Hacettepe University Graduate School of Social Sciences

Department of Economics

CHARACTERISTICS OF GLOBAL TOP WEALTH DISTRIBUTION

Umut KARATAŞ

Master's Thesis

Ankara, 2023

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ACCEPTANCE AND APPROVAL

The jury finds that Umut KARATAŞ has on the date of 12.06.2023 successfully passed the defense examination and approves his Master's Thesis titled "Characteristics of Global Top Wealth Distribution''.

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Umut KARATAŞ

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DEDICATION

Dedicated to, the one and only, my beautiful daughter,

Ekim…

ABSTRACT

KARATAŞ, Umut. *Characteristics of Global Top Wealth Distribution*, Master's Thesis, Ankara, 2023.

This thesis examines the characteristics of global top wealth distribution through a demographic model that focuses on age, employing the Forbes magazine 2014 dataset. This thesis aims to address two questions. The first investigates the impact of age on relative wealth distribution based on theoretical assumptions and explores the extent of this impact, if any. Furthermore, by utilizing microdata, this thesis examines the determinants of wealth accumulation by introducing heterogeneity into the homogeneous effect of age on relative wealth across individuals. The second question pursued by this research is to ascertain whether the top-level relative wealth distribution in the year 2014 exhibits a Pareto tail. In the affirmative case, the study seeks to identify the factors that influence the tail parameters of the Pareto distribution. The findings highlight that age alone explains over one-third of relative wealth distribution. Unlike gender, other individual-level variations, such as sectoral differences, entrepreneurship status, inheritance, and country-specific differences of billionaires influence the impact of age on relative wealth distribution.The financial sector, compared to others, has negative effects on wealth accumulation, whereas being an entrepreneur, inheritance as a form of wealth acquisition, and being a citizen of the United States compared to other countries positively affect wealth accumulation in the year 2014. Furthermore, cross-section distribution of top relative wealth distribution in 2014 has a Pareto tail, signifying an extremely skewed distribution of relative wealth. Also, consistent with initial findings, factors such as sectoral differences, entrepreneurial status, the influence of inheritance, and country-specific differences play a significant role in shaping the parameters of the Pareto tail. However, gender does not appear to exert any influence on the tail parameter of the Pareto distribution.

Keyword:
Age and Wealth, Determinants of Wealth, Pareto Distribution, Forbes Billionaires

ÖZET

KARATAŞ, Umut. *Küresel En Üst Servet Dağılımının Özellikleri*, Yüksek Lisans, Ankara, 2023.

Bu tez Forbes dergisinin 2014 yılı veri setini kullanarak, en üst düzey servet dağılımının özelliklerini yaşı merkezine alan demografik bir model üzerinden incelemektedir. Tezin amacı temelde iki soruya cevap aramaktır. Bunlardan ilki, yaş ve servet ilişkisinden doğan teorik bir varsayımdan yola çıkarak, yaşın göreli servet dağılımı üzerinde bir etkisinin olup olmadığı belirlemektir. Anlamlı bir etki bulunması durumunda ise, bu etkinin derecesini belirleyerek, yaşın göreli servet birikimi üzerindeki homojen etkisini mikro veriler yardımıyla heterojen hale getirmektir. İkinci olarak ise, 2014 yılı küresel en üst düzey servet dağılımının Pareto kuyruğuna sahip olup olmadığını araştırarak, Pareto dağılımının kuyruk parametresini etkileyen faktörleri belirleyeme çalışmaktır. Çalışma bulguları yaşın tek başına göreli servet dağılımındaki farklılıkların üçte birindenden fazlasını açıkladığını göstermektedir. Cinsiyet farklılıklarının aksine, sektörel farklılıklar, girişimcilik, miras, ve ülkesel düzeyde farklılıklar, milyarderlerin yaşlarındaki değişimin göreli servet düzeyleri üzerindeki değişime olan etkisi üzerinde anlamlı etkileri olan faktörlerdir. Bu faktörler arasından finansal sektörün etkisi diğer sektörlere göre negatif iken, girişimciliğin etkisi girişimci olmayanlara göre, mirasın etkisi diğer servet edinim yollarına kıyasla, ve Amerika Birleşik Devletleri vatandaşı olmanın etkisi diğer ülke vatandaşlıklarına göre servet birikimini pozitif etkileyen faktörlerdir. Ayrıca araştırma bulguları göstermektedir ki, 2014 yılı küresel en üst düzey göreli servet dağılımı Pareto kuyruğuna sahiptir ve yeryüzünün en zengin insanları arasında bile son derece eşitsiz bir dağılım vardır. İlk bulgular ile paralel olarak dağılımın kuyruk parametresini, milyarderlerin cinsiyetleri etkilemezken, sektörel farklılıklar, girişimcilik statüleri, miras, ve ülkesel düzeyde farklılıklar etkilemektedir.

Anahtar kelimeler:

Yaş ve servet, Servetin belirleyicileri, Pareto dağılımı, Forbes Milyarderleri

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LIST OF ABBREVIATIONS

ML: Maximum Likelihood

OLS: Ordinary Least Squares

GEN: Gender

FIN: Finance

FOU: Founder

INHER: Inherited Wealth

U.S.A: United States of America

W.B: World Bank

I.M.F: International Monetary Fund

U.N: United Nations

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"Of all the classes, the rich are the most noticed and the least studied. So it was, and so it largely remains."

(Galbraith, 1977, p.44)

INTRODUCTION

The distribution of wealth and income, and the consequences thereof, have constituted a subject of considerable interest to researchers. They have sought to explore how income and wealth are accumulated, how they are distributed among and within generations, the extent to which this distribution is equitable, the economic and social factors related to this distribution, and the underlying determinants. In the 20th, particularly since the period following the Second World War, numerous studies have been conducted on the consequences of income and wealth inequality, the economic and social factors associated with it, and the mechanisms that can be utilized to decrease it.

Kuznets (1955) argued that income inequality increases during the initial stages of economic growth, as evidenced by his famous inverted U-shaped curve, but decreases with sectoral changes in the economy. Kaldor (1955) developed a growth model in which he observed, in what he called stylized facts, that the ratio of labor and capital share in national income remains constant in the long run. Later, together with Solow's (1956) work, the economic view known as the Kaldor-Kuznets-Solow consensus essentially held that income and wealth inequality are the driving forces behind economic growth, meaning that policymakers face a trade-off between economic growth and wealth inequality, at least during the initial stages of growth (Fisher & Erickson, 2007).

In the literature, the growth models that have emerged alongside the consensus, as well as the neoclassical growth models that have gained popularity since the 1960s, suggest that the driving force behind the increasing economic growth (caused by income and wealth inequality) has led to a reduction in income and wealth inequality through the trickle-down mechanism. The mechanism behind this phenomenon is rooted in the higher savings rate of individuals and households in the upper-income and wealth groups. A higher marginal propensity to saving can facilitate increased capital accumulation through various investment channels and, in turn, creates new job opportunities in the economy. Furthermore, the expansion and development of existing employment prospects can be fostered. Ultimately, the enhanced capital stock and greater efficiency in labor allocation can increase the marginal productivity of labor and contribute to the growth of wages for workers, all due to the diligent work of individuals. In short, wealth flowed from the top to down, reducing income and wealth inequality.

Therefore, there has been a debate in the literature on whether fiscal policies such as tax cuts, which could initially contribute to income and wealth inequality in economic growth and development dynamics, would eventually reduce it through the trickle-down effect. Specific fiscal policies, such as tax cuts, were thought to potentially reduce this inequality through the trickle-down effect of increased savings, capital accumulation, and job creation among higher-income and wealth groups by promoting economic growth (İncekara & Mutlugün, 2016).

Overall, in the 20th century, there was a consensus in the neoclassical economics literature that economic growth and development were inherently driven by income and wealth inequality (Fisher & Erickson, 2007). Another topic of debate among scholars is the effectiveness of the trickle-down mechanism. This idea is based on the belief that the benefits of economic growth eventually trickle down from wealthy and upper-income groups to the poor and lower-income groups, thereby reducing income and wealth inequality through various means.

In the 21st century, a different approach to income and wealth inequality and its potential consequences is evident in the literature. Unlike Kuznets's (1955) approach, recent research that employs more comprehensive datasets demonstrates increased levels of income and wealth inequality despite high growth rates in many countries (Jones, 2014; Kanbur & Stiglitz, 2015; J. E. Stiglitz, 2015). Studies have been conducted that demonstrate Kaldor's (1955) well-known stylized facts, which indicate that the ratio of labor and capital shares in national income is not fixed in the long run. Moreover, the share of capital increases much faster than labor (Kanbur & Stiglitz, 2015). Contrary to the arguments of the Kaldor-Kuznets-Solow consensus, which is known as the positive relationship between inequality and growth, many studies suggest that inequality harms economic growth and development (Alesina & Rodrik, 1994; J. E. Stiglitz, 2015).

Also, the trickle-down mechanism, as proposed by Aghion & Bolton (1997), does not provide a mechanism for eliminating inequality by promoting capital accumulation, creating new job opportunities, or increasing entrepreneurship that would allow income and wealth to flow from the wealthy to the poor to ensure steady-state distribution of income and wealth in the economy as previously claimed (İncekara & Mutlugün, 2016). Even if this mechanism works correctly, the result is not exactly claimed. Recent studies show that the contribution of the marginal change in the income of the upper-income group to the marginal change in the income of the lower-income group is meager; therefore, the mechanism often exacerbates inequality by primarily benefiting the wealthy and further marginalizing the poor (Akinci, 2018).

An extensive body of literature examines the relationship between income and wealth inequality and its impact on economic growth and development. This literature encompasses various studies with diverse findings, contributing to our understanding of this complex relationship. However, the reason why scholars have extensively discussed income and wealth inequality in the 21st century is not only due to their impact on economic growth or development but also because income and wealth inequality has been rapidly increasing since the 1980s (Zucman, 2019), persisting over time (Piketty, 2014), and leading to various economic, social, and political consequences. These factors have made income and wealth inequality a subject of great interest.

Persistent high levels of income and wealth inequality have been identified as having a range of possible consequences, including impacts on social cohesion. There is a consensus in the literature that high income and wealth inequality levels can increase crime rates in a society (d'Hombres et al., 2012; Mooney, 2009). Other researchers demonstrate the likelihood that the wealthy elite influences economic policy decisions is greater in societies with high levels of wealth and income inequality (Gilens & Page, 2014). Consequently, studies indicate that the wealthy are more motivated to vote than the poor, which reduces political participation among the lower-income group and increases it among the upper-income group. As a result, there is a consensus that political outcomes are biased toward the interests of the rich, in line with the median voter theory[1] (d'Hombres et al., 2012).

In addition to its impact on social cohesion, income and wealth inequality have significant implications for social sustainability. It is well-studied that corruption has a negative effect on both social and economic sustainability. Studies argue that increasing levels of income inequality can lead to corruption, and corruption leads to income inequality which in turn creates a vicious cycle by exacerbating inequality (Uslaner, 2008). Therefore, the issue of income and wealth inequality has been a topic of research not only concerning social cohesion but also social sustainability.

Recent studies also demonstrate the harmful effects of income and wealth inequality on social mobility. Research suggests that in countries with high levels of income inequality, there is a lower level of intergenerational income mobility, which indicates social mobility. This implies that people in such countries have fewer opportunities to improve their economic conditions relative to their families. Therefore, some studies argue that social mobility is negatively affected by income and wealth inequality (Connolly et al., 2021; Corak, 2013).

In recent years, the Great Gatsby Curve has gained significant attention in the analysis of the economic and social consequences of income inequality. By displaying countries in terms of intergenerational income mobility and income equality, the Great Gatsby Curve illustrates the association between income inequality and intergenerational income mobility and symbolizes the potential outcomes of this inequality. Specifically, it indicates that in

[1] For detailed literature review about inequality and social cohesion relationship from other aspects, see d’Hombres et al. (2012).

countries with high levels of income inequality, intergenerational mobility tends to be low, irrespective of individuals' skills, abilities, and efforts (Corak, 2013).

Income and wealth inequality and their economic, political, and social consequences have been subject to discussion for a long time. The significant and rapid increase in wealth inequality since the 1980s, and its persistence, is an extremely debated phenomenon in the literature. Piketty (2014) highlighted the growing inequality in wealth distribution by showing with the famous $''(r-g)''$ that the rate of return on capital has increased more than the growth rate over the last 40 years, emphasizing that the widening gap of $''(r-g)''$ has increasingly contributed to the rise of wealth inequality around the globe.

Pareto (1896) proposed the 80/20 rule over a century ago, widely known in the literature as the Pareto principle. This rule refers to the distribution where a small fraction of the population holds a large share of the wealth or vice versa, in more general terms, the extent to which wealth is distributed unequally among individuals in the economy and whether this inequality conforms to Pareto's proposed 80/20 rule has been the subject of many studies in the literature.

Perhaps even more importantly, the increasing gap between the rich and poor over the last 40 years has become a topic of great interest for economists, social scientists, policymakers, and the bottom 80 or 99 (or 99.99) percent of society.[2] Recent reports on increasing wealth inequality indicate that the top one of the world's population owns two-thirds of the newly created wealth, and this highlights the highly unequal distribution of wealth in favor of the tiny elite group (Coffey et al., 2020). Studies also suggest wealth is distributed much more unequally than income (Davies & Shorrocks, 2000).

The consequences of wealth inequality are complex, interrelated with economic, social, and political issues, and have significant policy implications for growth and development. Given

[2] We are referring to the Pareto rule's 80 percent, which argues that 80 percent of the population possesses only 20 percent of the wealth in the economy.

these multifaceted consequences and the frequency of debates in the literature, investigating the determinants of wealth inequality is a significant motivational factor for a deeper understanding of wealth inequality.

Therefore, this study focuses on analyzing the factors that determine wealth inequality, specifically by examining the Forbes billionaires list, which represents the highest concentration of global wealth. Our study investigates the characteristics of the distribution of the highest level of global wealth and whether the distribution of wealth has a right Pareto tail, which is frequently debated in the literature. Moreover, we try to observe possible determinants of the top-wealth distribution around the globe, particularly concerning demographic structure. Given the wide array of factors that impact wealth inequality in literature, we aim to explore and identify the pertinent determinants that shape global wealth distribution, specifically focusing on age as a demographic variable.

The rest of this thesis is organized as follows: in Chapter 1, we discuss in (1.1) the research question and motivation, (1.2) the methodology and dataset used in the research, (1.3) the main findings obtained from the research, and (1.4) the summary of the contribution.

The following sections are as follows: Chapter 2 comprehensively reviews the literature on wealth and income inequality and their distribution. Chapter 3 presents the theoretical framework of the thesis, and Chapter 4 describes the dataset used and the methodology employed. Chapter 5 shares the empirical findings, and finally, Chapter 6 discusses the contribution of our study to the literature on the characteristics and distribution of income and wealth inequality.

CHAPTER 1

GLOBAL TOP WEALTH DISTRIBUTION AND ITS DETERMINANTS

1.1. RESEARCH QUESTION AND MOTIVATION

The relationship between equity and efficiency is a controversial issue that has attracted the attention of economists. Some studies have suggested that a trade-off exists between these two concepts, contending that increasing equity generates inefficiency in the economy (Okun, 2015). Other studies have argued that this inequality can boost savings and expedite capital accumulation, resulting in the creation of new job opportunities and subsequently promoting a more equitable distribution of the newly generated wealth from top to bottom through the trickle-down mechanism of increased growth and prosperity (Aghion & Bolton, 1997). Recent studies have shown that different factors play a role in the dynamics of a country's growth path. Growth may be focused on physical capital accumulation in the short run, but it tends to shift towards a greater emphasis on technology and human capital accumulation in the long run (Galor & Zeira, 1993).

Studies have emphasized the importance of the initial distribution of wealth among individuals in an economy, particularly in the presence of capital market imperfections. In economies where the distribution of wealth is unequal, this inequality affects the investment in human capital, leading to a negative impact on total output in both the short and long run (Galor & Zeira, 1993). Other studies have suggested that the positive effect of inequality on economic growth has been misinterpreted. When analyzed using long-term time-series data and cross-country datasets instead of horizontal cross-sectional data sets, inequality is found to have adverse effects on economic growth (Piketty, 2014).

Income and wealth inequality is a multidimensional issue that economists have extensively studied. Researchers have examined not only the impact of inequality on economic growth and welfare but also its social and political consequences. While studies have yielded different findings regarding the social and economic outcomes of income and wealth inequality, there is a consensus in the literature that wealth inequality, in particular, has increased significantly since the 1980s (Coffey et al., 2020; Piketty, 2014; Scheve & Stasavage, 2017; Wolff, 2002; Zucman, 2019).

Since wealth data are limited, researchers focus on income inequality in empirical studies and wealth inequality in theoretical studies (Bagchi & Svejnar, 2015). Today, the work of international organizations such as the World Bank (WB) and the International Monetary Fund (IMF) on increasing wealth inequality is made possible by the availability of modern data sets, as well as the accumulated knowledge and experience shared by sources such as Forbes Magazine, Bloomberg, etc. These resources have enabled empirical studies on wealth inequality to be conducted more recently. Given the importance of the consequences of wealth inequality, it is crucial to understand its determinants.

Our study aims to investigate the determinants of wealth inequality, with demographic factors such as gender, nationality, and age as central determinants as well as other determinants of wealth distribution. Furthermore, our study seeks to analyze the statistical characteristics of the top wealth distribution. Given the observed increase in wealth distribution since the 1980s and its profound economic and social consequences, our research is motivated to better understand this complex phenomenon by investigating its determinants.

Additionally, we aim to contribute to the theoretical discussion about wealth distribution by testing the validity of Pareto's principle for the year 2014. Specifically, our research is also motivated to gain insights into the characteristics of the tail parameter.

The two research questions addressed in this thesis can now be stated more explicitly:

- Intuition and theory suggest that age significantly drives relative wealth and its cross-section distribution. This thesis investigates whether the marginal effect of age is heterogeneous across individuals.

- The theory also suggests that the cross-section distribution of wealth may have a fat tail at large levels of (relative) wealth. This thesis examines whether the tail parameter of the global top wealth distribution is significantly associated with individual-level characteristics.

1.2 APPROACH

In this study, we employed an enriched version of the 2014 Forbes magazine dataset, which includes microdata on billionaires. Unlike the original Forbes dataset, the one used in our study is an open-source dataset curated by Whitcomb (2016). Forbes magazine publishes information on individuals with $1 billion or more wealth each year without including politically related or illegally acquired wealth of billionaires.

