial level of capital stock K_0 is estimated as follows:

$$K_0 = \frac{I_0}{g + \delta} \tag{4.1}$$

where g is the average geometric growth rate of investment variable for the available period, I_0 is the value of first observed investment level, and δ is depreciation rate, in my calculations I assume $\delta = 0.06$ [3] for all countries. Stocks of capital are calculated using the following formula:

$$K_T = (1-\delta)^T K_0 + \sum_{t=0}^{T-1} I_t (1-\delta)^{T-t} \tag{4.2}$$

The investment series is taken from the World Penn Tables, version 6.1 and it is expressed in the prices of local currency of 1996 year.

[2] I used Penn World Tables methodology Summers and Heston (1991) and methodology by Nehru and Dhareshwar (1993)

[3] This value consistent with other studies: e.g. Hall and Jones (1999)

Chapter 5

EMPIRICAL ANALYSIS

In this section, we conduct an empirical test of our findings. We consider two models, which differ in underlying assumptions. The estimation of two models will allow us to evaluate the importance of the Gini coefficient of skills in expression for Gini coefficient of the income distribution. For the empirical study, we use panel data on the 14 OECD countries for 1962-1991.

In the expression for Gini coefficient the variable that represents average hours worked enters with coefficient γ. To estimate the model in this case we have to run non-linear panel-data regression, which is very complicated issue and is beyond the scope of this paper. Thus for the rest of analysis we assume that agents inelastically supply labor to the market. This assumption reduces our coefficient to the form:

$$\frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} = \frac{c_{t-1}}{k_t}\frac{k_{t-1}}{c_{t-2}} \tag{5.1}$$

In our study, we use a panel data techniques. This choice was made due to several reasons. First of all it allows us to answer the question how fluctuation in the major macroeconomic variables affect inequality within one country over time, while the cross-country regression results show only the long-run relationship. Secondly in our case each unit represents a country with its own structure of economy with different governance systems and so on. Thus we have to expect the presence of time invariant, unobservable country characteristics and ignoring them may lead us to omitted variable bias. As further analysis shows dummy variables for each country are significant and implementing pooled OLS will lead to biased coefficients.

However this technique does not reduce the bias resulting from the omission of the variables that evolve over time. Our theory says that behavior of Gini coefficient of income distribution can be fully described in terms of its previous value and Gini coefficient of non-acquired skills. Therefore our framework suggests that we should not have a bias stemmed from omitted variables. In addition we have to be sure that there is no endogeneity problem. Again our theory, as we show before, tells us that income inequality does not affect macroeconomic aggregates and endogeneity problem should not be present.

We have to mention that data we use is highly unbalanced. Thus for 14 countries and 29 years we have only 152 observations. Actually this problem is common for empirical macro panel-data sets. To cope with this issue we can use two approaches. A simple solution is to drop any individual from panel, which has incomplete information and work with balanced sub-panel only. This method is highly inefficient for example in our case we will be left with only two countries. Another way is to allow for the fact that we have unbalanced data set and proceed in usual way. That is why we use all available data.

Our model predicts that the variable, which includes previous value of Gini coefficient has to enter with coefficient which is equal to one. That is why we should run restricted panel-data regression, which is impossible to do in Stata. There are actually two ways to solve this problem. The first is to subtract constrained variable from the dependent variable and run the regression on the remaining part. However one should note that despite the fact that we will obtain correct coefficients the R^2s will reflect extent to which we can explain variation in constructed variable. This is however is not the explanatory power of the model.

Another way is to impose the constraint on our variable and run least squares regression with inclusion of dummy variables (LSDV) for each country. Such regression is equivalent to the Fixed Effects regression, however in this case we are able to restore R^2s and consequently evaluate measure of fit. That is why in this paper we use second approach. Unfortunately Stata does not report R^2s for constrained regressions, that is why to restore them we use standard formulas:

$$R^2_{overall}(\hat{\beta}) = corr^2\{\hat{y_{it}}, y_{it}\} \tag{5.2}$$

$$R^2_{between}(\hat{\beta}_B) = corr^2\{\bar{x_i}^T \hat{\beta}_B, \bar{y_i}\} \tag{5.3}$$

$$R^2_{within}(\hat{\beta}_{FE}) = corr^2\{(x_{it} - \bar{x_i})^T \hat{\beta}_{FE}, y_{it} - \bar{y_i}\} \tag{5.4}$$

For completeness of the analysis we will examine two models: one with agents homogeneous in non-acquired skills, and model which allows heterogeneity in non-acquired skills among the agents. We consider the first model as a benchmark model. This will allow us to evaluate the importance of skill distribution as one of the determinants of the Gini coefficient.

