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The Drivers Behind Increasing Wealth-to-Income Ratios in Selected OECD Countries

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Abstract

Wealth-to-income ratios in developed countries have been increasing in the past decades and are now reaching levels comparable to those before the two World Wars. Earlier literature has shown that high levels of the wealth-to-income ratio go together with high degrees of wealth inequality, financial instability and asset price bubbles. We use a bias-corrected least squared dummy variable (LSDVC) estimator to quantitatively examine the main drivers behind these increasing wealth-to-income ratios. Our contributions are fourfold: (i) we quantitatively test earlier predictions by Piketty, and find that the impact of saving behavior on the wealth-to-income ratio is smaller than he predicts; (ii) our results suggest that wealth-to-income ratios are mainly driven by a single component of capital: housing; (iii) we control for earlier critique on Piketty's saving assumption; and (iv) we use a different, more complete, definition of returns on capital than earlier similar literature by not only considering capital gains but also yields.

In periods of low economic growth, such as the last decades, wealth-to-income ratios will continue to rise to even higher levels. Our results suggest that besides wealth and inheritance taxation, governments should also consider mitigating the continuously increasing house prices when aiming at stabilizing wealth-to-income ratios.

Keywords: Wealth-to-income ratio, wealth inequality, panel data, return on capital, saving rate, housing.

JEL Codes: C33, D31, E21, E22, O18.

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1. Introduction

Wealth inequality has received increasing attention in both the academic literature and the popular media since Piketty's *Capital in the Twenty-First Century* (Piketty, 2014). In this seminal work, Piketty argues that wealth-to-income ratios have increased in the post-war period due to the rate of return on capital (*r*) being larger than the growth rate of the economy (*g*). In the last decades, wealth-to-income ratios in developed countries have increased to levels comparable with the high levels just before World War I. High wealth-to-income ratios in themselves are not necessarily a problem, but since wealth is always highly concentrated in the richest percentiles, increasing wealth-to-income ratios imply that the inequality of wealth will also increase. Moreover, the wealth-to-income ratio indicates the overall importance of wealth and the capital intensity of production in a society (Piketty and Saez, 2014). When comparing the concentration of wealth with the concentration of income, it becomes clear that wealth is much more concentrated in the richest percentiles. To illustrate, the richest 10% in the United States owns about 71% of all the wealth in the country, while they 'only' earn 45% of total market income (WID, 2021). In most developed European countries, this gap between the concentration of wealth and income is lower than in the United States but still between 20 to 25 percentage points. The high wealth-to-income ratios that we observed in the early 20th century appear to come back in the 21st century, which could raise the demand for higher capital and inheritance taxation.

In absence of internationally comparable data on the distribution of wealth, Piketty and Zucman (2014) look at wealth-to-income ratios in a set of developed countries and find that it is increasing in all countries. They argue that this ratio is of high importance as high steady-state wealth-to-income ratios go together with large financial instability, asset price bubbles and high degrees of wealth inequality. Piketty (2014) predicts that in developed countries the return on capital will continue to be larger than the level of economic growth ($r > g$), and that in absence of 'wealth-consuming events' such as the two World Wars, the relative importance and the inequality of wealth will continue to increase in the coming decades. Piketty and Zucman (2014) find that the increase of wealth-to-income ratios between the period 1700-2010 is for 60% due to increased savings (volume effect) and for 40% due to increased capital gains (relative price effect). They base this finding on their descriptive analysis on the patterns in wealth accumulation data in these three centuries. Their work is a documentation of historical data and mainly focuses on the richest share of society. However, a sound quantitative analysis on the main drivers of the increased wealth-to-income ratios is missing in their study. Moreover, Piketty pays little attention to the income out of rents, and instead entirely defines income out of capital as 'capital gains' by focussing on increases in the value of assets. In light of Piketty's predictions regarding the increasing level of wealth-to-income ratios, and consequent increasing wealth inequality, a quantitative analysis of what exact forces are driving the development of wealth-to-income ratios could give valuable insights. If the relative importance of wealth will indeed continue to increase in the 21st century, then it would be relevant for policymakers to understand whether this is mainly driven by increases in incomes, housing prices, stock prices or by different saving behaviour.