In the 2014 dataset, they provide information on a billionaire's age, gender, country, and total wealth in current US dollars on a specific day of the year. However, the original dataset provides researchers with a limited scope of analysis. The data we employed in our research consists of 1.534 observations and includes additional micro information about billionaires, which are:

- Billionaires' sectoral information, in our case, we are interested in the financial sector.
- Billionaires' position during the founding stage of their companies, in our case, we are interested in the entrepreneurial effect.
- The way billionaires acquired their wealth which we are interested in inherited wealth.

- Also, the demographic structure includes age, gender, and nationality of billionaires.

The methodology employed in this study is based on the Blanchard-Yaari model, a simple model of wealth accumulation with a demographic focus and a constant probability of death among individuals in the economy, also known as the Perpetual Youth Model. Following the methodology of Jones (2014) and Attar (2020), the study investigates the relationship between age and wealth using a nonlinear regression model based on the prediction that age is an exponential function of relative wealth. We examined the second research question by estimating the Generalized Pareto Distribution Model using the Maximum-Likelihood method, which aims to determine whether the global top-level wealth distribution follows a Pareto distribution.

1.3. RESULTS

In our study, we analyze the 2014 cross-sectional dataset of Forbes magazine. The results indicate that age, operating in the financial sector, entrepreneurship status, inheritance, and being a citizen of the United States significantly affect relative wealth distribution. However, our analysis also reveals that gender is not significant. Specifically, individuals operating in the financial sector tend to have a negative impact on wealth accumulation compared to those in other sectors. In contrast, age, entrepreneurship compared to non-entrepreneurs, wealth acquired through inheritance compared to other means, and being a citizen of the United States compared to citizens of other countries have positive and statistically significant effects on relative wealth accumulation. These findings are based on the analysis conducted using the 2014 cross-sectional dataset of Forbes magazine.

Furthermore, our analysis indicates that the global relative wealth distribution in 2014 exhibits a right Pareto tail. The sectors in which billionaires operate, their entrepreneurship status, inheritance, and country information have significant effects on the tail parameters of the distribution. However, the analysis reveals that the gender variable does not exhibit a statistically significant impact on the tail parameters of the distribution.

1.4. CONTRIBUTION

Our study makes two contributions to the literature on income and wealth inequality. Firstly, we use a demographic model with age at the center, namely the Blanchard-Yaari Model, to make the homogeneous effect of age heterogeneous for each (relative) wealth level. This approach enables us to explain determinants of wealth inequality concerning demographics through a theoretical model that utilizes microdata.

Secondly, our study contributes to the field of econophysics by confirming the presence of Pareto tail distribution in the global top (relative) wealth distribution of 2014. This finding aligns with the theoretical predictions proposed by Vilfredo Pareto (Pareto, 1896). Furthermore, we identify the key factors that significantly influence the tail parameters of the 2014 global top (relative) wealth distribution. This empirical analysis sheds light on the specific determinants contributing to the shape and characteristics of global (relative) wealth inequality at the upper end of the distribution.

CHAPTER 2

RELATED LITERATURE

This research connects to the extensive literature on wealth inequality in two different ways. The first is the literature on the determinants of wealth inequality and its relationship with demography. The second is the empirical literature on the characteristics of the income distribution within countries and wealth distributions around the globe, whether these distributions exhibit fat tails as in the Pareto distributions.

The first section of this research centers on income, and particularly wealth inequality, from a broader perspective. It presents the reasons why this topic has been the subject of much social, economic, and political debate over more than 40 years in the literature. This section also encompasses the wide-ranging literature on the importance of identifying the determinants of wealth inequality and its various social, economic, and political consequences, underscoring why it is an essential issue. The first section of this study aims to establish the significance of wealth inequality as a research topic, particularly in the context of the broader macroeconomic picture. To accomplish this objective, the literature on the various social, economic, and political implications of income and wealth inequality is thoroughly examined. This section emphasizes the importance of understanding the larger economic factors that determine wealth allocation by examining the possible consequences of wealth inequality.

The second section of this study aims to review the literature on the determinants of wealth inequality. This section provides a summary of various theoretical models that attempt to explain the factors contributing to wealth inequality, as well as the relationships between these factors and different demographic variables. Furthermore, the second section provides a comprehensive overview of existing studies, highlighting the explanatory variables we employ as determinants of wealth inequality. This enables us to compare and contrast our chosen explanatory variables with those found in previous research.

The third and final section summarizes the different results and findings on whether income and wealth distribution have Pareto characteristics, which are frequently discussed in the literature.

2.1. CONSEQUENCES OF INCOME AND WEALTH INEQUALITY

Wealth and income inequalities are common themes in the political propaganda of political parties, the social and cultural studies of sociologists, the fundamental principles of law and justice, and the economic theories related to growth and development. These inequalities have become frequently discussed topics in the literature, especially in recent years.

The increase in worker productivity since the 1980s has not been equally reflected in workers' incomes and wealth (Mishel et al., 2007). However, over the last 40 years, the wealth and income inequality gap have grown enormously at both domestic and international levels (Öniş & Özçelik, 2019; Zucman, 2019). The increase in income and wealth inequalities pose significant challenges in both economic and social dimensions. It is frequently discussed in the literature that the increases in wealth inequalities, as well as the absence or very limited mobility of income and wealth, affect countries' economic growth and give rise to numerous social, political, legal, and economic consequences.

Effects of wealth inequality have been discussed in various ways, such as on growth, fiscal policy implications, entrepreneurship, human capital, poverty, and innovation.

Some economists have argued that wealth and income inequality positively affect economic growth. They discuss that high-income and wealth owners stimulate economic growth by spending and investing more (Kaldor, 1955). The trickle-down effect is a frequently discussed phenomenon in the literature (Aghion & Bolton, 1997; Akinci, 2018). Individuals with higher income and wealth in the economy possess a higher marginal propensity to save, and thus higher saving provides the necessary capital accumulation to create new job opportunities and expand existing ones. The trickle-down mechanism relies on tax cuts for high-income and high-wealth groups, which would allow them to earn more and create new businesses or expand existing ones based on the profit motive.

This mechanism, in turn, would increase the demand for labor and raise wages for low-income and low-wealth groups, stimulating human capital investment in low-income groups. As a result, the newly created wealth in the economy will trickle down from the top to the bottom. In a way, the view is advocated that existing income and wealth inequality in the economy can help reduce inequality through trickle-down mechanisms.

However, other studies argue against the validity of the theory and claim that the initial distribution of wealth has significant effects on economic growth (Galor & Zeira, 1993), even it is working the trickle-down mechanism primarily benefits the rich rather than the poor (Akinci, 2018).

Kuznets (1955) argues with the famous "Kuznets Curve" that growth stimulates inequality up to a point through shifting production methods from agriculture to industry; thus, increasing wages could decrease inequality, but after that, it adversely affects inequality. Kaldor (1955) argues that high-income owners invest more, these investments give positive momentum to the economy through the creation of new jobs and further growth of existing jobs, and this effect is only in the short run. Even some studies have argued that a choice has to be made between inequality and economic growth, that it is not possible to have both at the same time, and concluded that positive relationship between income inequality and growth is highly certain in the short run (Forbes 2000).

However, other studies argue that the effect of income and wealth inequality on growth and welfare is negative through several channels. (Aghion & Bolton, 1997) argue that growth may initially be positively affected by wealth inequality, as Kuznets (1955) envisioned, if there is no credit imperfection and technological change. However, in an economy with credit market imperfection, it will be determined more by human capital and technology. Several other studies have also advocated the view that income inequality is not the primary driver of economic growth; on the contrary, it hinders economic growth (Alesina & Rodrik, 1994). Moreover, it has been argued that an unequal distribution of wealth not only fails to reduce wealth inequality but also exacerbates it (Akinci, 2018).

Recent studies argue that growth mainly depends on institutions, technology, and human capital (Easterly, 2007; Zucman, 2019). Also, the relationship between income and wealth inequality and its effects on economic growth may vary depending on the level of development of countries (Barro, 2000).

The fact that wealth inequality is a much-debated phenomenon brings up the tax policy, perhaps the most critical tool for policymakers. The relationship between wealth inequality and taxation has been frequently discussed in the literature regarding the optimal tax practices that do not prevent growth for many years (Scully, 2003). However, this issue has gained a different dimension due to the increasing wealth inequality in recent years. Many studies have presented different perspectives on the need to reevaluate tax policies and implement interventionist fiscal policies to tackle wealth inequality in the economy (Ampudia, 2015; Crudu, 2015). Aside from different views on whether wealth inequality can be eliminated through fiscal policy, the relationship between wealth inequality and tax policy practices is frequently discussed in the literature. Some studies suggest that taxes have a significant role in reducing wealth and income inequality, but the effect is minimal (Martinez-Vazquez, 2001; Tanzi, 2013). Also, studies have argued that income and wealth inequality can be prevented if fiscal policies are used effectively through taxes (Goñi et al., 2011).

As a related topic to tax issues, tax havens have become a widely debated issue in recent years, with many arguing that it contributes to the growing wealth inequality at a global level. Studies argue that tax havens are one of the global causes of wealth inequality. (Yildiz & Demir, 2019). Scholarly work indicates that wealthy individuals widen the wealth inequality gap by holding their assets in tax havens with low tax rates, hindering the redistribution of wealth and undermining social welfare. Additionally, tax havens create incentives for economic growth in non-tax haven countries by encouraging capital flows to regions with lower tax rates (Foley et al., 2004).

Meh (2005) conducts a study on the effects of tax policies on entrepreneurship activity and wealth inequality using a general equilibrium model. He argues that the impact of changes in tax systems on wealth inequality in the economy depends on the entrepreneurship effect, and a shift from a progressive tax regime to a proportional tax regime has negligible effects on wealth inequality.

One of the controversial issues of wealth inequality in the economy is its relationship with entrepreneurship. Entrepreneurship lies at the heart of modern growth theories. The relationship between wealth inequality and entrepreneurship holds significance for countries' growth policies. The nexus between entrepreneurship and income and wealth inequality has been the subject of much debate in the literature. Researchers indicate that entrepreneurship is one of the main drivers of long-term growth and reduces inequality (Lecuna, 2020; Meh, 2005). Entrepreneurship causes the creation of new businesses and the growth of existing small businesses, increasing the total volume of production in the economy and contributing to growth. Some studies suggest increased entrepreneurship can decrease income inequality, particularly for low-income and rural populations, and contribute to economic growth (Kimhi, 2010).

On the other hand, many studies argue that a high degree of wealth inequality is a significant obstacle to entrepreneurship, often associated with the upper wealth group due to borrowing constraints and imperfect capital markets. Entrepreneurs typically require access to the necessary resources and capital, which is easier for the wealthy segment to obtain. Therefore, wealth inequality often hinders entrepreneurship, and since entrepreneurs typically come from the wealthy segment, it contributes to widening the wealth gap (Albattah & Melton, 2017).

The relationship between entrepreneurship and wealth inequality is controversial, and their causality is often disputed. Some argue that entrepreneurship may increase wealth inequality in a country with unequal income and wealth distribution as the upper wealth group has easier access to necessary resources. On the contrary, some argue that the relationship is weak and that the main characteristic of entrepreneurs is their high savings rates (Quadrini, 1999)

Others suggest that policies such as investing in human capital through improved education and health services can reduce wealth inequality by helping entrepreneurship (Lecuna 2020). Furthermore, while entrepreneurship is often seen as a driver of economic growth, its impact on income and wealth inequality has still remained a topic of debate.

Perhaps one of the most debated phenomena by respected international institutions such as the United Nations (U.N.), World Bank (W.B.), International Monetary Fund (IMF), etc., is the relationship between global wealth inequality and poverty. According to the Oxfam Report 2020, the world's total wealth of the world's 2,153 wealthiest individuals exceeds that of more than half of the global population's wealth based on the Forbes billionaires data (Coffey et al., 2020).

Poverty poses a significant obstacle to accessing education, healthcare, and other essential resources. As Atkinson (2015) noted, poverty remains a critical macroeconomic issue with far-reaching consequences, and it is challenging to achieve wealth equality in an economy where the wealth of the rich has increased tremendously more than that of the poor. He argues that wealth inequality should be eliminated to solve the problem of poverty.

The role of human capital in the development and growth of a country has been extensively explored and documented in the economics literature (Mincer, 1984). Human capital components, including intelligence, talent, and other necessary endowments, are expected to be randomly distributed within a country. Nevertheless, research suggests that access to resources such as education and healthcare, also crucial components of human capital, may be biased towards individuals with greater wealth levels. This bias in resource allocation could exacerbate wealth inequality, as those with more resources have better access to enhance human capital.

Galor & Zeira (1993) argue that different countries have varying growth paths depending on how wealth is distributed at the start among individuals. Their study also shows that individuals in the economy have two choices: they invest in education and human capital to become skilled labor or remain unskilled by not making such investments. The study concludes that the initial distribution of wealth determines these choices and, ultimately, the overall output of the economy, and these effects persist over time.

De Gregorio & Lee (2002) conducted a study on education as an indicator of human capital and found that an equal education level in the economy leads to a reduction in income inequality. They also concluded that increasing government expenditure to support education can be an effective policy tool to reduce income inequality. Scholars have extensively studied the relationship between human capital, innovation, and wealth inequality. It has been found that investment in innovation is one of the primary factors contributing to the increase in top-income inequality in America (Aghion et al., 2019). Moreover, Aghion et al. (2002) contend that the primary cause of fluctuating wages and income inequality is due to the divergent abilities stemming from technological changes and advancements.

Leaving other topics aside, the relationship between politics and wealth inequality also has been extensively researched in the literature. Scheve & Stasavage (2017) argued that politics directly affects wealth inequality, and the degree of wealth inequality in nations determines the direction of the effect of politics on wealth inequality. While their work addressed democracy and inequality, wealth inequality increased after the largely completed democratization period. Their study shows a significant relationship between wealth inequality and democracy.

There are also studies on the impact of various policy practices or, in the broadest perspective, politics on wealth inequality. The literature often discusses the potential impact of increased government spending on reducing wealth inequality by equalizing human capital through education spending or alternative channels. Another approach that has been explored is the use of a tax on inheritance in intergenerational models to address initial wealth inequality (Benhabib & Bisin, 2017; Gupta & Coady, 2012). Scholars underline the importance of analyzing these potential policy interventions and their potential effects on wealth inequality to conduct public policy decisions.

According to a different study, those with higher income and wealth significantly impact policymakers' decisions (Castells-Quintana & Royuela, 2017). An unequal distribution of wealth occurs in society because those in the higher wealth group influence policy choices in their favor. According to several studies, the higher wealth group influences policy through lobbying, tax breaks, and other means (Gilens & Page, 2014).

Aside from the political consequences of inequality, various studies have been conducted to examine the effects of wealth inequality on democracy. The high wealth inequality is an obstacle to democracy or seriously impairs its ability to function, according to numerous research. Unlike many previously discussed variables, the literature on the relationship between wealth inequality and democracy is indecisive (Scheve & Stasavage, 2017). In other words, it can be claimed that there is no consensus that wealth inequality, whether directly or indirectly, benefits democracy or vice versa. The arguable benefit of income and wealth inequality for democracy in literature is that it makes people more involved in political and economic issues in democracies (Brady, 2004).

Wealth and income inequality can have a significant impact on the legal system in addition to politics and democracy. Due to wealth and income inequality, some individuals are deprived of proper legal protection and subjected to unjust treatment. As a result, this phenomenon directly hinders the fundamental human right of protection (Frank, 2019). Additionally, economic inequality fosters the link between disbelief in the rule of law and belief in the existence of corruption. These mechanisms feed each other through the consequences of profound income and wealth inequality (Uslaner, 2008).

One of the topics frequently discussed and received significant attention recently, especially in the aftermath of the 2008 global crisis, is the relationship between crises and wealth inequality. Wealth inequality and financial crises have been researched extensively in the literature for many years. Numerous studies have found a connection between financial crises and wealth inequality, and some studies have found that the way crises occur has a different impact on wealth inequality (Öniş & Özçelik, 2019).

Some studies suggest that the presence of wealth inequality in an economy can turn something that generally has adverse effects, such as a crisis, in favor of certain elite groups. Additionally, it is debated that the level of income and wealth inequality may decrease as a result of the crisis, depending on the type of crisis. According to (Kuhn et al., 2018), individuals with higher levels of wealth typically invest in financial markets, while those with middle and lower levels of wealth invest in the real estate market. As a result, a rise in real estate prices can potentially reduce wealth inequality, whereas a rise in financial market prices can exacerbate it. This trend was particularly noticeable during the recent financial crisis. For instance, during the 2008 global crisis, the wealthiest one percent in America held approximately a quarter of the country's wealth, but this figure approached nearly half after the crisis. Their findings indicate that the outcome is just as crucial as the causes of the crisis itself.

Governments often consider bailing out large institutions and organizations, as the high-wealth owners hold a significant amount of resources in the economy, and reducing these resources can significantly impact the economy's functionality. Compensating for unemployment and the loss of middle-income wealth after a crisis is typically a challenging task. Therefore studies argue that while large institutions and organizations may require a bailout from the government due to the significant impact of high-wealth owners on the economy, the unemployment and income loss of the middle class is often difficult to recover from (Öniş & Özçelik, 2019). Therefore the effects of crises are not homogeneous for individuals in the economy and can exacerbate the existing wealth inequality (Castells-Quintana & Royuela, 2017; Schularick et al., 2018).

Also, while studies have proposed that the vast global inequality could result from the financial crisis because of reduced aggregate demand (J. Stiglitz, 2009), others argue that there is no direct relationship between crisis and wealth inequality, and especially the level of income inequality has no significant effect on the crisis (Shchepeleva et al., 2022). Nonetheless, most studies acknowledge especially on financial crises which more likely to occur after increasing wealth and income inequality (Atkinson & Morelli, 2011; Öniş & Özçelik, 2019; J. Stiglitz, 2009).

As crises occur with varying frequency, establishing a robust econometric relationship becomes challenging, and therefore, the results may not provide conclusive evidence. As a result, the relationship between crises and income or wealth inequality remains unclear, and studies on this issue often yield different findings regarding the direction of the relationship (Atkinson & Morelli, 2011).