We will start our analysis from the most simple case, where we assume that all agents have the same level of non-acquired skills $e^s = 1$ for $\forall s$. Hence the Gini coefficient on non-acquired skills will be equal to zero and we will obtain expression in the following form:

$$g_t = \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} g_{t-1} + \varepsilon_t \tag{5.5}$$

where

$$\frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} = \frac{c_{t-1}}{k_t}\frac{k_{t-1}}{c_{t-2}} \tag{5.6}$$

We estimate this equation using two techniques: pooled OLS and LSDV with restriction on the variable that includes previous value of Gini coefficient in both regressions. The results are present in the Table 1, column 1.1 for pooled OLS, and 1.2 for LSDV. First of all we have to mention that results from pooled OLS and LSDV differ not significantly. This finding coincide with result of the F-test given in the Table 2, column 1. Namely we can not reject null hypothesis $H_0 : u_i = 0, \forall i$ at any reasonable significant level. Thus we can use pooled OLS, however after estimating LSDV by using expressions (5.2), (5.3), (5.4) we can restore R^2 statistics. They are the only indicators, which can measure the appropriateness of the model, since in the regression we estimate only coefficients for dummy variables.

As we can see from the table $R^2_{between}$ is equal to one. And it is not surprising, because to control for unobservable country effects, we include dummy variables for each country. The main indicator which can evaluate the fit of the model is R^2_{within}. It says that with current specification we can explain 42 per cent of the variation in Gini coefficient within country.

Table 1: Estimation results. Dependent variable is Gini.
No leisure-labor choice

Model	(1.1)	(1.2)	(2.1)	(2.2)
method	OLS	LSDV	OLS	LSDV
$\frac{\vartheta_{t,0}}{\vartheta_{t-1,0}}g_{t-1}$	1.00	1.00	1.00	1.00
	(...)	(...)	(...)	(...)
$1-\frac{\vartheta_{t,0}}{\vartheta_{t-1,0}}$			.31427	.3279447
			(0.000)	(0.000)
const	-.0128112	-.010621	.0007983	.0256933
(0.00)	(0.00)	(0.036)	(0.609)	(0.001)
R^2: overall	0.8418	0.8501	0.9090	0.9212
between		1.00		1.00
within		0.4208		0.5954
Countries	14	14	14	14
Obs.	152	152	152	152

Note: In parentheses p-value of coefficients.

Now we will consider model with non-trivial distribution of the non-acquired skills. When agents differ in non-acquired skills the Gini coefficient of skills is not equal to one and expression for Gini coefficient of the income distribution now includes an additional term which represents inequality in skills:

$$g_t = \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}}g_{t-1} + (1 - \frac{\vartheta_{t,0}}{\vartheta_{t-1,0}})g^e + \varepsilon_t, \tag{5.7}$$

where

$$\frac{\vartheta_{t,0}}{\vartheta_{t-1,0}} = \frac{c_{t-1}}{k_t}\frac{k_{t-1}}{c_{t-2}} \tag{5.8}$$

The results of pooled OLS and LSDV estimations are shown in the Table 1, column (2.1,2.2) respectively.

The F-test is given in the Table 2, column 2. As we see we can reject null hypothesis $H_0 : u_i = 0, \forall i$ at 1 per cent level. Thus F-test says that pooled OLS estimators are biased. The inspection of the P-value for coefficient of skills inequality confirms importance of the skill distribution as one of the determinants of Gini coefficient. The improvement in $R^2_{overall}$ is not significant, however we can state that inclusion of the coefficient for skills distribution improves R^2_{within} a lot. With current specification we can explain about 60 per cent of the variation in Gini coefficient within a country.

Empirical analysis confirms our results. We find that our empirical model can explain about 60 per cent of the variation in the Gini coefficient within the countries. Gini coefficient of skills proves to be significant. Thus we can conclude that this predictions of the model find empirical support from the data.

Table 2: Tests of specification
F-test: $H_0 : u_i = 0, \forall i$

Model	(1.2)	(2.2)
Statistics	F(13, 96) = 1.32	F(13, 137) = 2.42
P-value	0.2125	0.0057

Note: That in first model H_0 can be rejected at 3% level.

Chapter 6

CONCLUSIONS

There are many papers that study the business cycle behavior of the income distribution, however, no theoretical framework for this type of analysis has so far been developed. The existing papers are empirical and explanatory variables are selected on the bases of common sense. In this paper we describe a theoretical framework that allows us to address the business cycle behavior of the income distribution. The model is a heterogeneous agents version of the standard neoclassical growth model. Heterogeneity is in two dimensions, initial endowment and non-acquired skills.

Maliar and Maliar (2001) showed that under the conditions of complete markets and identical preferences of the CRRA type, the evolution of the income and wealth distributions in the model is fully characterized by the dynamics of the associated representative consumer setup. This paper continues analysis done by Maliar, Maliar and Mora (2003), however we focus on the Gini coefficient as a measure of income inequality. This choice was made due to extensive employment of Gini coefficient in the empirical literature.