Building on a quantitative analysis, this thesis aims to find the main drivers of rising wealth-to-income ratios in developed countries. More specifically, the thesis focuses on the following research question: *What have been the main drivers of the rising wealth-to-income ratios in the years 1973-2015 in OECD countries?* By means of a series of fixed-effects regressions on panel data of 13 OECD countries, the thesis will give more insights in the impact that savings and the return on capital have had on wealth-to-income ratios in these countries over the last decades. We use the bias-corrected least squared dummy variable (LSDVC) estimator as proposed by Bruno (2005a, 2005b) on our dynamic baseline model with the wealth-to-income ratio as dependent variable. By including country- as well as time-fixed effects, we control for omitted variables that could determine time-independent differences between countries or generally impact wealth-to-income ratios over time. Controlling for these fixed effects is necessary since the level of wealth-to-income ratios can differ a lot between countries, mainly because savings and the return on capital can be affected by many different forces. We therefore carefully define these two concepts in order to substantiate the variables that should be included in the right-hand side of the regressions. The estimation results will therefore give more accurate insights on the impact that savings and the return on capital have on the wealth-to-income ratio in our sample. We also perform several robustness checks to strengthen our initial estimation results. However, we are not able to distinguish between differences in the importance of certain drivers between countries, as our results are estimations on the average relationship between the drivers and the wealth-to-income ratio over the entire panel.

The estimation results show that especially the return on housing has had a large significant impact on the wealth-to-income ratio in the period 1973 to 2015. The return on housing has been positive trough almost this entire period, except for the year 2009 when the global financial crisis struck the economy. Our results indicate that a 1% increase in the nominal return on housing leads to a 1.028% increase in the wealth-income-ratio. The return on another investable asset, equity, has a much lower impact on the wealth-to-income ratio in our sample, although a statistically significant one in several regressions. The return on safe assets however, in our model proxied by the nominal return on government bonds, does not have any significant relationship with the wealth-to-income ratio in our panel. Furthermore, we do not find a significant relationship between the saving rate and the wealth-to-income ratio, which suggests that changes in saving behaviour did not contribute to the increasing wealth-to-income ratios in the period 1973 to 2015. This finding contradicts the findings of Piketty and Zucman (2014), who argue that savings are responsible for 60% of the increase wealth-to-income ratios. This could possibly be explained by the relatively low interest rates on personal savings that we have seen in the last decades, since these low rates might give incentives to households not to save while it also simply generates lower returns. Next to our main results, we also find suggestive evidence that income inequality has a negative relationship with the wealth-to-income ratio. This could possibly be explained by a more equal distribution of income being mainly driven by smaller differences between low- and middle-incomes, which could restrict middle-income households in their ability to save. Moreover, since income is the denominator in the dependent variable, a negative coefficient could occur due to the possibility that a higher income inequality also represents higher aggregate income. Last, we find that economic growth indeed has a large negative impact on the wealth-to-income ratio in the period 1973-2015, which is in line with Piketty and Zucman's argumentation. This is likely a denominator effect, because incomes grow on a relatively similar scale as the economy.

This thesis contributes to existing research in several ways. First, it quantitatively tests the descriptive pioneering work by Piketty and Zucman (2014), who argue that savings (60%) and capital gains (40%) are responsible for the large recent growth in wealth-to-income ratios.

As mentioned, we find that in OECD countries the effect of savings has been far less in the period 1973-2015. Second, we find that the wealth-to-income ratio in the past decades has mainly been driven by a single component of capital: housing. Third, we control for the critique by Krusell and Smith (2015) on Piketty's growth formula as a robustness check of our estimations. In short, this means that we conduct regressions with savings defined as net-of-depreciation as well as gross-of-depreciation. We find that both models produce relatively similar estimates for the other variables. Fourth, our thesis uses a different, more complete, definition for the return on capital than similar literature. Where Piketty and Zucman only look at the relative price effect of capital (capital gains), we also incorporate: (i) the income out of rents in our indicator for the return on housing; (ii) the income out of dividend for the return on equity; and (iii) the income out of coupons for the return on government bonds. This is also where we extend the study of Fuller, Johnston and Regan (2020), who merely look at the impact of the return on housing on the wealth-to-income ratio. Where Fuller et al. use the inflation of house prices as a proxy for the return on housing, and thereby only measure the impact of capital gains, we use data on the nominal return on housing that includes capital gains and income out of rents. We here build on data collected by Jordà, Knoll, Kuvshinov, Schularick, and Taylor (2019) that allows us to also include the nominal return rates on other forms of investable capital, such as equity and government bonds. Furthermore, we extend the length of the time-series analysis of Fuller et al. (2020) by nine years and provide more recent results on the impact of housing on the wealth-to-income ratio.