The terms "wealth inequality" and "income inequality" are often used in conjunction in articles, as they represent closely interrelated phenomena. While studies have explored the connection between wealth inequality and income inequality, the effects of each on macroeconomic indicators could be separate research areas. The direction of causality between these two concepts is critical; however, they often bring each other to mind when one is considered. Nevertheless, the distribution of wealth is generally more skewed than income (Davies & Shorrocks, 2000), and as a result, their relative impacts on the economy can differ significantly. Despite having similar notions, wealth and income have very different meanings. While wealth is a stock variable that indicates the difference between total liabilities from total assets, which are not necessarily earned but can also be inherited, income denotes any amount of money made and includes a regular flow; this may be wages, rent, or interest. To put it simply, income is earned, but wealth is accumulated for a specific period[3] (Berman et al., 2016). The importance of this difference has an important place in the literature in terms of studies that argues income inequality has increased in recent years but that the wealth inequality gap has increased more. In addition, studies have been conducted which suggest that income inequality may contribute to wealth inequality (Wolff, 1992).

Berman et al. (2016) show that wealth and income inequality are positively correlated since wealth is a function of labor income, but eliminating one does not mean you can eliminate the other. Their research also draws attention to the fact that while income inequality is extremely low in Scandinavian countries such as Sweden and Norway but wealth inequality is very high. However, it is discussed may both cause economic problems as well as social problems.

Wealth and income inequality not only have economic implications, such as their effects on economic growth, poverty, innovation, and human capital, but they also have important social implications. Social cohesion is one of the most significant social issues related to wealth and income inequality.

[3] Another way to distinguish them is as follows: Income represents the flow of resources that can be sustained by any form of labor or other income-generating sources over a certain period of time, while wealth represents the duration of survival without any labor involved

Social division or social fragmentation is a matter that arises in situations where there is a persistent and rigid income or wealth gap among individuals in the economy, especially in cases where income mobility is low and some class in society becomes more disadvantaged; all of these circumstances contribute to the erosion of social cohesion. (d'Hombres et al., 2012). There are studies about the deterioration in social cohesion that occurs particularly when income and wealth inequality increases (Mooney, 2009; Satır, 2016). Social cohesion has significant economic implications, and empirical studies consistently demonstrate that a decline or deterioration in social cohesion can have detrimental effects on economic growth (Foa, 2011; Satır, 2016).

Social cohesion affects the costs of transferring information and the compatibility of demanded public goods[4], which in turn affects the cost reduction resulting from a reduction in diversity and crime rates.

Furthermore, social cohesion has an impact on the more efficient use of government resources. Therefore, addressing income and wealth inequality is crucial not only for economic reasons but also for social reasons, as it has a profound impact on the overall well-being of society (Satır, 2016). In addition, disruption of social cohesion caused by income and wealth inequality can have a negative effect on growth through human capital, which is one of the cornerstones of growth to be transferred to other countries through brain drain (Satır, 2016). Also, there are lots of studies on negative consequences of inequality on social cohesion through different channels can be found d'Hombres et al. (2012) 's outstanding review.

Social sustainability is crucial in transferring existing social and natural resources to future generations. The relationship between social sustainability and income and wealth inequality is frequently discussed among scholars. Sustainable development has three components:

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[4] The view is that when there are homogeneous preferences in society, the government can reduce costs by meeting similar demands instead of diversified demands, and this will benefit the entire society.

social sustainability, environmental sustainability, and economic sustainability, and they are not usually considered independently of each other. Therefore, studies in the literature have also revealed a negative relationship between inequality and environmental sustainability. Findings showed that high levels of inequality reduce social sustainability. Individuals with different levels of wealth in the economy also have varying impacts on the environment. Studies argue that wealth inequality may have adverse effects on the environment. According to the inequality report published by Oxfam (2016), the top ten percent of wealth owners in the United States and the top ten percent of wealth owners in Canada are primarily responsible for carbon emissions (Dorling, 2017).

So far, we have presented the debates and findings that have been particularly contentious over the last 40 years regarding wealth inequality and its impact on optimal growth, the development process, and specific social issues. Given the multifaceted and far-reaching effects of wealth inequality on various aspects of society, understanding the determinants of wealth inequality is an intriguing and crucial area of inquiry in economic research. The following section presents the studies about determinants of wealth inequality.

2.2. DETERMINANTS OF WEALTH INEQUALITY

Wealth and its distribution have always been the subject of socioeconomic debates. Aside from the social and economic consequences of wealth inequality, the determinants of why the wealth held by individuals varies so much has been an important research topic in the literature for a long time. Indeed, numerous factors can play a role in wealth inequality, such as demographic characteristics, variations in wealth distribution across different sectors, bequests, and geographic disparities. Also, other potential determinants may include levels of education, financial knowledge, and risk tolerance, among others, and many others.

Benhabib et al. (2017) stated that although earning inequality and precautionary savings as main factors of wealth inequality, these two factors do not explain wealth inequality sufficiently. They show that the distribution of wealth in both factors is not significant on its own in understanding the determinant and tail parameters of wealth distribution. However, in order to understand wealth distribution, the parameters of the distribution should include more heterogeneous information, such as entrepreneurship information. In addition, they stated that stochastic returns and saving rates are essential in the determinants of wealth inequality, and they suggested that the demographic information of wealth owners may play a significant role.

Fagereng et al. (2020), unlike Benhabib et al. (2017), propose that differences in tail properties in wealth inequality are determined either by stochastic returns or by inequalities in earnings, not both. Using Norway's 12-year administrative tax records, they tried to reveal the heterogeneous properties of wealth distribution with linear panel data analysis. In their findings, it is that the returns of wealthy owners vary greatly, and the heterogeneity in returns includes heterogeneity even within the assets that are both safe and risky. Also, they have found that individuals' returns on their wealth vary and that an increase in wealth levels is associated with an increase in returns. They have also concluded that the differences in returns are persistent. In addition, this heterogeneity in returns is positively correlated with differences in wealth accumulation or wealth inequality. Taxation differences, marital status, financial literacy, access to financial information, and entrepreneurial skills are some of the factors that contribute to heterogeneity in returns and wealth inequality.

In their work, De Nardi & Fella (2017) pointing heterogeneity to understand the dynamics of wealth inequality, same as Fagereng et al. (2020), also argue that in the theoretical framework of the Bewley model, which explains the differences in wealth inequality that people are at different levels of income and wealth by saving for precautionary purposes, does not adequately explain the heterogeneity. They consider the saving rate of the rich as unfavorable or puts too much emphasis on precautionary saving. They claimed that Bewley Model missed some critical elements for reasons that did not fit with the data set at hand, i.e., the rich do not have negative saving rates. They also argued in their study that the determinants of wealth inequality, mostly human capital, inheritance, entrepreneurship, and health expenditures, are often studied separately and that these effects remain isolated. They emphasized that evaluating these effects together with the life cycle models to be established will increase the depth and heterogeneity of the model by providing a relative advantage. Therefore, they emphasized that in determining wealth inequality, models that combine heterogeneous elements are important in terms of understanding the accumulation mechanism of wealth and the dynamics of wealth inequality.

Theoretical studies are conducted to understand the determinants of wealth inequality. Wang et al. (2023) established a simulation that tests social welfare and agents' utility with a stochastic general equilibrium model and a theoretical model that includes expenditure savings and income and investment. They have reached striking results, even if the theoretical model they have established is theoretical. They concluded that the financial system, well-being of the labor force, and risk aversion are determinants of inequality, but human capital does not have a significant effect on determinants of wealth inequality. They argue that it may not be possible to completely halt the increase in wealth inequality[5], and particularly the wealth transferred through inheritance can be a significant determining factor now, and it also will be in the future in the growth and development paths of countries. In the future, governments may have to implement strict fiscal policies to reduce the inequality caused by inheritance.

There are studies that highlights inheritance, and intergenerational transfers on inequalities. Kotlikoff & Summers (1980) focus on whether the primary source of wealth accumulation creates inequality through the life cycle model and, therefore, the effect of savings or whether inheritance is the main dynamic of inequality. Using a U.S. database, they found that only a small and negligible level of real wealth accumulation is effective in explaining wealth inequality by saving decisions and inheritance. These determinants have a direct effect on the accumulation and unequal distribution of wealth in the United States.

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[5] Also Piketty's (2014) work underlines same findings with his famous "$r - g$" figure.

In their study, Gale & Scholz (1994) examined the underlying causes of wealth accumulation and wealth inequality by utilizing the life-cycle model in the literature, and they disaggregated inheritance into its components. The first category includes inter vivos transfers, which are intentionally and willingly transferred by the owner during their lifetime. The second category includes bequests, which are transferred directly upon the owner's death. In their studies, which propose the importance of understanding the weights of these two transfers in order to comprehend wealth inequality, Gale & Scholz (1994) highlighted that previous literature focused on considering bequests transferred directly upon death to understand and analyze wealth accumulation. However, they emphasized the need to comprehend the mechanisms of inter vivos transfers in order to understand the dynamics of wealth inequality. In their study based on 4-year household data, they found that more than half of wealth accumulation is primarily attributed to inheritance, with at least 20 percent of it originating from inter vivos transfers.

Boserup et al. (2016) analyzed the distribution of wealth and found that inheritance directly increased wealth by 36 percent. They also concluded that the share of inheritance in total wealth was 26 percent after acquiring wealth through inheritance. They argue that it is challenging to determine whether inheritance has an exacerbating or balancing effect on wealth inequality. However, they noted that it significantly increases the variance of inequality.

Later, in another revised and expanded version of the same work, Boserup et al. (2017) used the intergenerational transmission model and the life cycle model together with Danish tax records between 1984-2013 and conducted a theoretical study. They study reveals the mechanism of wealth mobility, where wealthy families transfer wealth to their children in their 20s through inter-vivos transfers. They found that this transferred wealth is invested in human capital, leading to high-income levels lifetime and eventual inheritance for their children in later stages of life. This creates a U-shaped pattern with a high and persistent correlation between age and wealth, indicating the existence of a robust intergenerational wealth mechanism. Thus, their research demonstrates that both inheritance and inter-vivos transfers play a significant role in wealth distribution and highlight the high correlation in intergenerational wealth.

Hurd (1987) argues that wealth increases with age, supporting the life cycle hypothesis, which suggests that individuals benefit from consumption and exhibit altruistic behaviors, leading to higher savings rates after retirement. His study examining inheritance motivation finds no significant evidence of individuals saving after retirement or displaying altruistic tendencies. Using a longitudinal model, he suggests that his study provides more insights into the relative impact of wealth accumulation on wealth inequality. He indicates that there may be no inheritance motivation among wealth owners, suggesting that inheritance could be considered a superior good only for the upper-income group by highlighting the highly skewed distribution of wealth. Additionally, his study suggests that to some extent, the inequality in wealth accumulation can be reduced through inter vivos transfers same previous studies; however, according to him the effect is minimal.

In the literature, there are also other studies that interpret the effects of inheritance and other wealth transfer mechanisms on wealth inequality differently. Wolff (2002) 's study explores how inheritance affects wealth inequality. Contrary to many studies in the literature, its findings suggest that all forms of inheritance decrease wealth inequality. The underlying logic of the study argues that when the wealth acquired through inheritance by the rich and the poor is compared to their wealth, the marginal contribution of inheritance to the wealth of the poor is relatively greater. Therefore, the study discusses how inheritance contains a balancing mechanism.

Several studies highlights the effect of being in the financial sector, having financial knowledge, and financial experience on wealth inequality. (Lusardi & Mitchell, 2007) conducted a study using two cohort models to examine the impact of financial information on total wealth levels. Their research highlighted the presence of heterogeneous returns among two distinct groups selected as samples. This variation can be attributed to differences in retirement plans, portfolios, and investment instruments. Furthermore, the study shed light on the dynamic nature of top wealth, revealing that the level of high net worth individuals fluctuates over time. Their study demonstrated that the different financial and political literacy of different generations has an impact on wealth holding. Lusardi et al. (2017) examine financial information sets as an endogenous choice variable within a stochastic life cycle model framework. They model different wealth levels and levels of financial information using cross-sectional data to demonstrate that financial information offers advantages, particularly in optimizing resource allocation within an imperfect capital market. According to their study, financial knowledge has a significant impact on wealth inequality. Their study reveals that more than 30 percent of the inequality in after-retirement wealth levels can be attributed directly to differences in individuals' financial skill sets.

Also, other studies argue that the financial information set directly affects wealth accumulation. Rooij et al. (2012) connected financial literacy and varieties in net wealth holding and showed financial information has role on factors that illustired with of the wealth accumulation at different levels. They showed that the heterogeneity between different wealth levels diverged on a sectoral basis with the effect of the financial literacy information set. Financial literacy can contribute to an increase in wealth inequality through various means, such as individuals who possess financial literacy being more likely to engage in activities like investing in the stock market, effectively managing their portfolios, and planning for retirement and savings. Their research suggests that having comprehensive financial information set and possessing financial literacy skills can lead to optimal returns from the financial sector and may increase wealth inequality.

There are also studies dealing with the relationship between finance and wealth inequality on a global scale, Hasan et al. (2020) investigated the determinants of wealth inequality on a global scale using 73 countries and 37 explanatory variables. The results of their analysis within the framework of the Bayesian model attach great importance role of finance on wealth accumulation. Finance is the most significant explanatory variable among all the variables they have used, and many other explanatory variables have not been profoundly related to wealth inequality. In their findings, they have stated that the efficiency of the financial system in a country and access to finance have reduced wealth inequality.

In another global-scale study about the effects of finance-related topics which specifically focused on wealth inequality among billionaires worldwide, rather than solely analyzing the wealthy elite of individual countries, Fruend & Oliver (2016) conducted that the financial sector is the determining factor in wealth inequality for the U.S. Their analysis, using the Forbes billionaires list, shows that the financial sector is the most fundamental sector in the increase in the number of billionaires in America from 1996 to 2014. They state that hedge funds are particularly influential in this wealth variation among billionaires. Their study especially underlines the impact of the financial sector on wealth differentiation and inequality and the fact that this effect is extreme in the United States.

It is evident from the literature that numerous studies have been conducted on the relationship between entrepreneurship and economic inequality. Studies investigating income and wealth inequality in the context of entrepreneurship primarily concentrate on income inequality as a manifestation of economic inequality. As mentioned earlier, this could be attributed to income data being more accessible. However, it is worth noting that several empirical studies have been conducted in this field. In his panel data study involving 54 countries, Lecuna (2020) demonstrated that the mechanism through which entrepreneurship reduces income inequality differs between formal and informal entrepreneurship. The study found that investments in informal entrepreneurship have a higher impact on reducing income inequality compared to formal entrepreneurship.

Fruend & Oliver (2016) examined income and wealth inequality at a global level as well as at a regional level. They explored the different dynamics of regional wealth inequality and found that developed countries have a more dynamic impact of entrepreneurship on wealth inequality and wealth accumulation compared to developing countries. At a regional level, they observed a significant wealth accumulation dynamic driven by entrepreneurship in East

Asia among emerging markets. At a global level, they argued that entrepreneurship better explains wealth inequality in the United States, while factors such as inheritance have lower explanatory power in Europe.

Cagetti & De Nardi (2006) argue that increasing specific barriers to borrowing in entrepreneurship, as a factor influencing wealth inequality, could potentially reduce wealth inequality. However, this approach would come with some trade-offs, such as a decrease in the size of companies, a decline in the number of individuals involved in entrepreneurial activities, or a decrease in capital accumulation. Additionally, based on the life cycle model they developed, they argued that if entrepreneurship is promoted, it can serve as an incentive for talented individuals. On the other hand, if entrepreneurship is primarily driven by inheritance, it can have a positive impact on wealth inequality, but the associated costs need to be considered.

In his study, Quadrini (1999) presents a contrasting viewpoint to the commonly discussed literature by highlighting the presence of financial and other barriers that limit entrepreneurship to individuals with high levels of wealth. This perspective suggests that the impact of entrepreneurship on wealth inequality may be limited. He emphasizes that if entrepreneurs predominantly come from the high-income group, it indicates that entrepreneurship does not have the expected effect on wealth accumulation. However, when examining the asset-holding patterns of households and differentiating between workers and entrepreneurs, Quadrini (1999) argues that there are distinct preferences in asset allocation between entrepreneurs and workers. Holding more assets is a natural behavior for entrepreneurs, resulting in higher returns. Additionally, he demonstrates these differences by analyzing household data from the United States and separating workers based on these characteristics.

De Nardi & Fella (2017) argue that entrepreneurship is a direct force on inequality, extending the view of the entrepreneur from previous discussions by noting that most entrepreneurs are wealthy and vice versa. The second significant contribution to this discussion, and hence to Quadrini's (1999) work, is that entrepreneurs have a high savings rate both before and after becoming entrepreneurs, showing, as Quadrini (1999) does, that the entrepreneur differs from the worker in terms of savings preference. This is also a determinant of wealth inequality in the life cycle wealth accumulation mechanism explained by the savings rate in the wealth inequality and entrepreneurship causality debate. By employing the Bewley model, they find that entrepreneurship is one of the main determinants of wealth inequality.

Demography highly studied phenomenan analyzing wealth inequality and understanding its determinants. Demographic determinants about income or more specifically wealth inequality can be linear and quadratic. Davies (1999) established a life cycle model in his research and noted that the relationship between age, a demographic variable, and wealth inequality has a U-shaped distribution of wealth inequality for almost all countries. In his study, the change in age until the middle ages decreased wealth inequality, whereas wealth inequality increased after the middle age. In addition, his findings indicate that the decrease in wealth inequality can be explained by two different reasons, that which are the differences in the age of employment and shocks to the earnings of individuals, while the increase draws attention to the heterogeneity in the increase of age and wealth.

Mierau & Turnovsky (2014) established a single-sector endogenous growth model and studied the relationship between demographics, growth, and wealth inequality in the United States. As a result of their studies, they concluded that the change in demographic structures can cause different changes in wealth inequality. The results of their work show that while fertility rate and wealth inequality are positively correlated, an increase in the fertility rate slightly increases wealth inequality. In contrast, decreasing mortality rates on the impact of wealth inequality is also positive but more efficient. In their study, Sánchez-Romero et al. (2018) reached partially similar results through different models. However, they differed in their results between cohorts and within cohorts, constructed an overlapping generations model in which individuals do not exhibit altruistic behavior, and concluded that the decline in birth rates affects the age difference between those who create bequest(parents) and those who receive an inheritance(children), thus affecting the size of the accumulated inheritance, which in turn leads to a differentiation of wealth inequality within cohorts and thus to an increase in wealth inequality. Nevertheless, low fertility as the demographic structure of populations decreases the wealth differences through increases in the age of wealth holders.