We have shown that in a heterogeneous-agent variant of the standard neoclassical growth model a simple closed-form expression for Gini coefficient of the income distribution exists. Furthermore, at any point in time, the Gini coefficient of income distribution can be fully represented by a linear combination of its previous value, Gini coefficient of non-acquired skills and such macroeconomic aggregates as consumption, capital stock and efficient hours worked. The novelty of this paper is that it for a first time presents the analytical expression for the Gini coefficient. The expression has intuitive form and under logarithmic preferences it can be shown that Gini coefficient of income distribution moves counter-cyclical. Thus during the expansion society becomes more equal as weight of Gini coefficient of skills rises, and in recession we observe inverse picture, inequality starts to rise as weight of previous Gini becomes greater than one.

The empirical analysis using panel data that covers 14 OECD countries for 1962-1991 confirms our theoretical model. We find that our model can explain about 60 per cent of the variation in the Gini coefficient within the countries. The empirical analysis also confirms importance of the presence a Gini coefficient of skills in our expression. Thus we can conclude that model adequately describes the business cycle behavior of the Gini coefficient of the income distribution.

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Appendix A

THE DESCRIPTIVE STATISTICS.

Table 3: The summary statistics of the Gini coefficient by countries.

Country	Obs.	Mean	Std. Dev.	Min	Max
Canada	23	0.31273	0.01673	0.2741	0.3297
United States	42	0.35305	0.01325	0.335	0.3816
Japan	23	0.34822	0.01348	0.325	0.376
Finland	12	0.29933	0.02175	0.2611	0.3204
Germany	7	0.3122	0.01709	0.2813	0.3357
Italy	15	0.34934	0.02613	0.3202	0.41
Netherlands	12	0.28594	0.00948	0.2666	0.2968
Norway	9	0.34208	0.02897	0.3057	0.3752
Portugal	4	0.37443	0.02161	0.3563	0.4058
Spain	8	0.3285	0.01853	0.3102	0.3711
Sweden	15	0.31633	0.01489	0.2731	0.3341
United Kingdom	31	0.25984	0.02606	0.229	0.324
Australia	9	0.37884	0.03082	0.3202	0.4172
New Zealand	12	0.34363	0.02904	0.3004	0.4021

Table 4: The summary statistics of the Consumption expressed in local currency by countries

Variable	Obs	Mean	Std.	Dev.	Min
Canada	51	2.83E+11	1.34E+11	9.43E+10	5.44E+11
United States	51	3.00E+12	1.47E+12	1.10E+12	6.26E+12
Japan	51	1.60E+14	1.08E+14	1.91E+13	3.38E+14
Finland	51	2.52E+11	1.12E+11	8.73E+10	4.53E+11
Germany	31	1.76E+12	5.22E+11	1.06E+12	2.65E+12
Italy	51	7.13E+14	4.07E+14	1.83E+14	1.42E+15
Netherlands	51	2.39E+11	1.26E+11	7.47E+10	4.98E+11
Norway	51	3.74E+11	1.67E+11	1.49E+11	7.04E+11
Portugal	51	6.50E+12	3.55E+12	1.79E+12	1.40E+13
Spain	51	3.27E+13	1.66E+13	7.97E+12	6.33E+13
Sweden	50	7.22E+11	2.73E+11	3.37E+11	1.32E+12
United Kingdom	51	3.67E+11	1.36E+11	1.85E+11	6.67E+11
Australia	51	1.92E+11	1.08E+11	6.09E+10	4.34E+11
New Zealand	51	4.46E+10	1.54E+10	1.78E+10	7.30E+10

Table 5: The summary statistics of the Capital stock expressed in local currency by countries

Country	Obs	Mean	Std. Dev.	Min	Max
Canada	51	2.25E+12	7.92E+11	1.60E+12	4.63E+12
United States	51	2.24E+13	1.01E+13	1.50E+13	5.97E+13
Japan	51	8.64E+14	4.40E+14	4.13E+14	1.80E+15
Finland	51	2.14E+12	6.87E+11	1.66E+12	4.24E+12
Germany	31	8.42E+12	2.52E+12	5.89E+12	1.96E+13
Italy	51	7.11E+15	2.48E+15	5.39E+15	1.61E+16
Netherlands	51	3.34E+12	1.49E+12	2.17E+12	7.59E+12
Norway	51	5.48E+12	2.51E+12	3.56E+12	1.26E+13
Portugal	51	3.66E+13	8.67E+12	2.77E+13	5.80E+13
Spain	51	1.97E+14	3.61E+13	1.58E+14	3.06E+14
Sweden	50	9.51E+12	4.85E+12	5.31E+12	2.39E+13
United Kingdom	51	2.53E+12	9.99E+11	1.72E+12	5.41E+12
Australia	51	7.22E+11	3.68E+11	2.31E+11	1.50E+12
New Zealand	51	5.86E+11	3.17E+11	3.14E+11	1.45E+12