The thesis is further structured as follows. Chapter 2 gives an extensive literature review where we discuss the relevant concepts, as well as empirical papers that study drivers of wealth accumulation and the growing importance of capital in the wealth inequality debate. Chapter 3 describes our panel of countries and the data that we include in our analyses. In Chapter 4, we discuss our main variables of interest with the help of descriptive graphs. Chapter 5 discusses our empirical methodology, the estimation results and various robustness analyses. In Chapter 6, the policy implications of our results will be discussed, and Chapter 7 concludes the thesis.

2. Literature Review

This section gives an overview of relevant literature and concepts when examining wealth inequality and wealth-to-income ratios. In Section 2.1, we discuss the consequences of high wealth inequality and the difficulties around collecting data on wealth and its distribution. The paper of Piketty and Zucman (2014) forms the foundation for this thesis, since their descriptive findings will be tested later. The relevant methods, assumptions and results of their paper are discussed in Section 2.2, where we also look at the critique on their work by Krusell and Smith (2015) and Rognlie (2014). This is followed by Section 2.3, which gives an overview of literature that examines the relationship between wealth inequality and capital. In Section 2.4, the paper by Jordà et al. (2019) that estimates the rate of return on capital will be discussed to give more insights in the development of $r > g$ over the last decades.

2.1 Wealth Inequality

Besides moral arguments against financial inequality, inequality of income and wealth also results in high social costs, especially at high levels of inequality. Households and individuals are influenced in their educational and occupational choices by their financial status relative to that of others. A certain amount of inequality could provide incentives to stimulate productivity or entrepreneurship, but if the inequality of outcomes is highly based on economic profit, then these 'positive' incentives are not generated. With high financial inequality, individuals would have the incentive to divert their choices towards ensuring that they are being favoured and protected, which would lead to resource misallocation, nepotism, corruption and individuals would lose their confidence in institutions (Stiglitz, 2012). Moreover, recent studies find that high inequality increases the likelihood and the severeness of financial crises, and therefore harms economic growth. For example, Rajan (2010) shows that a period with increasing wealth inequality in developed economies is positively correlated with the size of financial leverage, the overextension of credit and the relaxation of restrictions on mortgages, which all increases the likelihood of financial crises. In addition, Acemoglu (2011) finds that periods of high inequality allow lobbyists to gain bargaining power when pushing for financial deregulation, thereby weakening the monitoring of the banking system.

As mentioned in the introduction, the concentration of wealth is much higher than the concentration of income. By combining different data sources such as national accounts, survey data and fiscal data, the World Inequality Database (2021) is able to produce estimates of the distribution of wealth in the United States. In Figure 1, the development of the share out of total wealth that the richest 1% of individuals owns is shown. This has increased from 21.47% in 1978 to 36,01% in 2015.

Figure 1. Net Share of Richest 1% in Wealth Distribution in the United States (1973-2015) (Data source: WID, 2021)

Contrary to the relative complete wealth distribution data in the United States, availability of data on wealth and its distribution in almost all other countries is very limited, mainly because wealth data among the richest share of households is rare. These households hold a significant share of total wealth, but the size of this group is often too small to be sampled, making it difficult to work with survey data. Moreover, underreporting of wealth is likely more present when households become wealthier, making survey data even more problematic (Meyer, Mok & Sullivan, 2015). Furthermore, the data on wealth of national accounts used to be mostly about the flows and not the stocks of capital and savings, making it difficult to address questions regarding wealth-to-income ratios and capital-output ratios. In earlier literature on a macro-level, research to wealth (inequality) typically involved using cumulations of past flows of investment and savings to estimate the level of capital stocks. This changed when Piketty and Zucman (2014) created a historical database for several countries with more accurate measures of wealth accumulation. Even though internationally comparable data on the distribution of wealth is still limited, an indicator such as the wealth-to-income ratio could give much more insights in the development and drivers of wealth (inequality) over time.