Vandenbroucke & Zhu (2017) argues that one of the central dynamics of inequality is age structure, that the youngest hold a minor portion of wealth in the United States, and that the aging population can reduce wealth inequality. However, for the United States, the aging population is a concern for other macroeconomic reasons. However, they noted that other determinants of wealth inequality play an important role. Vandenbroucke (2016) established an overlapping generation model with the neoclassical growth model and separated the effect of the aging population as wealth into its compositions. According to him, the aging population affects wealth inequality in two ways, relative dominance of people who are aged 65 more, the first being the relevance of changing population demographics to the increase in life expectancy, and the other being the tendency of wealth to accumulate in those close to retirement with age. The former reduces wealth inequality, while the latter increases wealth inequality.

The Blanchard-Yaari model, which is directly related to age as a demographic variable and developed independently of each other and is frequently used in the literature as a joint result of two studies. Yaari (1965) examined the expenditure-saving relationships of agents in the economy in the age-related consumption model in the first model Blanchard (1985) has established a model by making the risk of death independent of age, in other words, by accepting the probability of death as the same for all age levels. Although different macroeconomic variables, such as economic growth and budget deficits, are used in his study, uncertain and fixed death probabilities are an essential factor in developing the Blanchard-Yaari model. Although the Blanchard Yaari model is not a model that directly examines wealth inequality, many studies have examined wealth inequality within the framework of this model due to its demographically strong foundation (Attar, 2020; Benhabib et al., 2016; Jones, 2015)

In his study, Attar (2020) examined the dynamics of the highest level of wealth distribution by exploring the relationship between age and wealth. Using the Blanchard-Yaari model and employing microdata Attar (2020) estimated meta-parameter as a whole of structural nonlinear model also the study investigated the age-wealth relationship within a theoretical framework. Additionally, by utilizing the 2018 dataset of Forbes billionaires Attar (2020) discovered that age accounted for a significant portion, approximately one-quarter, of the variations in wealth inequality.

Our study contributes to the extensive literature on wealth inequality by focusing on the determinants of wealth inequality related to demographic structure. This aspect has received less attention than wealth inequality's consequences in literature. We address this gap by employing a well-established demographic model to examine the factors influencing wealth inequality. The foundations of our study are based on the Blanchard-Yaari model with age at the center and examine wealth inequality on a global scale.

Our research aims to connect and contribute to the literature by showing the effect of age as a demographic variable on wealth inequality by making its effect heterogeneous for wealth holders. Our study aims to investigate the determinants of global wealth distribution using a demographic model and analyzing microdata. By focusing on the demographic factors that influence wealth distribution, we seek to gain a deeper understanding of the drivers behind the unequal distribution of wealth on a global scale.

2.3. WEALTH DISTRIBUTION AND ITS CHARACTERISTICS

Since the famous principle of Pareto was introduced nearly 130 years ago, it has been frequently discussed whether the distribution of wealth is unequal with a long and thick tail, as Pareto (1896) claimed, especially in the field of econophysics. The distribution of wealth inequality and whether this distribution exhibits the characteristics of Pareto Power Law (PPL) is a subject discussed in countries and on a global scale.

Based on our literature review, studies in this area primarily focused on a country and income basis until the 2000s. However, there was less emphasis on examining the characteristics of the wealthiest individuals globally. While studies on country-basis generally show only the statistical characteristics of wealth or income distribution in the country and do not consider other data, these studies are generally based on data from tax records of countries or household survey data. The use of this approach has been discussed by scholars (Vermeulen, 2016, 2017) to address several challenges that arise from relying on country-level data.

However, some research focuses on analyzing the characteristics of global wealth distribution and determining whether it follows Pareto characteristics. Most studies have utilized billionaires' lists from reputable journals as a data source rather than relying on household surveys or tax records of individual countries. Ogwang (2011), one of the first economists to draw attention to the distribution of wealth on a global scale, examined whether the top wealth distribution had Pareto features and used the Forbes Magazine data set for the years 2000-2009. Kolmogorov-Smirnov(K.S.) and Anderson Darling (A.D.) and the Chi-Squared results of his study claim that the distribution of the 10-year top wealth distribution dataset does not have a Pareto tail.

Capehart (2014) made some observations directly on Ogwang's (2013) study arguing that the previous study contains some rounding errors and that errors may change the results of the test. He emphasized that the test results would differ if these errors were corrected since the previous tests did not measure wealth with complete precision and included some rounding errors. He argues that when this error is minimized by comparing the results of magazines (Forbes, Hurun, Bloomberg, Ceoworld, and similar magazines) with each other, and when this rounding error is corrected, it is more likely to observe the Pareto distribution.

Brzezinski (2014) analyzed whether the frequently discussed tail distribution of the top wealth distribution exhibits Pareto characteristics by examining the wealthiest people in the world and by countries (America, China, and Russia). In his study, Brzezinski (2014) estimated the exponents of the power law distribution with the Maximum Likelihood Method (MLE) , and, according to his main findings, 35 percent of the results are consistent with the Power-Law distribution, and the rest of the results can not completely reject the Pareto distribution, but other statistical distributions that can explain this distribution should be taken into account.

Čabla & Habarta (2019) analyzed the tail parameters of the characteristics of the top wealth distribution using a dataset of a different list of billionaires. The first significant result of their work emphasizes the importance of finite variance for precise results in the statistical distribution of wealth inequality research. Maximum Likelihood method is one of the ideal methods to deal with this problem. Using the Maximum Likelihood and L-Moment methods, they analyze the Ceoworld Magazine dataset of 2019 and show that the entire distribution has Pareto properties, but since this billionaire list reflects a relatively small portion of the extensive dataset, the right tail distribution converges to the Pareto distribution in general terms. However, the right tail distribution has the characteristics of an exponential distribution.

We mentioned some wealth inequality studies results that included data quality concerns. Some studies specifically focused on the potential occurrence of false results in wealth inequality analysis due to rounding errors (Capehart, 2014). Other studies aimed to assess the extent to which the available data accurately reflected reality, hence making efforts to improve the accuracy by combining data from various sources (Schmidt, 2017).

As mentioned in the introduction to this section, two critical problems exist in the analysis of income and wealth. In the dataset based on households and some other surveys, when measuring wealth and income inequality, respondents may give either incomplete or incorrect answers when declaring their wealth and income.

Vermeulen (2016) categorizes problems under two categories in his work. The first of these, the non-response problem, is related to the fact that the participants do not participate in the survey for specific reasons, suggesting that if this situation is evenly and randomly distributed, this problem can be overcome statistically. However, if this problem is seen especially in the upper wealth groups, this wealth distribution may give a biased result in the distribution's extreme tails.

Secondly, it was demonstrated that higher-wealth groups underreport their wealth, motivated by reasons such as tax avoidance or concealing their assets, thereby contributing to the issue of non-reporting. He suggested that the data set should be cross-checked with other data sets so that these two problems do not give biased results in the tail distributions because the wealth gap between the ten percent and the ten percent appears to be more prominent when these adjustments are made through magazines such as Forbes. It has been shown that it is more possible to obtain results converging to the Pareto distribution if these adjustments are made.

Schmidt (2017), using the Forbes billionaire list, states that the Ordinary Least Squares technique does not provide adequate results regarding the nature of the Pareto distribution but that the Maximum Likelihood method is more appropriate. According to him the results does not exhibits Pareto characteristics ,but, still there may be some measurement errors due to the problems mentioned earlier, and emphasizes that it may be possible to speak more precisely with a more extensive data set if an equal value is determined below one billion dollars, which is the lower limit of the lower Forbes list, and concludes that although his study does not give results in the direction of the Pareto Power Law distribution, the Pareto distribution cannot be rejected entirely.

Many other studies examine whether the income and wealth distributions of countries have Pareto distribution characteristics. Ding & Wang (2007) showed that the wealth distribution in China has Pareto characteristics, Levy (1998) showed that the tail parameters of the wealth distribution in France have Pareto distribution characteristics, and in another country, basis study Levy (2003) showed that the wealth distribution in Sweden has Pareto tail. Klass et al. (2007) and Klass et al. (2006), with different approaches, analyzed Forbes 400 list for the years 1998 and 2003 in the United States and assumed that the distribution of wealth is consistent with the Pareto distribution, while for India, Jayadev (2008) conducts that wealth is Pareto distributed.

In Attar's (2020) study, a cross-sectional dataset of the 2018 Forbes billionaires list was used to illustrate the presence of significant wealth inequality in global top wealth distribution. The study revealed the existence of a Pareto tail, indicating a concentration of wealth among a small proportion of individuals, both in terms of absolute wealth and relative wealth levels.

Some studies look at both income and wealth distribution. Drăgulescu & Yakovenko (2001) examined the distribution of income in the United States and the distribution of income and wealth in the United Kingdom. In his studies, he found that a considerable part of the population exhibits an exponential distribution, while the part with low density but high wealth shows Pareto distribution characteristics. Sinha (2006) concluded that the distribution of income and wealth in India shows Pareto characteristics, and the tail parameters of the distribution are 0.81-0.92 and around 1.5, respectively.

As proposed about 130 years ago, there have been many empirical studies on whether the distribution of wealth and income exhibits Pareto properties. These studies examine the concentration of wealth and income and provide insights into the level of inequality in wealth and income distribution within the framework of the theory. Our study connects to the extensive empirical literature in economics and especially econophysics by examining the existence of the Pareto tail in the global top wealth distribution. We analyze cross-sectional data from the Forbes billionaires 2014 dataset to determine whether top wealth distribution around the globe has a Pareto tail. Our research contributes to the literature by examining the characteristics of the parameters of the Pareto tail in the global top wealth distribution.

Furthermore, we investigate the determinants of the distribution by analyzing the heterogeneity of each observation along the tail of the distribution.

CHAPTER 3

THEORETICAL BACKGROUND

This section introduces the theoretical framework we employ to analyze global top wealth distribution and inequality. The theoretical foundation we use is essentially based on the Blanchard-Yaari model, which is a combination of two independently developed models by Yaari (1965) and Blanchard (1985). The model examines intergenerational inequalities and consumption-(retirement) saving preferences under the risk of death at any time *t*.

The model is highly relevant from a demographic standpoint as it incorporates the heterogeneity in wealth distribution across individuals in the population and captures the influence of age on wealth accumulation. This model assumes wealth as an endowment and does not consider income generation through labor. It also assumes a heterogeneous distribution of age and wealth, while maintaining a constant population growth rate. These assumptions provide a suitable theoretical background for our study. However, since Blanchard-Yaari Model does not directly examine the distribution of wealth (Benhabib et al., 2016) and we are directly interested in the distribution of wealth for our research questions, for the empirical background of our study, we draw upon the works of Jones (2014) and Attar (2020), which provide a more refined formulation of our research question. Several fundamental assumptions of the Blanchard-Yaari model is important to understand the model we employ.

- Individuals make rational decisions on optimal consumption and saving preferences and have no motivation to bequest.
- Mortality rate is fixed and follows a probabilistic distribution in society. It is considered that mortality event is stochastic, meaning it occurs randomly.

Furthermore, the model assumes that an individual's mortality rate is independent of time and has no impact on their optimal consumption choices.

- Individual wealth exponentially increases among individuals with constant rate. Population growth rate remains steady, and the wealth of a deceaded individual is transferred to the new owner in accordance with a constant population growth rate.
- All individuals have initial endowments of wealth, which is capital income, and do not earn income by supplying their labor. They are not, therefore, motivated to save for retirement. The incentive to save stems from aspiration amass wealth and ensure a consistent level of consumption over prolonged period.

We define a demographic model that does not involve migration and incorporates a simple birth-death process. The model we define has fixed birth rates, represented by ratio, the births rate signifies the number of total births relative to population, and death rates, which represent by ratio of total deaths to the population. The model we define simply adheres to the stable population theory and extends from time $t = 0$ to diverges to ∞.

$$B_t = B_0 e^{\pi t} \tag{3.1}$$

The quantity of births at a specific time "t" exhibits an exponential growth pattern. B_t represents number of people born and B_0 represents initial number of the people at the starting date. Also π is growth rate parameter that determines exponential growth rate of births where $B_0 > 0$, and $\pi \geq 0$ fixed numbers. Equation (3.1) represents the total births at any given time *t*, while death in the model occurs due to Poisson arrivel death rate $\delta \in (0,1)$. Equation (3.2) expresses the differential change in population in terms of the total death and birth rates.

$$\frac{\dot{N}_t}{N} = \frac{B_t}{N} - \delta \tag{3.2}$$

A fraction β of the population represents the individuals who are newly born at each moment, accounting for both compensating for deaths and contributing to the net population growth. The birth-death process ensures stable age distribution while maintaining a constant rate of population growth

$$Let \ \frac{\dot{N}_t}{N} = \pi , and \ \frac{B_t}{N} = \beta.$$

To maintain a constant population growth rate, the population increase must be directly proportional to the birth rate (B_t).

$$\beta = \pi + \delta \ \ where \quad \beta > 0 , \pi \geq 0 \tag{3.3}$$

Jones (2014) applies that stationary distribution process to the probability of an agent's age greater than a at time t , and finds

$$\Pr[Age > a] = e^{-\beta a} \tag{3.4}$$

Equation (3.4) implies that the death process is a form of the Poisson process with the compensated birth rate at β and the probability of agents whose age greater than some a in the population is negatively correlated and decreasing with a. Also but also increases with β where $\beta = (\pi + \delta)$.

From this point on, in our demographic model, we focus on the share of expected consumption in wealth under the assumption that time is infinite and individuals are not motivated to inherit to their children, therefore B_t and N_t are outside of the model, and there is no migration.

Lets $w_{it}(a)$ represent individual *i* at time *t* with the age of a. At time *t* for individual i, c_{it}, is a constant fraction of the wealth, individuals maximize discounted sum of utility in time. Also, individuals do not acquire wealth by supplying labor. Therefore, they save to cover their expected future consumption, not for a bequest motivation.

In this case, for individual i,

$w_{it}(a)$ is the wealth at time *t* as the only source of income as a form of capital income, $c_{it}(a)$ is the expected consumption for individual.

The individual utility function is a form of natural logarithm which represent the discounted utility function where $t \in [\,0, \infty\,)$ is represented as a form

$$U_{it}(0) = \int_{0}^{+\infty} \ln\big(c_{it}(a)\big) \exp[-(\rho + \delta)a] \mathrm{d}a \tag{3.5}$$

Equation (5) stands for the individual utility function for individual age of 0, initial age[6], that enter the economy. Under the assumption of time is infinite with discount rate ρ where $\rho > 0$ and and Poisson death rate δ, and there is no bequest motive, hence individual well aware of δ so that prefers the utility of the present to that of the future since death can occur at any moment in time *t*.

The optimal control problem for the optimal growth rate for wealth accumulation for individual *i* in the given budget constraint in equation (3.6).

[6] In $U_{it}(0)$, 0 represents Forbes billionaires' age when they get into the billionaires list, and *t* represents the year of 2014 which is the year we employed of Forbes dataset.

$$\dot{w}_{it}(a) + c_{it}(a)da \leq (r - \tau)w_{it}(a) \quad \text{where} \quad \dot{w} = \frac{dw_t}{d_t} \tag{3.6}$$

Since newborn individual *i* at time *t* inherit an amount of wealth by chance $w_{it}(0) > 0$ and $\dot{w}_{it}(a)$ and $c_{it}(a)$ represents also refer to individual *i* at time *t* total saving and consumption respectively. Also $(r - \tau)w_{it}(a)da$ is capital income flow where r real interest rate and τ is the wealth tax rate $r, \tau \in (0,1)$. The solution to the optimal control problem, as presented in Attar (2020), is as follows in equaition (3.7)

$$c_{it}(a) = (\rho + \delta)w_{it}(a) \tag{3.7}$$

Also, for individual *i* capital accumulation process can be represented by $\dot{w}$ which denotes the change in capital wealth over time.

$$\dot{w}_{it} = \ rw_{it} - \tau w_{it} - c \tag{3.8}$$

Where r, τ, c are the real interest rate, capital wealth tax rate, and consumption, respectively. Let constant fraction of c denotes the optimal fraction of consumption, with discount rate and Poisson death rate $(\rho + \delta)$ under the decision of optimal consumption path, which represents by equation (3.9)

$$\dot{w}_{it} = w_{it}(\, r - \tau - \lambda) \tag{3.9}$$

Since consumption is a fraction of wealth, let $\lambda = c/w_{it}$, also $\frac{c_{it}}{w_{it}} = \rho + \delta$ for individual i, the individual's wealth accumulation can be written as equation (3.10).

$$\dot{w}_{it}(a) = (r - \tau - \rho - \delta)w_{it}(a). \tag{3.10}$$

This means wealth grows exponentially where individual i accumulate his/her wealth in a ratio of $(r - \tau)$ of capital wealth and consume at the same time with an effective discount rate of $(\rho + \delta)$. As we can see, the difference between both represents the change in wealth accumulation of individual i at the age of a.

Notice that $\Delta t \cong \Delta a$, to rewrite the equation (3.10), First, divide both sides of the equation by $w_{it}(a)$, then we proceed by exponentiating both sides of the equation with the base' e' in equaitions (3.11) and (3.12)

$$\int \frac{dw_{it}(a)}{w_{it}(a)} da = \int (r - \tau - \rho - \delta) da \tag{3.11}$$

$$w_{it}(a) = e^{(r-\tau-\rho-\delta)a+c} \tag{3.12}$$

c is the arbitrary integral constant, let $c = w_{it-a}(0)$.We can generate equation (3.13) as follows:

$$w_{it}(a) = w_{it-a}(0)e^{(r-\tau-\rho-\delta)a} \tag{3.13}$$

Individual i inherit the wealth of individual who dies. Hence $w_{it}(0)$ should be greater than zero ($w_{it}(0) > 0$). An important note in our analysis is that in the Forbes billionaire dataset, the year when individuals enter the list and their total wealth in that year are represented in the model as the year when individuals (newcomers) enter the economy.

Since individuals in the economy exhibit heterogeneity in terms of their ages, we can consider leaving the variable i aside in the subsequent stage. Now, we want to understand the distribution of $w_{t-a}(0)$ since we already have insights about exponential distribution of wealth with respect to change in age in infinite time horizon from equation (3.13). We now consider the initial distribution of individual'(billionaires') wealth at time $t - a$.