2.2 Wealth-to-Income Ratio

In the past two decades, the statistical institutions of most developed countries started to publish national stock accounts. Piketty and Zucman (2014) were able to develop a wealth accumulation database (World Inequality Database) with the reported market values in these accounts of both financial and non-financial assets and liabilities that were held by the government, corporations and households. Based on this database, Piketty and Zucman estimate wealth-to-income ratios during the period 1970-2010 in the eight most developed countries: Australia, Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. This resulted in the new insight that wealth-to-income ratios in these countries increased from approximately 200-300% in 1970 to 400-600% in 2010. For the countries that have data going back to 1700 (Germany, France, the UK and the US), the recent high levels seem to be a return to the levels reached before World War I. Piketty and Zucman describe a gradually increasing wealth-to-income ratio in these countries, which could only be discontinued by dramatic events as the two World Wars, resulting in a U-shaped pattern. In absence of another war, they predict that the wealth-to-income ratios will only increase further in the 21st century.

Since wealth is always very concentrated in the highest percentiles, Piketty and Zucman argue that an increase in the total stock of wealth also suggests an increase in the inequality of wealth. As internationally comparable data on the distribution of wealth within countries is very limited, the level of the wealth-to-income ratio could serve as a reference point for increasing wealth inequality. Furthermore, Piketty and Saez (2014) emphasize the importance of the level of wealth-to-income ratios, as high levels go together with large financial instability and asset price bubbles.

2.2.1 Growth Rate of Wealth-to-Income Ratio

According to Piketty (2014), who's book is highly based on the findings in Piketty and Zucman (2014), the accumulation of wealth is largely determined by the *volume effect* of savings and to a smaller extent by the *relative price effect* of capital gains. The volume effect depends mainly on the level of national savings, since higher savings imply a larger accumulation of assets, but also on the level of productivity growth. If productivity or population growth is low then the growth of national income will be lower, which implies a larger wealth-to-income ratio due to a denominator effect. The relative price effect is dependent on the development of asset prices, such as housing and equity, relative to the evolution of consumer prices (inflation). Piketty and Zucman (2014) argue that the U-shaped evolution of wealth-to-income ratios can be explained by two factors: (i) a long-run swing in the relative prices of assets; and (ii) a slowdown in the productivity and population growth rate. The first (i) can be explained by capital-reducing policies, implemented just before World War I due to overheated capital markets. These policies were still in place after both wars when assets prices were at extremely low levels and reduced them even further. From the 1980s these policies were gradually lifted, thereby helping asset prices to recover and consequently also wealth-to-income ratios. The second (ii) can be best explained by the Harrod-Domar-Solow formula ($\beta = \frac{s}{g}$), which is the growth rate of the wealth-to-income ratio. This growth formula states that the wealth-to-income ratio (β) in the long run is equal to the saving rate (s) divided by the growth rate of income (g). This formula forms the basis for Piketty and Zucman's argument that the increasing wealth-to-income ratios are for 60% due to increased savings and for 40% due to capital gains.

The foundation of Piketty and Zucman (2014) are Piketty's two 'laws of capitalism'. The first 'law' is the definition of capital's share of national income, $\alpha = r * \frac{k}{y}$, where r is the return on capital, k the measure of capital stock and y the measure of national income. The second 'law' is that the earlier mentioned Harrod-Domar-Solow formula, $\beta = \frac{s}{g}$, has to equal the ratio of capital-to-income, $\frac{k}{y}$, in the long run when assuming that the saving rate is positive and constant over time. When putting these two laws together one can derive the central relationship in Piketty's book (2014) for capital's share of income: $\alpha = r * \frac{s}{g}$. This relationship is the reason for Piketty's prediction that wealth inequality will increase when r will continue to be larger than g. Especially when economic growth (g) is low, which has been the case in the last decades according to Piketty, capital's share of income could increase largely. Much depends on whether the elasticity of substitution between capital and labor, σ, is smaller or larger than one. If $\sigma > 1$, then the decrease in the return on capital (r) should be smaller than the increase in the wealth-to-income ratio (β). This implies that capital's share of income ($\alpha = r * \beta$) is an increasing function of β. If $\sigma < 1$, then the decrease in the return on capital (r) is larger than the increase of β, which then implies that capital's share of income ($\alpha = r * \beta$) is a decreasing function of β. Piketty and Zucman (2014) predict that the elasticity of substitution between labor and capital is likely to be larger than one in the next decades, which means that wealth-to-income ratios will continue to increase.

2.2.2 Critique

Krusell and Smith (2015) argue that Piketty and Zucman's findings and predictions do not rest sufficiently on historical data, but instead mainly on economic theory. According to Krusell and Smith, the problem is that this theory is highly debatable, in particular Piketty's 'second fundamental law of capitalism': $\frac{s}{g} = \frac{k}{y}$. Where Piketty refers to $\frac{s}{g} = \frac{k}{y}$ as a 'pure accounting equation', Krusell and Smith argue that it is merely a theory, since it makes assumptions about the saving behavior of individuals which are not as commonly recognized by economists as Piketty implies. Krusell and Smith show that this formula implies a saving rate of 100% of GDP per year at times where the growth rate approaches zero. Even though this equation is mathematically correct, it is inconsistent with standard textbook models that are usually recognized by macroeconomists.

The growth rate of the wealth-to-income ratio of Piketty is written as $\beta = \frac{\tilde{s}}{g}$, where $\tilde{s}$ is the saving rate net-of-depreciation, while textbook models would compose it as $\beta = \frac{s}{g+\delta}$, where s is the gross saving rate and δ is the depreciation rate of fixed capital stock. With the second formula, the wealth-to-income ratio would only increase marginally when growth approaches zero, since the denominator will then be equal to δ and will not approach zero. However, the reason why Piketty's formula is not inconsistent is because Piketty defines his variables as 'net-of-depreciation'. Krusell and Smith (2015) argue that leaving out the depreciation rate of fixed capital in all of Piketty's equations is crucial for the interpretation of his second 'law' when the economic growth rate approaches zero. At $g = 0$, the saving rate net-of-depreciation should be equal to zero regardless of what the gross rate is (as long as it is <100%). Likewise, if the saving rate net-of-depreciation is positive when g approaches zero, which is what Piketty assumes, then the gross saving rate must be 100%. So, when $g = 0$, the saving rate net-of-depreciation is zero or the gross saving rate is equal to 100%. Krusell and Smith maintain that according to saving theories, the former is plausible but the latter not at all. They look at data from the United States in the period 1950-2009 and find that Piketty's second law is inconsistent and does not fit the data, whereas optimal-saving models by Cass (1965) and Koopmans (1965) that are often applied in a microeconomics context and the Solow-growth model are consistent and do fit the data. As mentioned before, not including the depreciation rate in the growth formula is the crucial reason for the inconsistency in Piketty's model.

The absence of the depreciation rate in Piketty's model also leads to other criticism on his predictions. Rognlie (2014) argues that the elasticity of substitution between capital and labor is not likely to be higher than one and that the presumed gap between the return on capital (r) and economic growth (g) is lower than what Piketty predicts. Rognlie uses different estimates of capital returns and finds that they are diminishing, and that a decrease in the net income out of capital is more likely than an increase. By following Piketty's saving model, a decrease in economic growth (g) results in an increase in the long-term stock of capital, which should result in a decrease in both the capital's share of income ($\alpha = r * \beta$) as well as the size of ($r - g$).

Piketty does not recognize this implication, simply again because he defines his variables as net-of-depreciation and does not include the rate of depreciation in his models. Where Piketty looks at the net elasticity of substitution between capital and labor, Rognlie argues that the vast majority of relevant literature uses elasticity concepts that are gross-of-depreciation. Piketty does not recognize the importance of a careful distinction between these two concepts. Net elasticities are mechanically much lower than gross elasticities, and Rognlie claims that almost all estimates of net elasticities in relevant literature are much lower than the estimates by Piketty.

Rognlie (2014) empirically estimates the same models as Piketty, with the important difference that he does include the depreciation rate in his models and that he uses standard estimates of the elasticity of substitution between capital and labor that are consistent with relevant literature. He finds that Piketty overestimates the size of $(r - g)$ in the last decades, and that this gap between the return on capital and the economic growth rate is likely to decrease in the next decades. Moreover, he finds that a single component of capital, housing, is driving the increase in the wealth-to-income ratio almost completely in the long-term.

2.3 Wealth Inequality and Return on Capital

Several researchers have studied drivers of wealth accumulation and examine if these drivers also increase the inequality of wealth. A large part of this focusses on the role that capital plays and what its relation to the distribution of wealth is.