Notice $t - a \cong 0$ since $\Delta t \cong \Delta a$.

$$w_t(0) = \frac{\delta W_t}{(\pi + \delta)N_t} = \theta \overline{w}_t \tag{3.14}$$

In equation (3.14), the numerator represents the total wealth of deceased individuals, while the denominator represents the total number of newborns. There is no accidental bequest at individual optimal consumption and saving decision between equations. Until equation (3.12), we have not employed initial stock of wealth of an individual we only deal with wealth accumulation of billionaires[7], but now we now deal with the initial stock of wealth of an individual (notice that in our case newcomers is the Forbes billionaire) at initial time (notice, the year that billionaire is on the Forbes list), and we assume that earlier: Total wealth is distributed equally among newcomers through accidental bequest. W_t is the total wealth, and, N_t is total population. Additionally, in equation (3.15)

$\frac{\delta}{(\pi+\delta)}$ represents by θ, a fixed ratio, where $\theta \in (0.1)$

Also, $\frac{W_t}{N_t}$ represents by $\overline{w}_t$ which is capital per person.

We define population growth rate in equation (3.1) as $\pi \geq 0$, a noteworthy observation here are

- If $\pi > 0$, then , $\theta \in (0,1)$, and $w_t(0) < \overline{w}_t$. It means that an individual who enters the economy, newborn, gets smaller proportion of average wealth capital per person.

[7] Except Poisson death rate, δ, since individuals optimal consumption path is directly related with $(\delta + \rho)$ *as shown by* equaiton (7).

- If $\pi = 0$, then $\theta = 1$ and $w_t(0) = \bar{w}_t$. It means that individual who enters the economy, newborn, gets exactly the same average wealth capital per person, and newborn start with a positive initial wealth level $\bar{w}$ at time *t*.

So assume average capital wealth in the economy shown by

$$\bar{w}_t = \bar{w}_0 e^{\gamma t} \tag{3.15}$$

Average capital wealth, $\bar{w}_t$, is exponential grows in the economy with some contents, $\bar{w}_0$, and fixed γ represents instantaneous rate of growth $\gamma > 0$.

The well-defined equation of newborns initial wealth endowment is as follow

$$w_t(0) = \theta \bar{w}_t \tag{3.16}$$

Since average capital wealth is specified in equation (3.16), we , now, can easily rewrite both individuals' initial wealth endowment and average capital wealth stock in the economy at the time $t - a$ where individual first enter the economy

- Wealth endowment of an individual at time $t - a$

$$w_{t-a}(0) = \theta \bar{w}_{t-a} \tag{3.17}$$

- Average capital wealth stock in the economy at time $t - a$

$$\bar{w}_{t-a} = \bar{w}_0 e^{\gamma(t-a)} \tag{3.18}$$

In this case, if we generate the capital wealth of a newborn at time $t - a$, we have

$$w_{t-a}(0) = \theta \bar{w}_0 e^{\gamma(t-a)} = \theta \bar{w}_0 e^{\gamma t} e^{-\gamma a} \tag{3.19}$$

After factoring second equation, we substitute equation (3.15) in equation (3.19)

$$\overline{w}_{t-a}(0) = \theta \overline{w}_t e^{-\gamma a} \tag{3.20}$$

Then we substitute equation (3.19) in equation (3.13) as follows

$$w_t(a) = \theta \overline{w}_t e^{-\gamma a} e^{(r-\tau-\rho-\delta)a} \tag{3.21}$$

With better representation, we simply have cross-section distribution of wealth

$$w_t(a) = \theta \overline{w}_t e^{(r-\tau-\rho-\delta-\gamma)a} \tag{3.22}$$

Equation (3.22) implies that the capital stock of an individual is in an exponential form of age with some constant of $\theta \overline{w}_t$. One can notice that uniquely derived equation (3.22) from Blanchard-Yaari assumptions and exponentially distributed age and wealth relationship from a hypothetical economy also represent the Forbes billionaires' wealth accumulation process for billionaires *i* and the year *t.*

CHAPTER 4

DATA AND METHODOLOGY

4.1. DATA AND ITS PROPERTIES

The dataset we used is the enriched version with microdata of Forbes magazine in the year 2014 by Whitcomb (2016). Forbes magazine ranks the world's richest people with a net worth of $1 billion or more. Forbes (American Business Journal) is a magazine that offers content on topics such as finance, money, investment, technology, etc. In addition, it has traditionally started to keep data on the top wealth distribution which is of great interest and, in many respects, of great importance for macroeconomic issues.

Forbes magazine, which gained significant attention with its first publication in 1982, has been publishing domestic richest people in United States (400 Richest Americans) since its inception. Since 1987, it has also been publishing international billionaires. The individuals included in this list have a net worth of at least $1 billion or more. Every year, typically in February, Forbes conducts calculations to determine the wealth of individuals who qualify for the list and announces their rankings in March. The Forbes "400 Richest Americans" list represents the total net worth of individuals on a specific day. In our dataset, we capture their net worth as of February 12, 2014, while the list itself was released on March 3, 2014. As such, it is important to note that this list reflects the actual value of billionaires' wealth only on that particular day.

Determining the wealth of the world's wealthiest people is a challenging task, given the size and complexity of their wealth. Billionaires' wealth is generally not collected in a single center; wealth totals are usually extremely difficult and intricate. Since total assets and liabilities of individuals are usually aggregated using countries' tax data for many reasons compiling this information is extremely laborious and complicated such as different tax policies of countries, tax exemptions, taxable goods subject to fortune, distribution, and diversity of wealth. That is why Forbes magazine uses all possible sources to determine all fortune.

First of all, the billionaires are tried to meet with them in person. Then they collect data from anyone who has information about their financial assets or debts by meeting with their firms and employees (such as senior managers, lawyers, etc.) all information try to collect. In this process total assets of the billionaires are all the assets they can reach, such as luxury vehicles they own, stocks, real estate, investment, etc.). Forbes calculates total net wealth by subtracting his total debts. Because the amount of wealth can take different values over time, the dataset published by Forbes represents the total wealth at a particular point in time. Indeed, the business cycle can have a significant impact on the total net wealth of billionaires during economic expansions or boom periods. For example, a change in the wealth of the real estate sector riches when the real estate market rises or falls or the change in the total wealth of people who made their fortunes in the financial sector during financial crises. (Warren Buffet's loss of the title of the world's richest person after the financial crisis in 2009, falling to second place on the list)

In addition to all these, Forbes magazine has been keeping the current status of the people's fortunes on the list under the name of "Real Time Billionaire" for interested followers since 2012 which first publishes domestic report (in the USA (1982)) and then the international wealth (1987), is not the only source on this subject. Other journals are working for the same purpose. While some of them are global resources: such Bloomberg Billionaires Index, Wealth-X Report, CeoWorldMagaine, and Hurun Report, some of them are mostly country based: The Sunday Times Rich List (United Kingdom), Manager Magazine(Germany), and so forth.

Although other data sources are not as famous as Forbes, they are used in the literature as direct primary data sources and sometimes for cross-checking. Čabla & Habarta (2019) investigate whether the wealth of the world's richest individuals exhibits Pareto distribution characteristics by utilizing the CeoWorldMagazine's top billionaires list. Bloomberg and Hurun Report are two additional journals that conduct research in this area, competing with Forbes in terms of providing comparable dataset and analysis. In the study of Capehart (2014), these two journals were used as alternative data sources in order to avoid measurement errors in Forbes data.

Even if these journals conduct the same research, they may yield different results. Certain challenges arise due to variations in the calculation of data, differences in the sources of information obtained, or discrepancies in the dates on which the data were collected. These difficulties are also mentioned at the end of this section. It is quite understandable for different publications to present varying results based on their respective datasets. When we compare these magazines at one point in time, besides the fact that the wealth of billionaires is different, even the billionaire on one list may not appear on another list (Capehart, 2014).

One thing to remember is that all of these datasets from different journals are estimations and are not official sources. Due to the fact that the datasets of the journals are different from each other because of the method employed, the information obtained, the date of calculation, and the unique difficulties of estimating the highest level of wealth, these estimates are only estimates. However, considering the experience of the journals (especially Forbes magazine), these data are frequently studied in the literature for the closest results.

Two main reasons underlie the choice of Forbes magazine's dataset and the year 2014 for this study:

i) The dataset under consideration, which will be thoroughly examined in the data design section, includes specific micro-level features of billionaires that distinguish it from other datasets. Forbes magazine typically gives information about people's age, net worth, and source of wealth. The traditional dataset of Forbes in normal circumstances creates a limited workspace due to its content. Likely, Whitcomb (2016) made some additions to observations and created a richer dataset to allow macroeconomic research with a microeconomic foundation[8]. This valuable work has deepened the internal analysis of the our study. Since the dataset contains micro information such as the sectoral information of the people, the categories of their wealth, the way they acquire their wealth, in which fields they operate, it provides a more profound understanding of how to present macroeconomic policies grounded in micro data.

ii) The second important factor in choosing Forbes magazine as the dataset and choosing 2014 as the year is that Forbes magazine has been chosen as the dataset many times in the literature (Attar, 2020; Capehart, 2014; Ogwang, 2013; Schmidt, 2017; Vermeulen, 2016). Another reason Forbes magazine was chosen is for the internal consistency and comparability of the analyzes and to be compatible with the literature. The reason for choosing 2014 is that there are three years in our dataset, which includes extra information for analysis. There are 215, 400, and 1.534 observations in 1996, 2001, and 2014, respectively. As 2014 represents the year with the highest number of observations, this cross-sectional dataset is used to ensure the robustness of the analysis. Hence, this study uses the micro-founded, relatively rich version of the 2014 cross-sectional dataset of Forbes magazine as a dataset for the reasons explained above among the alternatives.

4.1.1 Design of the Data

Forbes magazine publishes some of the key characteristics of wealth owners in its annual report. These include the names of the people on the list and their families in relation to wealth, their estimated net worth, their ranking on the list, their nationality, the names of the companies that are the primary source of their wealth, and the demographic variable such as age and gender. Since the information disclosed about the wealthy is limited to these variables, scholars have generally focused on the distributions of the wealth of international

[8] The dataset originally trace back to Fruend & Oliver's (2016) outstanding work. We uses edited version by Whitcomb (2016) in this study.

the top wealthy people on the planet, or relatively few studies have theoretically examined the relationship between the age and wealth of the multi-rich people using demographic variables as age and using wealth distribution as an international top wealth distribution (Attar, 2020; Benhabib et al., 2016; Jones, 2014).

The dataset we employed has more information about the components of the billionaires' wealth on the Forbes list. In addition to age and gender as the demographic explanatory variable, new data such as from which sectors billionaires generally acquire their wealth, relationships with their companies, how they acquire their wealth has been added this data.

Given the presence of missing observations in our dataset for conducting regression analysis, we have taken the necessary steps to address this issue by cleaning the missing data and transforming them into dummy variables for utilization in the regression analysis. On behalf of regression analysis, we utilize a total of 1534 observations to yield robust results. This number corresponds to 1609 observations when we organize the data (%4.66 of the raw data). Through this organization, we ensure that there are no missing observations in any of the dummy variables we employ. The dummy variables utilized in our analysis encompass categorical information, serving as explanatory variables that provide insights into how billionaires acquired their wealth. These variables provide a comprehensive understanding of the various pathways through which billionaires accumulate their fortunes and explain the wealth differences among billionaires.

After cleaning the data, we focus on five primary categories for our research that relate to age and wealth. Before giving detailed information about these categories for the clarity of the research and the concreteness of what is trying to be observed, let us explain what these categories represent for our study.

The first category focuses on demographic variables, specifically age, and gender. Our objective is to examine how demographic variables influence the distribution of relative top wealth. The age data is directly obtained in its original form. The square of age is calculated and included as an additional explanatory variable. Moreover, gender is included in the analysis as a dummy variable. In the regression analysis, a value of 1 is assigned to male billionaires, while a value of 0 is assigned to female billionaires among the 2014 dataset.

The second category represents the primary source of billionaires' wealth. Given that the individuals on the list represent the world's wealthiest people, it is important to acknowledge the diversity of their wealth and not generalize that wealth creation occurs through a singular channel. Instead, we focus on the specific industries commonly associated with wealth generation, and within this category, there are six different categories aggregated by Fruend & Oliver (2016). These are Energy, Finance, New[9] sector, Non-Traded Sectors, Traded Sectors[10], Resources Related Sectors[11].The independent variables have been grouped into six different categories. We consider the explanatory variable to be the source of billionaires' wealth, with a primary focus on the financial sector. To indicate this, we use a dummy variable. If an individual has accumulated wealth in the financial sector, the variable is assigned a value of 1; otherwise, if they operate in other sectors, the value is 0.

The third category includes the position and relation of the billionaires on the list in their companies which are mainly responsible for their wealth. The main effect we expect to observe here is the entrepreneurship effect. In the original data, the individual relationship with the company is divided into sub-categories such as CEO, chairman, chief executive officer, chief operation officer, shareholder, former chairman, head of the board of directors etc. Specifically, the founder and other sub-groups are combined within themselves (CEO and founder, chairman and founder, etc.). Given that our primary objective is to examine the entrepreneurial effect, we consolidate all subgroups consisting of founders into a unified

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[9] New Sector encompasses sectors operating in technology and healthcare, see Fruend & Oliver (2016)
[10] The key distinction between the traded sector and the non-traded sector lies in the scope of trade. In the traded sector, trade occurs at an international level On the other hand, the non-traded sector operates within a domestic scope, see Fruend & Oliver (2016) for insight of dataset.
[11] Whether or not they are in natural resource-related sectors, see Fruend & Oliver (2016) for insight of dataset.

category. We create a dummy variable, assigning a value of 1 to billionaires who are founders and 0 to those who are not.

The fourth category pertains to the means and methods through which billionaires acquire their fortunes. In the original dataset, this category consists of five sub-categories: executive, founder-nonfinance, inherited, privatized and resources, and self-made finance. Our focus is to examine the impact of inheritance, which is frequently discussed in the literature and aligns with studies on wealth inequality. Since there is sufficiently broad literature about inheritance as a driver factor of inequality (Gale & Scholz, 1994a; Kotlikoff & Summers, 1980) and also we already observe other effects may occur in this category (self-made effect and founder non-finance effect combined with entrepreneur effect) in our third category as a founder effect, we take only inheritance as a dummy variable in this category to put this topic at the center of our research with other dummy variables to stay connected to the literature. Consequently, we assign a value of 1 to billionaires who have acquired their fortunes through inheritance, and a value of 0 to those who have obtained their wealth through other means.

The fifth category pertains to categorical independent variables, specifically focusing on country information. In this context, we utilize data from the United States to examine the citizenship of billionaires. By incorporating this variable, we aim to understand the influence of nationality on wealth accumulation. In the dataset, the United States is represented by a dummy variable. It is assigned a value of 1 if the billionaires hold United States citizenship, and a value of 0 if they do not.

Finally, the dependent variable used in our analysis is relative wealth, as we are interested in examining the positioning of individuals' wealth in relation to the average. By considering relative wealth, we can also gain insights into the distribution of wealth and assess the inequality between individuals' wealth levels and the overall average. the relative wealth of individuals is determined by aggregating and averaging the total wealth of billionaires.

4.1.2. Descriptive Statistics

This section shares a statistical summary of Forbes magazine dataset from 2014 and provides detailed information about the relationship between billionaires' age and wealth, as well as characteristic information about billionaires. It also includes a comprehensive overview of all the variables utilized in this study. Table 1 presents a detailed age and wealth distribution of billionaires.

Table 1: Age and Wealth Distribution

	Age *years*	***Wealth*** *2014 USD*
Mean	63.21	3.98
Standard Dev.	13.15	5.92
Skewness	.11	5.61
Kurtosis	2.44	48.21
Minimum	24	1
Maximum	98	76
Percentiles		
%5	43	1.1
%25	53	1.4
%75	72	3.7
%95	86	13.5
#Observation	1534	1534

Data: Forbes (2014)

The detailed age and wealth statistics in Table 1 reveal that the average wealth for billionaires at the average age of 63 is approximately $4 billion. Additionally, there is a relatively high standard deviation of average wealth, indicating significant variability in wealth levels among billionaires. The skewness value of the age data for the 2014 Forbes data is close to zero, suggesting a nearly symmetrical distribution. These summary statistics highlight that the age distribution of billionaires in 2014 is relatively evenly spread around the mean, indicating a balanced representation of ages in the billionaire population.

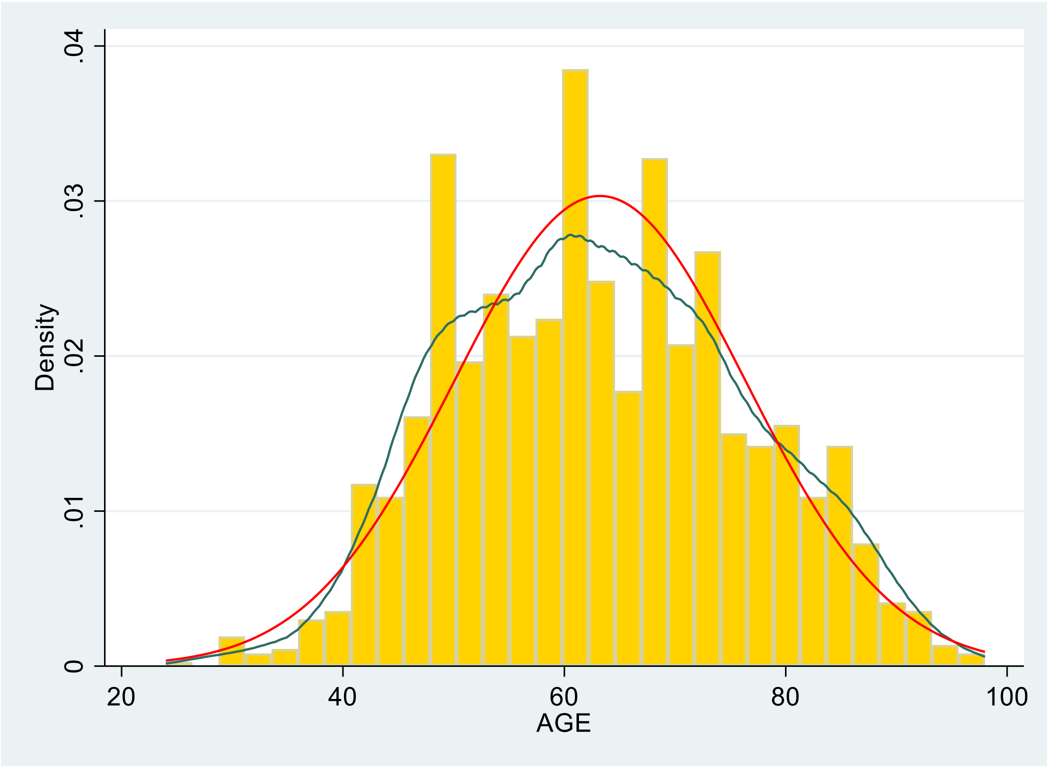
According to the descriptive statistics, the skewness value of wealth is relatively high, with a value of 5.61. This indicates that the distribution of wealth is not symmetrical around the mean, but rather skewed. Specifically, the positive skewness value suggests a right-skewed distribution of wealth, characterized by a fat tail on the right side. This means that there is a significant concentration of extremely high wealth values in the dataset, leading to a rightward skew in the distribution.

When examining the kurtosis values of age and wealth, we observe that the kurtosis value for age is not significantly different from the average, suggesting that the age distribution does not exhibit a distinct peak. However, for wealth, the kurtosis values indicate that extreme values are highly pronounced. This implies that the distribution of wealth has heavy tails and deviates significantly from a normal distribution and presence of extreme wealth values, indicating a distribution with heavy tails rather than a normal distribution.

Our analysis progresses to the graphical examination after presenting a comprehensive summary table illustrating the statistical distributions of age and the global top wealth distribution. To delve deeper into the data, we turn our attention to the graphical analyses. Figure 1 showcases the kernel density function and histogram function of age, presenting an insightful visual representation. To facilitate comparison, the red line corresponds to the normal distribution. Notably, the histogram captures a wide range of ages, spanning from a minimum of 24 years to a maximum of 98 years.

With the histogram divided into 31 columns, each column represents approximately 2.4 years of age. This detailed breakdown allows us to discern the distribution pattern more precisely. The histogram exhibits a concentrated distribution between the age range of around 50 and 70 years, indicating the prevailing average age distribution within the dataset.

Figure 1: Age Distribution of Forbes Billionaires (2014)



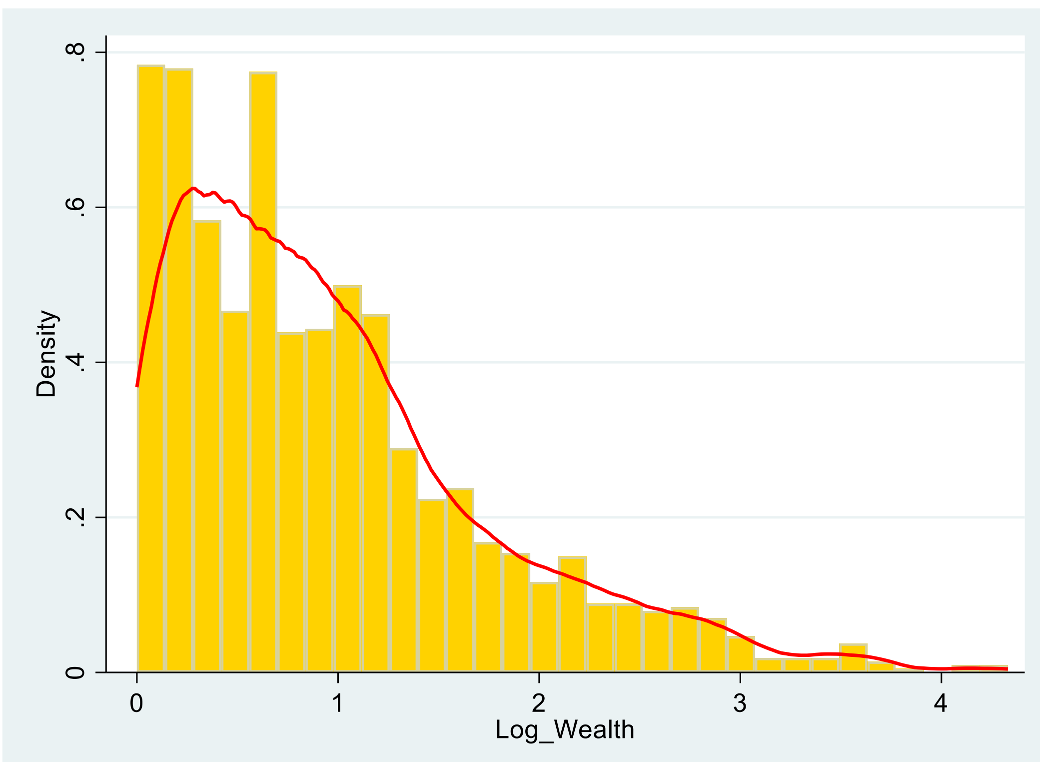
Data Source: Forbes (2014)

In Figure 2, we observe a right-skewed statistical distribution where the tail parameters extend to extreme values. Notably, the mean significantly exceeds the median, indicating a notable positive skewness. To enhance the clarity of the distribution, which spans a wide range, we employ the logarithm of wealth. By doing so, we provide a more visually informative representation of wealth. The histogram distribution of the logarithm of wealth is complemented by the inclusion of the kernel density function.

Within Figure 2, a significant observation arises in the wealth distribution analysis of Forbes billionaires in 2014. Notably, there is a notable concentration between 1 billion and 3.4 billion US dollars, indicating a distinct cluster within this range. Moreover, when examining the broader global top wealth distribution, it becomes evident that the majority of billionaires possess wealth below 20 billion US dollars.

Furthermore, a minuscule fraction of billionaires is found to possess wealth equal to or exceeding 54 billion US dollars. These findings shed light on the distribution patterns and variations in wealth among Forbes billionaires, providing insights into the diverse wealth profiles within the cross-section distribution of top wealth.[12]

Figure 2: Wealth Distribution of Forbes Billionaires

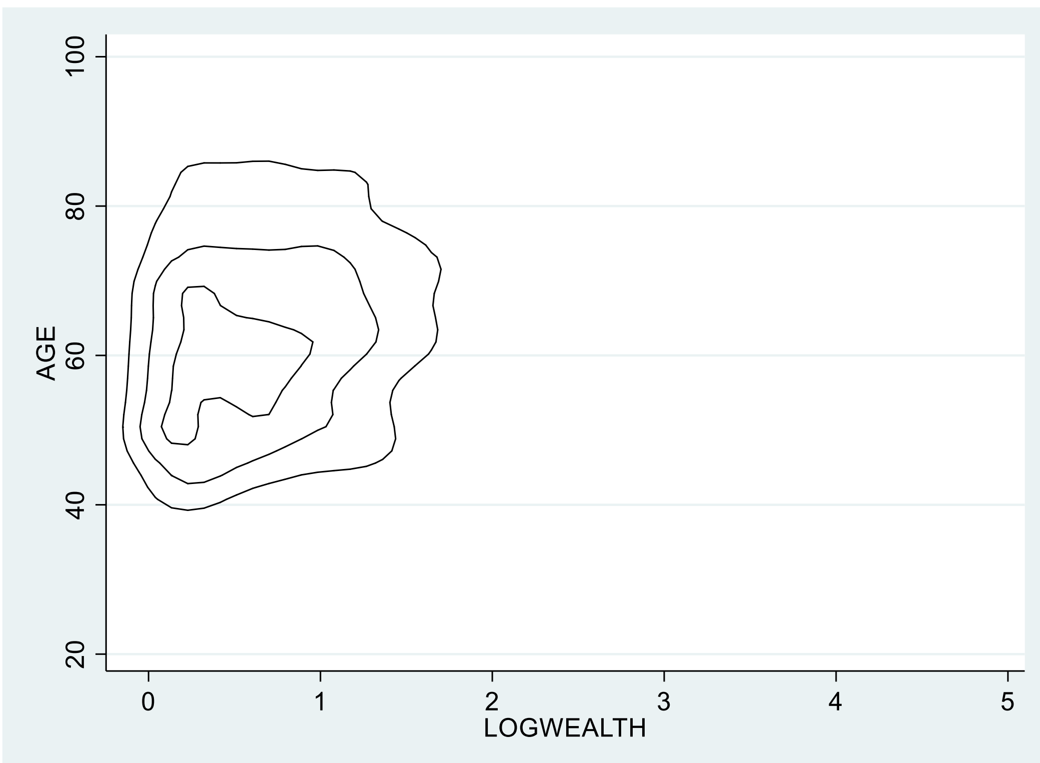


Data: Forbes (2014)

[12] $e^3 = 20.0855$ and $e^4 = 54.5981$ billion US dollars.

We have presented graphical analyses of age and wealth for the Forbes billionaire list in 2014. Now, we move on to Figure 3, where bivariate kernel density function estimates for age and logarithmically transformed wealth are displayed. The dataset indicates a significant concentration of data points within the age range of 50 to 70, as well as within the wealth range of approximately 1.1 to 2.7 billion dollars.

Figure 3: Bivariate Density Plot of Age and Wealth of Forbes Billionaires



Data: Forbes (2014)

Thus far, we have provided statistical summaries and graphical representations of age and wealth individually, as well as their interrelation, which constitutes the primary emphasis of this investigation. Moving forward, our attention turns to the statistical summaries of categorical variables pertaining to the attributes of billionaires utilized as explanatory factors in this study.

Table 2 showcases the distribution of billionaires within the financial sector, those classified as entrepreneurs, and individuals who inherited their wealth. A comparative analysis is conducted between the United States, serving as our reference country, and other nations. This examination aims to shed light on the disparities and similarities observed across countries regarding the composition of billionaires within these distinct categories.

Table 2*:* Forbes Billionaires Characteristics

	Finance	***Founder***	***Inheritance***
United States	180	269	135
Other Countries	312	531	323
Total	492	800	458
% of United States	%38,70	%57,84	%38,70
% of Total	%32,07	%52,15	%29,85

Data::Forbes (2014).

Notes:% of United States represents related categories' weight in the sample and % of Total represents the percentage of related categories' weight in the sample size (1534).

The summary table presents characteristic information about the billionaires included in the 2014 Forbes magazine's billionaire list. Our dataset comprises a total of 1534 observations. Among these, 465 billionaires are from the United States, while the rest come from 64 other countries. The total represents the overall number of billionaires worldwide in each category. The percentage of United States reflects the proportion of billionaires from the United States within their respective category in the United States only. On the other hand, the percentage of total represents the proportion of billionaires from all countries in the sample.

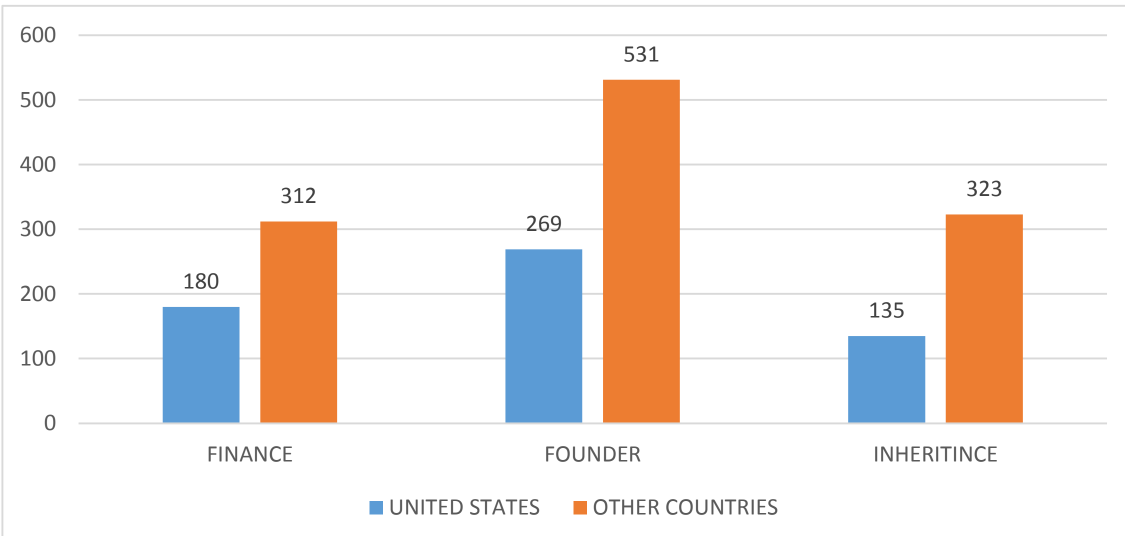
Table 2 indicates that more than one-third of the people who have managed to enter Forbes list are directly operating in the financial sector around the globe. Among the sectoral differences of billionaires, it shows that the financial sector takes a 32 percent share of the pie of aggregated top wealth.

The categorical variable Founder represents the entrepreneurial effect in our study, showcasing the relationship between billionaires and their companies, regardless of their current position. More than half of the billionaires who have achieved the status of the world's richest individuals in the United States have accumulated their wealth through entrepreneurship. It is noteworthy that regardless of the sector they operate in, entrepreneurs contribute to more than half of the total aggregate top wealth.

Around 4 out of 10 billionaires acquired their wealth only through inheritance is in US. This finding highlights the impact of inheritance on shaping the inequality in the distribution of top wealth in the country. Furthermore, inheritance constitutes approximately one-third of the total wealth acquisition among billionaires globally.

Moreover, the three categorical variables Finance, Founder, and Inheritance in the United States are not significantly different from the percentages observed in the rest of the world but are slightly higher. Additionally, the United States accounts for one-third of the individuals (465) listed on the 2014 Forbes billionaires List (1534), representing a percentage of 30.31%. This means that one in every three billionaires worldwide is from the United States, according to the Forbes magazine 2014 billionaire list. We present Figure 4 for a graphical representation of the shares of the categorical variables for cross-comparison between the United States and the rest of the world.

Figure 4: Distribution of Categorical Variables in United States vs Other Countries .



Data: *Forbes (2014)*

So far, we have presented summary statistics and graphical analysis of age and wealth. We have also examined the distribution of categorical variables among billionaires in the United States and the rest of the world. To combine these findings, we present Table 3, which displays all the categorical variables we have utilized and their respective relationships with age and wealth.

Table 3: Billionaires' Characteristics in Terms of Age and Wealth

Study Variables	***Age***			***Wealth***		
	M	*SD*	*%*	*M*	*SD*	*%*
Gender						
0	62.51	14.17	10.56	4.07	5.53	10.56
1	63.30	13.03	89.94	3.97	5.96	89.94
Founder						
0	63.24	12.82	47.85	3.79	4.93	47.85
1	63.19	13.46	52.15	4.16	6.69	52.15
Finance						
0	62.82	13.19	67.93	4.19	6.46	67.93
1	64.10	13.04	32.07	3.54	4.53	32.07
Inherited						
0	62.45	13.04	70.14	3.77	6.01	70.14
1	65.00	13.26	29.86	4.49	5.68	29.86
USA						
0	62.12	12.95	69.69	3.61	4.95	69.69
1	65.73	13.27	30.31	4.83	7.64	30.31
Sample Size		1534			1534	

Data: Forbes (2014).

Notes: M and SD stand for mean and standard deviation. For Gender; 0 is female 1 Male. For Founder, Finance and Inherited, 1 means billionaire founder of the company, operates in the financial sector, and inherited her wealth, 0 otherwise. For USA 1 means billionaires'' country is the United States, 0 otherwise.

For the Gender variable, a value of 1 is assigned if the billionaire is male, and 0 is assigned otherwise. Similarly, a value of 1 represents if the billionaire is a Founder of a company, operates in the Financial sector, or acquired their wealth through inheritance (for variable

Inherited). Additionally, a value of 1 is assigned if the billionaire is a citizen of the United States, and 0 is assigned otherwise. By utilizing these variables, we present the statistical summary of billionaires, including all the categorical variables, and their individual relationships with age and wealth.

The summary table reveals that in 2014, nearly 90% of Forbes billionaires are male. However, female billionaires on the list have slightly higher average wealth compared to male billionaires. Entrepreneurs (founders) have a higher average wealth than non-entrepreneurs. Those in the financial sector have a relatively higher average age and slightly lower average wealth compared to individuals in other sectors. Individuals who acquire their wealth through inheritance have an average age that is nearly three years older than others, and they possess approximately 720 million dollars more in average wealth. The average age of billionaires in the United States is approximately four years higher than the average age of billionaires in the rest of the world. Additionally, billionaires in the United States have an average wealth that is 1 billion dollars higher on the Forbes list.

4.1.3. Discussion on Data

As previously mentioned, Forbes magazine, along with other publications that aim to determine the global distribution of wealth, utilizes a unique method for calculating billionaires' wealth. When examining the dataset published by Forbes annually, it becomes apparent that the magazine rounds the final fortune to the nearest 100 million. Consequently, it may appear as though there are multiple billionaires with exactly the same wealth in the dataset, although this is likely not the case in reality. This rounding practice can potentially result in less precise outcomes in analyses (Capehart, 2014). It is worth noting that this phenomenon is not exclusive to Forbes magazine; other publications, such as Bloomberg, also employ similar rounding techniques. Another notable aspect is that Forbes magazine does not include individuals who have accumulate wealth through corruption, monarchs, illegal means, or any other sources that do not align with legal acquisition, in their list of top level wealth distribution (Fruend & Oliver, 2016). It is important to note that while we acknowledge that all forms of wealth theoretically impact the shape and distribution of wealth, we do not possess this specific information in our dataset, and this is also the case with other publications.

Another concern that may arise is the reliability of the data provided by Forbes magazine compared to other alternatives, as different magazines often offer varying estimates. Since Forbes is a private institution, its data is not considered official. The information available is an outcome of several calculations and estimations, as mentioned earlier. However, it is important to note that Forbes is highly regarded and has extensive experience in this field. Consequently, the majority of scholars rely on these estimated results due to the magazine's expertise and reputation (Attar, 2020; Bagchi & Svejnar, 2015; Fruend & Oliver, 2016; Ogwang, 2013; Vermeulen, 2016).

4.2. METHODOLOGY

This section starts with a continuation of Chapter 3, where we explain the theoretical foundations of the model we use. Firstly, we demonstrate how our research question takes its final form based on the theoretical foundation. Then, focusing on the two questions we seek to answer in our thesis, we provide a detailed explanation of how we model our research questions.

The methodology we follow directly derives from equation (22) in the earlier chapter. We define in the theoretical framework section that the age and wealth relationship takes the form of an exponential relationship with a certain constant. To address our first research question that since age is a significant driver of relative wealth and its cross-section distribution, whether the marginal effect of age is heterogeneous across individuals,

First, we recall equation 22 in Chapter 3, (3.22) , the total stock of wealth of an individual (billionaire) at time t and age a :

$$w_t(a) = \theta \bar{w}_t e^{(r-\tau-\pi-\delta-\gamma)a} \tag{3.22}$$

Equation (3.22) proofs wealth accumulation process of an individual (billionaires) at age a time *t* is a form of the exponential function of age with some constant $\theta \bar{w}_t$.