Benhabib and Bisin (2018) examine several wealth accumulation models that are used in relevant literature that feature stochastic returns to capital. They look at the impact of a larger gap between the rate of return on capital and the economic growth rate on the distribution of wealth. Their results suggest that a higher gap between r and g is positively related to the steady-state Pareto index of wealth distribution and that it increases inequality. They find that a higher return on capital, results in a fatter tail to the right in the wealth distribution.

Studies on a micro-level have also shown that there is heterogeneity in the returns on capital across different percentiles of the wealth distribution. Kuhn, Schularick and Steins (2017) study the distribution of wealth in the United States during the period 1949-2013. They use a micro-level dataset that is compiled with the Survey of Consumer Finances (SCF). Their results suggest that especially the middle-class households (between the 25^{th} and 75^{th} percentile) are relatively worse off as the distribution of wealth becomes more skewed at the top. This can be largely explained by the differences in the composition and size of household portfolios across the distribution. The large returns on housing compensated the loss of the middle-class somehow, but almost all these gains disappeared after the financial crisis of 2008-09. Kuhn et al. emphasize that returns on capital differ much across the wealth distribution and depend mainly on the ability of leveraging. Bach, Calvet and Sodini (2016) achieve similar results in their quantitative analysis of Swedish household wealth. The find that households that are wealthier are able to get higher returns on their portfolios. The results by Fagereng, Guiso, Malacrino and Pistaferri (2020) also confirm the heterogeneity in the returns of capital across the wealth distribution. They study Norwegian tax data that is relatively accurate in measuring wealth accumulation since Norwegians always report both income out of capital and out of wealth holdings. Their results indeed suggest that there is a positive relation between wealth and the rate of return on capital.

These studies show that wealthier households seem to be able to get higher returns on their assets than poorer households, which would explain the recent increase in wealth inequality. The increased importance of the income on wealth or capital is also emphasized by Karabarbounis and Neiman (2014). They use a macro-panel that includes 59 countries with data from 1975 to 2012 to estimate changes in the labor and capital share of GDP. They find that in the majority of these countries (42) the labor share of GDP has large declined in the time period of their sample. Consequently, the capital share of GDP has increased in these countries. Karabarbounis and Neiman argue that this can be explained by the decline in the relative price of investments goods, driven by technology. Efficiency gains in production out of capital increases the relative importance of capital.

On a macro-level, it is however still very difficult to obtain accurate wealth distribution data. Therefore, Fuller et al. (2020) use the wealth-to-income ratio as a proxy for measuring wealth inequality. We discuss the conditions proposed by Fuller et al. in more detail in Section 4.1. They use an error correction model to estimate the impact of certain indicators on the wealth-to-income ratio in the period 1970-2003 in a set of OECD countries. One of the assumptions of error correction models is that the dependent and (a set of) independent variables are co-integrated, which is not the case in the model by Fuller et al. (2020). They recognize this but argue that the estimates are still able to give valuable insights in the relationship between their independent variables and the wealth-to-income ratio.

Their estimations results suggest that in particular the return on housing has driven the wealth-to-income ratio. Other financial assets, measured by the inflation in share prices and the long-term interest rate on government bonds, also positively affect the wealth-to-income ratio but to a lesser amount. Their estimations do not suggest any statistically significant impact of the saving rate on the wealth-to-income ratio, which contradicts the descriptive analysis by Piketty and Zucman (2014).

2.4 Has r Been Larger than g?

Most of the studies that we discussed emphasize the increase of the importance of capital and that wealth seems to be positively correlated with capital. Piketty and Zucman (2014) show that if the rate of return is higher than the level of economic growth in an economy, then the stock of wealth will continue to increase in size and consequently wealth inequality will rise. Piketty and Zucman claim that the rate of return on capital has been much larger than the rate of real economic growth in the last decades in developed economies, whereas Rognlie (2014) finds that Piketty overestimates the size of this gap and argues that the size of the gap is likely to decrease even more. According to Piketty and Zucman (2014), this gap is the reason that the steady-state level of wealth inequality is being magnified. Jordà et al. (2019) aim to shine light on the size of $r - g$ by empirically estimating the rate of return on capital as accurately as possible over the last 150 years. Their estimates in the period 1973-2015 will be used as a measure of the return of capital in our empirical model later in this thesis, in order to quantitatively examine what components of capital have been driving wealth-to-income ratios. The methods that Jordà et al. use for their estimations will be further discussed in Section 4.3.

Jordà et al. (2019) construct an indicator for the real return on capital by weighting averages of the return on housing, equity and government bonds, which 'reflects the typical household-portfolio'. They compare this to the growth rate of the real GDP for 16 developed countries and find that for almost all countries, the return on capital has indeed been much larger than the rate of economic growth. Their method differs from Piketty (2014) in that they use market values of annual returns for individual assets, whereas Piketty uses aggregate balance sheet data. Jordà et al. (2019) find that the rate of return on capital has been much larger than the GDP growth rate in 13 out of the last 15 decades, while it has only been lower during both World Wars. On average, the annual gap between the rate of return on capital has been three percentage points higher than the real GDP growth rate since 1870. These results contradict the findings by Rognlie (2014) but seem to be in line with Piketty and Zucman (2014), who argue that only wealth-consuming events such as the two World Wars can stop the increase in capital accumulation. In absence of another World War, the results by Jordà et al. (2019) indeed suggest that r will continue to be larger than g. It seems therefore likely that the wealth-to-income ratio and wealth inequality in developed economies will also continue to increase. In particular when we consider the findings from the studies discussed in Section 2.3, which emphasized the positive relation between the return on capital and wealth. In the following chapters, we aim to examine what the relationship between certain components of capital and the wealth-to-income ratio is, and what role saving behavior plays in this story. This could give more insights in what has been driving the wealth-to-income ratio in the period 1973-2015.

3. Data

Before we discuss the methodology of our regressions, this chapter gives more information on the data that is used. First, we describe the panel of countries that we include in our dataset. Then, we discuss the variables that are included in our regressions and their relevance.

3.1 Panel

The panel that is constructed for the dataset of this thesis includes 13 developed countries: Australia, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States. These countries are selected based on the availability of data and are also regarded as representative for the predictions about developed countries that Piketty (2014) makes. The data on the dependent variable is not available for other OECD countries. The quantitative analysis uses annual data of the period 1973-2015. Piketty also focusses on the period after the 70s, and this particular time frame gives the most complete dataset. However, data in this entire time period is only available for Australia, France, Germany, Italy, Japan, Spain, Sweden, the United Kingdom and the United States. We therefore have an unbalanced panel dataset. For Germany only the years 1991-2015 are included, since the reunification of East and West-Germany in 1990 could give misleading results as the country suddenly increased significantly in size. For Norway, data is available for the period 1980-2015 and for Denmark, Finland and the Netherlands data is available for the period 1996-2015. All countries that have data for a shorter time period show similar patterns, when comparing them with the countries that have data from 1973 to 2015. We therefore do not expect that including these countries will result in internal validity problems.

3.2 Variables

This section will shortly describe the variables that we use in our regressions. Also, we indicate where the data on these variables stems from so that our regressions can be replicated. We first describe the variables that we include in our baseline model. These are our main variables of interest and the variables that we regard necessary to control for in order to prevent omitted variable bias. Then, we describe the variables that we will include one-by-one, but separately, to our baseline model. These are variables that could give interesting additional insights but are not necessarily expected to directly affect the wealth-to-income ratio.

3.2.1 Baseline Model

Our dependent variable is the wealth-to-income ratio, since its level and development over time is of high importance for the analysis of wealth inequality. Our motivation for using the wealth-the-income ratio as dependent variable will be further discussed in Section 4.1. The data for the wealth-to-income ratio comes from the WID (2021), where it is defined as 'net-of-liabilities national wealth to net-of-taxes and -transfers national income ratio'. Our main independent variables of interest are the saving rate and the rate of return on equity, housing and government bonds. We discuss these in more detail in Chapter 4. We compute the net saving rate by subtracting the consumption rate of fixed capital from the gross savings rate, both expressed as % of GDP and taken from the World Bank (2021a, 2021b, 2021c)[1]. This is the definition that Piketty uses for his saving rate. As a robustness check, we will control for the critique by Krusell and Smith (Appendix B.4). The nominal rate of return on equity, housing and government bonds is taken from Jordà et al. (2019).