Since we are interested in relative wealth for two reasons—to facilitate better comparisons across different wealth levels and because relative wealth is directly derived from the structural model—we divide both sides of equation (3.22) with respect to the average wealth stock of an individual

$$R^w = \theta e^{(r-\tau-\pi-\delta-\gamma)a} \tag{4.23}$$

Relative wealth, R^w, of an individual *i*, in the cross-section distribution of age and relative wealth, can be expressed in regression, in the following form:

$$R_i^w = \omega_o e^{\omega_1 a_i} + \varepsilon_i \tag{4.24}$$

Where R_i^w represents the relative wealth level of individual *i* as a dependent variable and a_i denotes for age of individual i as an independent variable in the regression. (ω_0 , ω_1) are regression coefficient where ω_0 and ω_1 stand for θ and $(r - \tau - \delta - \pi - \gamma)$, respectively, and, ε_i, is the error term of the nonlinear cross-section regression. Hence, equation (4.24) represents the final form of the structural model, which we compare later with the reduced form for the robustness of our analysis.

To address the second research question, the cross-section distribution of wealth may have a fat tail at large levels of (relative) wealth, we examine whether the distribution of relative wealth among Forbes billionaires in the year 2014 has a right Pareto tail, we refer back to equation 4 in Chapter 3 (3.4).

$$\Pr[Age > a] = e^{-\beta a} \tag{3.4}$$

Remember we define β as $\beta = \pi + \delta$, and since equation (3.22) shows how wealth is distributed among individuals in an exponential form of age, we can derive a and substitute in equation (3.4)

$$a = \ln\left(\frac{w}{(\theta\overline{w})}\right)\left(\frac{1}{r-\tau-\rho-\delta-\gamma}\right) \tag{4.25}$$

To substitute $a(w)$ in equation (3.4), we have

$$\Pr[Age > a] = e^{-\beta\ln\left(\frac{w}{\theta\overline{w}}\right)\left(\frac{1}{(r-\rho-\tau-\delta-\gamma}\right)} \tag{4.26}$$

Equation (4.26) allows us to obtain the Pareto inequality. Also we derive,

$$F(w) = F(R^w) = \Pr[Age > a] = \Pr[Wealth > w] = e^{-\beta\ln\left(\frac{w}{(\theta\overline{w})}\right)\left(\frac{1}{r-\tau-\rho-\delta-\gamma}\right)} \tag{4.27}$$

a counter-cumulative function as a form of wealth, $F(w)$, and relative wealth $F(R_w)$

$$F(w) = F(R^w) = \left(\frac{w}{(\theta\overline{w})}\right)^{-\beta\left(\frac{1}{r-\tau-\rho-\delta-\gamma}\right)} \tag{4.28}$$

Remember $\beta = \pi + \delta$, then the cross-sectional distribution of Pareto is

$$F(w) = F(R^w) = \left(\frac{w}{(\theta\overline{w})}\right)^{-\left(\frac{\pi+\delta}{r-\tau-\rho-\delta-\gamma}\right)} \tag{4.29}$$

As an important note here, notice the possible determinants of (relative) wealth inequality. For example, if arrival death rate (δ) decreases, the capital interest rate increases *(r)*, or the capital tax rate (τ) decreases, etc., (relative) Pareto inequality increases. But all this determinants is homogenous across individuals (billionaires), in the economy.[13]

Counter cumulative functions of $F(w)$ and $F(R^w)$ of Generalized Pareto Distribution (GDP) estimated by Maximum Likelihood method (ML) as a form of probability density function. Using the cross-sectional dataset of Forbes magazine, ML shows how well the observed distribution fits the Pareto distribution and the parameters that best explain this estimated distribution.

$$F(R^w) = F(w) = \left[1 + \frac{\xi\left(w - w^{min}\right)}{\sigma}\right]^{-\frac{1}{\xi}} \tag{4.30}$$

Counter cumulative function estimated via ML in the form of Generalized Pareto Distribution is given in equation (4.30). Parameters of our model:

- w is the individual current (relative) wealth
- w^{min} is threshold where w^{min} =1 billion US dolar
- σ scales the overall value of $\left(w - w^{min}\right)$
- ξ is the inverse shape parameter which determines the heaviness of the distribution's tail.

Where intuitively, the exponents of the counter cumulative functions in equation (4.29) and (4.30) should be equal, but more precisely, generalized Pareto distribution in Extreme Value

[13] Our contribution lies in the fact that while all exogenous parameters of Pareto inequality derived from the model have a homogeneous effect on individuals, except for age, we utilize micro data to introduce heterogeneity in the determinants of this inequality for each wealth level along with age

Theory, Pareto shape inequality index represented by the inverse of the $\frac{1}{\xi}$, we have denoted the inverse shape parameter as follows:

$$\xi = \frac{r - \tau - \rho - \delta - \gamma}{\pi + \delta} \tag{4.31}$$

Let α denotes for $\alpha = \xi^{-1}$ where $\xi > 0$.

We are interested in the α, tail characteristic , degree of α, as known from the extreme value theorem, is essentially the probability of observing extreme values in the distribution, with lower degrees of α indicating a higher frequency of observing extreme wealth values at the extremes of the tail of the distribution. Simply put, the lower degree of α, the higher heaviness or thickness of the tail. The Pareto distribution suggests that most of the wealth is held by a small proportion of the population (and vice versa), so a high degree of α, or low degree of ξ , is well consistent with the characteristics of the Pareto distribution.

Now that we have derived the common theoretical underpinnings on which our methodology is based for both of our research questions, we can now demonstrate our methodology for each of our research questions separately.

4.2.1. Determinants of Top Relative Wealth Distribution Part 1: Reduced-Form

We model the determinants of the top level relative wealth distribution, our primary focus, in two parts. In the first part, we model the reduced form through four different linear regression models. In the second part, we develop two separate regression models, one based directly on the structural model derived from theory equation (24), and the other utilizing micro-level data.

The simplest thing we can imagine without any theoretical background is that older billionaires would have larger wealth levels. Hence, if we define relative wealth R_i^w of billionaire i as his/her total wealth divided by the average, we would imagine a linear regression in the form of

$$R_i^w = \omega_0 + \omega_1 \mathrm{AGE}_i + \varepsilon_i$$

Where ε_i is a typical error term.

One variation of this setup would introduce another indepedent variable in regression, age-squared. Here, we try to capture some nonlinear effects:

$$R_i^w = \omega_0 + \omega_1 \mathrm{AGE}_i + \omega_2 (\mathrm{AGE}_i)^2 + \varepsilon_i$$

Also, one can add various billionaire-level covariates such as gender and the country of residence to the model, both to the linear and to the quadratic ones, to arrive at a more general model.

$$R_i^w = \omega_0 + \omega_1 \mathrm{AGE}_i + \omega_2 X_{2i} + \cdots + \omega_k X_{ki} + \varepsilon_i$$

Hence, we derive four linear regression models from reduced-form:

$$R_i^w = \beta_0 + \beta_1 AGE_i + \mu_i \tag{1}$$

$$R_i^w = \beta_0 + \beta_1 AGE_i^2 + \mu_i \tag{2}$$

$$R_i^w = \beta_0 + \beta_1 AGE_i + \beta_2 AGE_i^2 + \mu_i \tag{3}$$

$$R_i^w = \beta_0 + \beta_1 AGE_i^2 + \beta_2 GEN_i + \beta_3 FIN_i + \beta_4 FOUNDER_i + \beta_5 INHERITED_i + \mathrm{B}_6 USA_i + \mu_{\mathrm{i}} \qquad (4)$$

GEN is the variable representing the gender of the billionaire. *FIN* represents that the billionaire's industry is the financial sector, *FOUNDER* represents that the billionaire is the founder of the company that is mainly responsible for the billionaire's wealth and also entreprenuel effects, *INHERITED* represents that the billionaire acquired his/her wealth through inheritance, *USA* represents the nationality of the billionaire. All the explanatory variables are dummy variables in the regressions.

4.2.2 Determinants of Top Relative Wealth Distribution Part 2: Structural Models

The alternative way of understanding the variation in the relative wealth of billionaires is to derive the estimated equations from the structural theory. Recall that the cross-section of wealth distribution is pinned down by a set of fixed parameters and as a function of age. Specifically, we have

$$w_t(a) = \theta \bar{w}_t \exp[(r - \tau - \rho - \delta - \gamma)a]$$

$\boldsymbol{w_t(a)}$**:** the total wealth of a billionaire at age *a* and at time *t*

$\boldsymbol{\theta}$: the fraction of average wealth obtained by each new billionaire

$\bar{\boldsymbol{w}}_t$: average wealth among billionaires at *t*

r: rate of return on wealth

$\boldsymbol{\tau}$**:** tax rate on wealth income

$\boldsymbol{\rho}$**:** pure subjective discount rate

$\boldsymbol{\delta}$**:** death rate

$\boldsymbol{\gamma}$**:** growth rate of average wealth

Hence, we define the relative wealth of a billionaire

$$R_t^w(a) = \frac{w_t(a)}{\bar{w}_t} = \theta \exp[(r - \tau - \rho - \delta - \gamma)a]$$

For any *t*, this directly implies a cross-section distribution that we can write as a nonlinear regression equation

$$R_i^w = \omega_0 \exp(\omega_1 \mathrm{AGE}_i) + \varepsilon_i$$

where ε_i is a typical error term and the identification equations for parameters are

$$\theta = \omega_0$$

$$(r - \tau - \rho - \delta - \gamma) = \omega_1$$

But we can also imagine that ω_1 differs across billionaires because they reside in different countries, they invest in different assets, they face different mortality and tax rates, etc. The uniquely identified parameters, ω_0 and ω_1, derived from the long-run equilibrium of age and relative wealth, can be defined as heterogeneous for each relative wealth level.

$$R_i^w = \zeta_0 \exp[(\zeta_1 + \zeta_2 X_{2i} + \cdots + \zeta_k X_{ki})\text{AGE}_i] + \varepsilon_i$$

$$\omega_0 = \zeta_0 \text{ and } \omega_1 = \zeta_1 + \zeta_2 X_{2i} + \cdots + \zeta_k X_{ki}$$

Where the effect of age on relative wealth is now endogenous through covariates $(X_{2i}, \ldots, X_{ki})$. That is, even though we cannot separately identify ρ or r, we can estimate the meta parameter

$$(r - \tau - \rho - \delta - \gamma)_i$$

as a whole for billionaire i.

Hence, we conduct two nonlinear regression analyses. The first regression Model (5) represents the cross-sectional distribution of age and relative wealth. The second regression model Model (6) incorporates additional micro-information from Forbes billionaires to examine the overall effects of age on relative wealth levels and the marginal effect of age on relative wealth levels, taking into account the heterogeneity among billionaires

$$R_i^w = \psi_1 \exp(\psi_2 AGE_i) + \mu_i \tag{5}$$

$$R_i^w = \psi_1 \exp[(\psi_2 + \psi_3 GEN_i + \psi_4 FIN_i + \psi_5 FOUNDER_i + \psi_6 INHERITED_i + \psi_7 USA_i)\text{AGE}_i] + \mu_i \tag{6}$$

4.2.3. Pareto Distribution

First, we recall equation (30) which is a representation of Generalized Pareto Distribution by substituting wealth level with relative level for our research question.

$$F(R_i^w) = \left[1 + \frac{\xi\left(R_i^w - R_{i,min}^w\right)}{\sigma_r}\right]^{-\frac{1}{\xi_r}}$$

Let R_i^w *and* $R_{i,min}^w$ represent billionaires' relative wealth level and threshold, respectively ($R_{i,min}^w = .25087$). The generalized Pareto distribution is usually expressed in terms of two parameters: scale (σ_r) and shape parameter (ξ_r). The model is estimated by Maximum Likelihood Method (ML).

Shape parameter ξ_r helps us to observe the tail characteristics . More precisely, it measures the probability of seeing extreme wealth values in the relative wealth distribution of the cumulative density function above a certain threshold in our 2014 cross-sectional dataset.

Let $\alpha = \xi_r^{-1}$. In a right-skewed relative wealth distribution, higher ξ_r values indicate that the tail of the distribution decays more slowly, and therefore extreme relative wealth levels are more likely to occur along the tail. The larger the ξ_r value and lower α mean fat tail of the distribution.

Following that, conditions simply demonstrate our model (1) and model (2)

$$\forall R_i^w, R_i^w \sim GPD(\xi_r, \sigma) \text{ if } R_i^w \geq R_{i,min}^w, \sigma > 0, \xi_r > 0 \tag{1}$$

$$\forall R_i^w, R_i^w \sim GPD(\xi_r(X_i), \sigma) \text{ if } R_i^w \geq R_{i,min}, \sigma > 0, \xi_r(X_i) > 0 \tag{2}$$

Where $\xi_r(X_i) \equiv \omega_1 + \omega_2 X_{2i} + \cdots + \omega_k X_{ki}$.

CHAPTER 5

RESULTS

This section presents the results of the analysis that we have relatively deepened the relationship between age and wealth with characteristic microdata of the global top wealth distribution. Furthermore, it also shares the findings on whether relative wealth exhibits Pareto tail characteristics for the year of 2014 Forbes magazine dataset, as frequently discussed in the literature. Whether the tail parameter of the global top relative wealth distribution is significantly associated with individual level characteristics.

We analyze the results of the research questions in two separate subsections. The first section presents the results of the nonlinear regression model in which we decompose age effect to return of relative wealth by comparing it to the linear model. Nonlinear model enables us to capture the heterogeneous effect of age on relative wealth levels among billionaires. In the second part, we discuss the results of the second question of this study, which examines the significant association between individual-level characteristics and the tail parameter of the global top relative wealth distribution.

5.1. THE MARGINAL EFFECT OF AGE ON RELATIVE WEALTH AND DETERMINANTS OF THE TOP RELATIVE WEALTH DISTRIBUTION

We present both linear and nonlinear models to compare the regressions. Our results indicate that the selected nonlinear model has better explanatory power than the linear model, aligning with the theory of age and wealth distribution (Attar, 2020). Table 4 presents the estimation results for the cross-sectional data of the year 2014, encompassing four different linear regressions.

Table 4: Determinants of Relative Wealth: Linear OLS Estimates

	(1)	*(2)*	*(3)*	*(4)*
Cons	.29924 (.18189)	.62843*** (.09322)	1.29218* (.78157)	.30257** (.14463)
Age	.01109*** (.00301)		-.02133 (.02523)	
Age-squared		.00008*** (.00002)	.00025 (.00019)	.00007*** (.00002)
Gender				.09644 (.11809)
Finance				-.20468*** (.07311)
Founder				.32800*** (.07579)
Inherited				.41665*** (.08770)
United States				.27191*** (.09937)
Adj. R-squared	.0089	0.0097	.0095	.0262
F stat. p. value	0.0002	0.0002	0.0007	0.0000
RMSE	1.4793	1.478	1.478	1.466
log Likelihood	-2776.3291	-2775.7735	-2775.3601	-2760.3641
#Observations	1534	1534	1534	1534

Data: Forbes(2014)
Notes: Robust standard error for each coefficient are in the parenthesis. *p<0.1, **p<0.05, and ***p<0.01.

The four different linear regression results shown in the Table 4 above, regression analyses (1) and (2), prove that age-squared explains the variation in relative wealth better than age itself with a higher level of significance.

Model (3) represents the regression where age and squared age together explain the change in relative wealth. However, in this case, it causes a loss in the significance levels of the explanatory variables, both age and age-squared, compared to the model (1) and (2). In both cases, we see that the square of the age due to the structure of the relationship is more explanatory power than the age itself.

Based on the findings from models (1), (2), and (3), we proceed to build regression model (4) incorporating the age-squared variable. This decision is motivated by the anticipation that the inclusion of the squared age enhances the model's ability to explain variations in relative wealth within the linear framework.

Lastly, we enrich models (4) by incorporating new explanatory variables outlined in the data section. This enables us to introduce heterogeneity in the marginal effect of age on the relative wealth levels of billionaires by incorporating characteristic microdata. Model (4) exhibits relatively higher explanatory power compared to the first three models by utilizing heterogeneity. In the reduced form of Model (4), unlike gender, the square of age, the finance sector compared to other sectors, the founder variable incorporating the effect of entrepreneurship, inheritance as a form of wealth acquisition, and being a United States citizen compared to other countries, statistically have significant effects on differences in relative wealth distribution. However, even when considering the utilization of comprehensive microdata, the explanatory power of this effect remains relatively modest at (.0262).

The structural models, derived directly from the simple age and wealth theory, are presented in Table (5). Model (5) captures the exponential relationship between age and wealth within the cross-sectional distribution of relative wealth. Furthermore, model (6) estimates this relationship by leveraging microdata obtained from a dataset that encompasses detailed information on the characteristics of Forbes billionaires.

Table 5: Determinants of Relative Wealth: Nonlinear OLS Estimates

(5)		*(6)*	
$R_i^w = \psi_1 \exp(\psi_2 AGE_i) + \mu_i$		$R_i^w = \psi_1 \exp[(\psi_2 + \psi_3 GEN_i + \psi_4 FIN_i + \psi_5 FOU_i + \psi_6 INHER_i + \psi_7 USA_i) AGE_i] + \mu_i$	
Cons	.47891*** (.09284)	Cons	.63005*** (.12687)
Age	.01146*** (.00283)	Gender	.00090 (.00194)
		Finance	-.00230* (.00131)
		Founder	.00668*** (.00173)
		Inheritence	.00764*** (.00181)
		United States	.00335** (.00135)
Adj. R-squared	0.3181	Adj. R-squared	0.3269
RMSE	1.4789	RMSE	1.4693
log Likelihood	-2775.9434	log Likelihood	-2763.4901
#Observations	1534	#Observations	1534

Data: Forbes(2014)

Notes: Robust standard errors for each coefficient are in the parenthesis. *p<0.1, **p<0.05, and ***p<0.01.

The overall findings from our analysis show that the nonlinear model (6) outperforms the linear model (4), providing a higher level of explanatory power. This result aligns with the existing literature (Attar, 2020; Jones, 2015), confirming the superiority of the nonlinear model in addressing our research question.

The very brief version of the results indicates that billionaires' gender is not statistically, however; However, sectoral differences, entrepreneur status, bequest as a form of wealth acquisition, and billionaires' country have a significant effect on the marginal effect of age on relative wealth at different significance levels in both models employed.

Also, the detailed findings for our first research question are:

- The Gender, as a demographic variable, is not statistically significant, indicating that it does not have a significant impact on the marginal effect of age on relative wealth.

- The Finance variable shows a statistically significant coefficient of -0.0023, indicating a negative association with the marginal effect of age to return of relative wealth. This indicates billionaires who operating financial sector experience a decline in relative wealth as they age, compared to those outside the financial sector.

- The Founder variable which represents the effect of entrepreneurship, exhibits statistical significance with a coefficient of 0.0066. This implies that the change in age has a more pronounced impact on the relative wealth level of billionaires who have accumulated their wealth through entrepreneurial endeavors compared to those who have acquired it through other means.

- The coefficient of 0.0076 for the Inheritance variable is statistically significant, indicating a significant impact of inheritance on age effects to relative wealth level This means that the change in age has a positive influence on the change in relative wealth levels among billionaires who have inherited their relative wealth compared to those who have acquired relative wealth through other means.

- The coefficient of 0.0033 for the United States variable is statistically significant, indicating that being a citizen of the United States has a significant impact on the marginal effect of age on relative wealth. This suggests that compared to other countries, a one-unit change in billionaires' age in the United States increases the marginal return of relative wealth.

Relative wealth, which serves as the dependent variable in both reduced-form and structural models, is convenient for comparing wealth levels among billionaires. It is directly derived from the theoretical model that incorporates the relationship between age and wealth. Since relative wealth is derived from wealth itself, the overall results should be the same.

However, to provide further insights, we also present the results of nonlinear regressions in which wealth is used as an explanatory variable. These additional models are presented in Appendix A as Model (7) and Model (8).

5.2. PARETO DISTRIBUTION OF THE GLOBAL TOP RELATIVE WEALTH DISTRIBUTION

This section shares the findings of the second question of the research, whether the highest level of wealth distribution has a right Pareto tail. The parameters of the probability distribution for the 2014 cross-section data set of the generalized form of the Pareto distribution are calculated by estimating with the Maximum Likelihood method. Using this method, we calculate the probabilities of the statistical distribution of relative wealth in our dataset for the year 2014. We then assess the goodness of fit by estimating the parameters of the generalized Pareto distribution and evaluating how well the data align with this distribution. The Generalized Pareto Distribution has two properties[14].

The first is the scale parameter (σ), and the second is the shape or tail parameter (ξ). The first determines the scale and spread of the distribution, and the second determines the shape of the distribution and the tail behavior of the distribution. Our model's tail parameter (ξ) indicates the likelihood of observing extreme values above the chosen threshold in the data.

Table (6) presents the findings of the second research question, providing the results of the predicted models. Since relative wealth is just an another form wealth that derives from theory, as explained in the data section, we use the relative wealth level as an explanatory variable in both models we established. In the first model (1), we investigate whether the relative wealth distribution of billionaires in the year of 2014 all around the world has Pareto tail as frequently discussed in the literature (Attar, 2020; Brzezinski, 2014; Capehart, 2014; Clementi & Gallegati, 2005; Ogwang, 2013; Schmidt, 2017).

We consider this distribution in more detail in the second model (2). By incorporating characteristic micro-information, we are able to capture the nuanced factors that influence the tail parameters of the relative wealth distribution among billionaires. This enables us to gain a deeper understanding of the factors that contribute to the extreme wealth observed in the distribution's tail.

[14] There is also location parameter (μ). But majority of studies considers only shape and scale parameters.

Table 6: Generalized Pareto Distribution of Relative Wealth

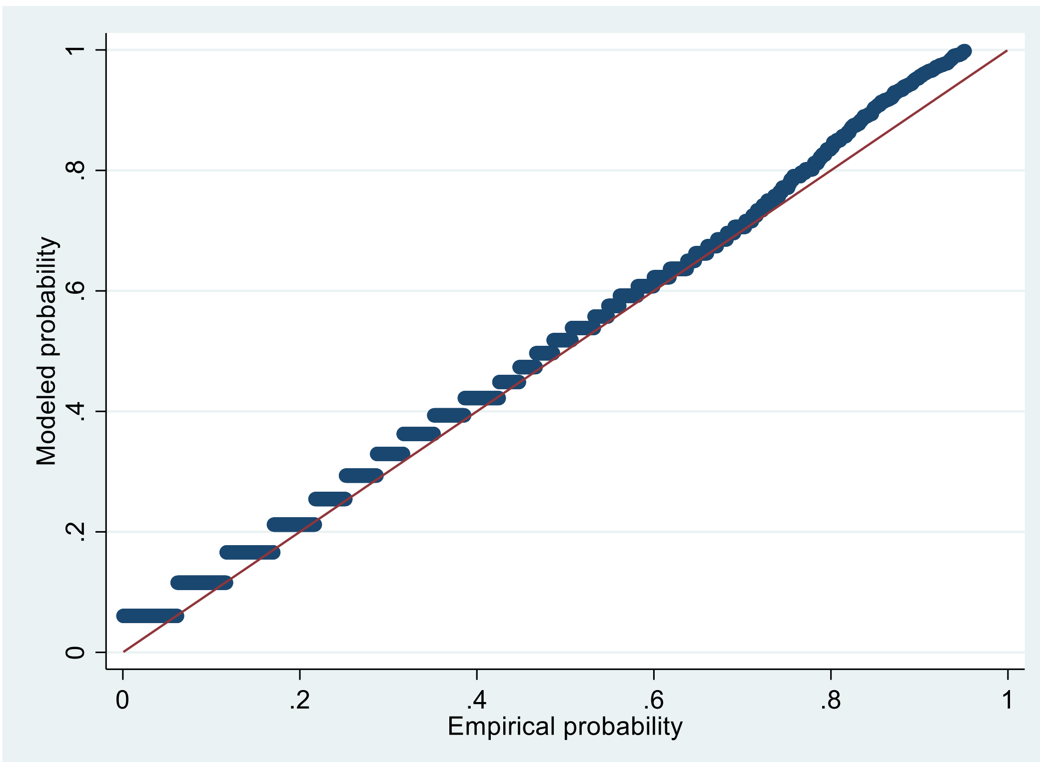
	(1) *Exogenous* (ξ_r)	*(2)* *Endogenous* $(\xi_r(X_i))$
$\ln(\sigma_r)$	-.92790*** (.04454)	-.92935*** (.04465)
ξ_r	.52022*** (.03852)	
Constant		.16108 (.13807)
GENDER		.12249 (.12248)
FINANCE		-.19757*** (.06420)
FOUNDER		.28124*** (.07470)
INHERITENCE		.32330*** (.09623)
UNITEDSTATES		.15827** (.07088)
Log Likelihood	-864.77902	-852.2705
R^w_{min} (threshold)	.25087	.25087
#Observations	1,460	1460

Data: Forbes (2014)
Notes: Models are estimated with Maximum Likelihood method. The robust standard errors for each coefficient are in the parenthesis. *p<0.1, **p<0.05, and ***p<0.01.

Table 6 displays the analysis results obtained using the cross-sectional data of the 2014 Forbes billionaires list. The fitness of the relative wealth distribution to the Generalized Pareto Distribution is tested using the Maximum Likelihood method, and the log-likelihoods for Model (1) and Model (2) are -864.77 and -852.27, respectively. Both models share a threshold wealth level of .25087. The estimation results exhibit distinctive features, with Model (2) showing particularly noteworthy characteristics.

The estimation results for Model (1) indicate that the relative wealth distribution in 2014 confirms the existence of the Pareto tail. Figure (5) showcases the goodness of fit between the modeled probability density function and the observed probability density function, indicating a strong level of agreement.

Figure 5: Fitness of Modeled and Observed Probability of Pareto Distribution



The tail parameter (ξ_r) and scale parameter ($ln(\sigma_r)$) are both statistically significant, with low standard errors. The empirical evidence derived from Model (1) provides compelling support for the assertion that the relative wealth distribution among the top global individuals in 2014 exhibits a Pareto distribution characterized by a fat tail. This finding implies a pronounced level of wealth inequality during the specified year.

In Model (1), the scale parameter, $ln(\sigma_r)$, has an estimated value of -0.92790, which is statistically significant. The negative value indicates a right-skewed distribution in the relative wealth data. Additionally, the tail parameter has a value of 0.52022 and is also statistically significant. This parameter represents the heaviness (or thickness) of the tail and signifies the probability of observing extreme wealth values along the tail of the distribution. The analysis results clearly demonstrate that the relative wealth distribution in 2014 exhibits a heavy tail, indicating a highly skewed and unequal distribution of (relative) wealth.

Similar to Model (1), the results from Model (2), estimated using microdata, reveal a heavy-tailed Pareto distribution in the cross-sectional dataset of 2014. The scale parameter ($ln\sigma_r$) is statistically significant and has a coefficient value of -0.92935, indicating a right-skewed distribution. Although the estimated scale parameter value in Model (2) is nearly the same as in Model (1), however, the tail or estimated shape parameter assumes different values. This discrepancy arises due to the inclusion of microdata in Model (2), which allows for an examination of the individual-level characteristics of the tail distribution observed in Model (1). By doing this, we introduce heterogeneity to the tail parameter of the distribution for each relative wealth levels.

Model (2) incorporates additional explanatory variables related to the predicted tail parameters of the generalized Pareto distribution. This model examines the impact of various factors on the tail of the distribution, including gender as a demographic variable, finance as sectoral information, founder variable indicating the effect of entrepreneurship, inherited variable reflecting the impact of inheritance, and the United States variable capturing the country information of billionaires.

By including these variables, we gain insights into how these factors influence the tail behavior of the generalized Pareto distribution.

The estimation results of model (2) in Table 5 indicate that:

- The Gender variable does not have a significant impact on the tail parameter as its coefficient is not statistically different from zero
- The Finance variable, incorporating sectoral information, has a significant impact on the tail parameter of the top relative wealth distribution with a coefficient of -0.19757. This suggests that individuals in the financial sector have a reduced likelihood of having extreme wealth levels in the tail distribution compared to individuals in other sectors. Simply put, being in the financial sector decreases the probability of observing extreme wealth levels in the tail of the distribution.
- The Founder variable, which represents the entrepreneurial effect, has a significant impact on the shape parameter and, consequently, the tail distribution. A positive coefficient of 0.28124 indicates that being an entrepreneur increases the probability of observing extreme wealth levels along the tail. This finding suggests a potential link between entrepreneurship and extreme wealth levels in the cross-sectional distribution of relative wealth.
- The inheritance effect is statistically significant and positive, with a coefficient of 0.32330, indicating an increased probability of observing more extreme wealth levels in the right-skewed tail distribution. The relatively large coefficient suggests that billionaires who inherit their wealth are more likely to be located at the edge of the tail distribution compared to other means of acquiring wealth. This finding highlights the contribution of inherited billionaires to a more skewed and unequal wealth distribution.
- The United States variable, representing the country effect of billionaires, is statistically significant with a positive coefficient of 0.15827. This indicates that United States citizens are more likely to be located at the extreme end of the tail distribution compared to individuals from other countries. However, the impact of the country effect is relatively smaller compared to other explanatory variables. Nonetheless, the country information of billionaires still contributes to the presence of wealth inequality in the global distribution of top relative wealth by increasing the probability of observing more extreme levels.

In Appendix B, we also share the results of the analysis conducted using wealth instead of relative wealth for interested readers.

Findings also indicate that the global top wealth distribution in 2014 reveals that the top 1 percent of wealth holders own roughly 10 percent of the total wealth, the top 10 percent own 30 percent of the total wealth, the top 20 percent share 43 percent, and the top 50 percent own approximately 70 percent of the total wealth in the economy. Overall findings indicate that there is unequal and skewed wealth distribution even among the world's richest people according to the Forbes magazine 2014 dataset.[15]

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[15] $\left(\frac{100}{p}\right)^{\xi-1}$ formulation is used to capture the wealth shares going to the top, where "p" represents the percentile of the top wealth holders and "ξ" is the shape parameter of the wealth distribution. This formulation is presented in both Table 6, which shows the relative wealth distribution's shape parameter, and Appendix B, which provides the wealth distribution's shape parameter.

CONCLUSION

In this study, we investigate the relationship between age and wealth using the 2014 cross-sectional data from Forbes magazine. By employing the Blanchard-Yaari Model, we analyze the determinants of top wealth distribution and identify several key factors that influence global wealth distribution. Additionally, we examine the theory suggesting that the cross-sectional distribution of wealth may exhibit a fat tail at higher levels of (relative) wealth, akin to the Pareto distribution. Moreover, we explore the impact of individual-level characteristics on the tail parameter of the (relative) wealth distribution.

Our analysis findings indicate that stuctural form of the age and relative wealth which based on theoretical model has significantly higher explanatory power compared to the linear form, which is in line with Attar's (2020) study. Change in age explains approximately one-third of the change in relative wealth. Additionally, our study introduces heterogeneity in the impact of marginal changes in age on the rate of return of relative wealth for each individual. Based on our analysis, we find that age has a negative impact on the rate of return of relative wealth for individuals in the financial sector compared to other sectors. However, factors such as being an entrepreneur compared to non-entrepreneurs, acquiring wealth through inheritance compared to other means, and being a United States citizen compared to citizens of other countries can positively influence the impact of marginal changes in age on the rate of return of relative wealth. Also, our findings indicate that gender does not significantly impact shaping global top (relative) wealth distribution.

Additionally, the cross-sectional global top relative wealth distribution in 2014 is characterized by a Pareto family distribution, which signifies a highly unequal wealth distribution. Moreover, individual characteristics demonstrate heterogeneous effects on the tail parameters of the distribution. Consistent with the initial finding of this study, gender has no significant effect on the estimated tail parameter. Based on our results, billionaires in the financial sector decrease the probability of extreme wealth levels appearing in the tail of the distribution, compared to other sectors. Entrepreneurial billionaires increase the likelihood of extreme wealth values in the Pareto tail, relative to non-entrepreneurs. Similarly, billionaires who inherit their wealth contribute to a higher probability of extreme wealth values in the tail, compared to those who acquire wealth through other means. Additionally, being a United States citizen enhances the likelihood of observing extreme wealth values in the Pareto tail, compared to citizens of other countries.

Our findings indicate that, unlike gender, sectoral differences, entrepreneurial status, the impact of inheritance, and country-level variations among billionaires have significant effects on both the determinants of relative wealth distribution and also the tail parameters of the Pareto distribution in 2014. Also, our findings indicate that the top 1 percent of wealth holders own roughly 10 percent of the total wealth, the top 10 percent own 30 percent of the total wealth, the top 20 percent share 43 percent, and the top 50 percent own approximately 70 percent of the total wealth which implies extremely unequal and skewed wealth distribution even among the wealthiest people in the world.

Future studies can gain further insights into the characteristics of global top wealth distribution by exploring the two-third portion that remains unexplained in this study by employing more comprehensive individual-level dataset of billionaires. Additionally, by including/estimating other individuals close to the threshold of $1 billion but not included in the Forbes billionaire list, more extensive research can be conducted to investigate the determinants of global top wealth distribution. Longitudinal studies can also be conducted to help in understand the dynamics of global top wealth distribution over time.

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APPENDIX 1: WEALTH ESTIMATIONS OF THE STRUCTURAL MODELS

Equations (5) and (6) are multiplied by the average wealth to derive the wealth. Let $\bar{w}\psi_0 = \Omega$.

Table 7: Determinants of Wealth: Nonlinear OLS Estimates

(7)		*(8)*	
$w_i = \Omega_1 \exp(\Omega_2 AGE_i) + \mu_i$		$w_i = \Omega_1 \exp[(\Omega_2 + \Omega_3 GEN_i + \Omega_4 FIN_i + \Omega_5 FOU_i + \Omega_6 INHER_i + \Omega_7 USA_i) AGE_i] + \mu_i$	
Cons	1.90898*** (.35208)	Cons	2.511452 (.50573)
Age	.01146*** (.00287)	Gender	.00090 (.00194)
		Finance	-.00230* (.00131)
		Founder	.00668*** (.00173)
		Inheritance	.00764*** (.00181)
		United States	.00335** (.00135)
Adj. R-squared	0.3181	Adj. R-squared	0.3269
RMSE	5.89513	RMSE	5.85703
log Likelihood	-4897.163	log Likelihood	-4884.709
#Observations	1534	#Observations	1534

Data: Forbes (2014)

Notes: The robust standard errors for each coefficient are in the parenthesis. *p<0.1, **p<0.05, and ***p<0.01

APPENDIX 2: PARETO DISTRIBUTION OF WEALTH AND THE IMPACT OF INDIVIDUAL-LEVEL HETEROGENEITIES ON TAIL PARAMETERS

Table 8: Generalized Pareto Distributions of Wealth

	Exogenous (ξ)	***Endogenous*** $(\xi(X_i))$
$\ln(\sigma)$	.45489*** (.04454)	.45344*** (.04465)
ξ	.52022*** (.03852)	
Constant		.16108 (.13807)
D_GENDER		.12249 (.12248)
D_FINANCE		-.19757*** (.06420)
D_FOUNDER		.28124*** (.07470)
D_INHERITED		.32330*** (.09623)
D_UNITEDSTATES		.15827** (.07088)
Log Likelihood	-2883.6713	-2871.1628
W_{min} (threshold)	1 billion USD ($)	1 billion USD ($)
#Observations	1,460	1460

Data: Forbes (2014)

Notes: Models are estimated with the Maximum Likelihood method. The robust standard errors for each coefficient are in the parenthesis. *p<0.1, **p<0.05, and ***p<0.01

APPENDIX 3: ETHICS COMISSION FORM

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ETHICS COMMISSION FORM FOR THESIS

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ECONOMICS DEPARTMENT

Date: 19/06/2023

Thesis Title: **CHARACTERISTICS OF GLOBAL TOP WEALTH DISTRIBUTION**

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. **19.06.2023**

Date and Signature

Name Surname:	Umut KARATAŞ
Student No:	N20227680
Department:	Economics
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ADVISER COMMENTS AND APPROVAL

Assc. Prof. Dr. Mustafa Aykut ATTAR

APPENDIX 4: ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
MASTER'S THESIS ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ECONOMICS DEPARTMENT

Date: 19/06/2023

Thesis Title : **CHARACTERISTICS OF GLOBAL TOP WEALTH DISTRIBUTION**

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I respectfully submit this for approval. 19.06.2023

Date and Signature

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ADVISOR APPROVAL

APPROVED.

Assc. Prof. Dr. Mustafa Aykut ATTAR