Besides the wealth-to-income ratio, the net saving rate and the nominal return on equity, housing and government bonds, we include other variables in our baseline model to avoid omitted variable bias. We include the annual real GDP growth rate per capita to ensure that the increase in wealth-to-income ratios is not driven by a relative decline in the growth rate. Moreover, Piketty (2014) emphasizes the importance of population growth and economic growth in the determination of the wealth-to-income ratio. The data for the GDP growth rate stems from the

[1] The consumption of fixed capital is initially expressed in current US dollars by the World Bank. We divide this absolute number by the total GDP in current US dollars for each country, so that it is measured on the same scale as the gross saving rate.

World bank (2021d). Furthermore, we control for inflation, which is necessary due to the nominal structure of our return data on equity, housing and government bonds. We do this by including the annual growth rate of the Consumer Price Index (CPI) in our model, taken from the OECD (2021a). We also control for the level of the share of public wealth, so that the changes in the wealth-to-income ratio that occur can be ascribed to changes in private wealth. This will give more insights when interpreting the results with regard to an increasing private wealth-to-income ratio. The data for this variable is taken from the WID (2021) and is defined as 'net-of-liabilities public wealth to net-of-income and -taxes national income ratio'[2]. Last, we include the degree of pre-tax income inequality in each country in our baseline regression model. We are curious to find out what the relation between income inequality and the wealth-to-income ratio is in our panel. One could argue that higher income inequality would lead to higher wealth (inequality), by simply providing relatively higher incomes for the households that are already relatively wealthier. However, if a more equal distribution of income is mainly driven by smaller differences between low- and middle-incomes, then this could restrict middle-income households in their ability to save relative to a less equal distribution where these middle-income households could have the opportunity to 'catch up' with the top percentiles of the wealth distribution. Moreover, since income is the denominator in the dependent variable, a negative coefficient could occur due to the possibility that a higher income inequality also represents higher aggregate income. This variable is defined as the inequality in pre-tax and pre-transfer income and stems from the Standardized World Income Inequality Database (SWIID) by Solt (2020). The SWIID collects income data from many databases and academic papers to make accurate estimations of the Gini-coefficient. The variable is therefore also expressed as the Gini, where zero represents complete equality and one represents complete inequality.

3.2.2 Additional Variables

After forming our baseline model, we add several variables one-by-one to the model. We do not include all of them jointly, since most of them are expected to be correlated with each other.

[2] Net public wealth is measured as: $government\ nonfinancial\ assets + government\ financial\ assets - government\ debt$

Moreover, we do not regard these variables as necessary to control for since their statistical significance and qualitative relevance is debatable.

We first add union density to our baseline model, since a higher density rate could result in a relatively higher degree of power for the labor share of income in total income. Moreover, lower union density could increase high concentration of wealth by reducing the growth of wages, which makes it difficult for households with lower incomes to save a certain share of their income (Dabla-Norris, Kochhar, Suphaphiphat, Ricka & Tsounta, 2015). The data on union density comes from Visser (2019). We also add a variable that controls for the 'centralization of wage bargaining'. This data also comes from Visser (2019) and is included in our model in the form of a continuous indicator that can take all possible values on a scale from zero to five, where zero stands for the lowest possible degree of bargaining centralization and five for the highest. The value of this variable is a summary measure of various measures of union concentration, but also the degree of legal basis that exists in a country for successful wage bargaining[3].

We also add the degree of progressivity of income taxation in a country to our baseline model. More progressive income taxation should in general reduce the possibilities that richer households have to accumulate wealth, since it sets a limit to the amount that they can directly invest in assets (Guillaud, Olckers & Zemmour, 2020; Piketty & Saez 2003). We use data on the relative redistribution of income for this variable, which is an indicator created by Solt (2020). The indicator is measured as a ratio of Ginis, and is calculated as:

$$\frac{\textit{Pretax income inquality} - \textit{Net income inequality}}{\textit{Pretax income inequality}}.$$

Then, we add the share of the elderly population to our baseline model, since older people are more likely to own valuable assets and other forms of wealth. By controlling for this share of the population, we could get more insights in the relative importance of the increasing value of these assets as an explanation for the rising wealth-to-income ratios. This data comes from the OECD (2021b) and is defined as the share of the population that is of the age 65 or older. We also add

[3] This variable is a summary measure of the following five indicators: the frequency of additional firm bargaining in the market; the integration of bargaining on several levels; the legal basis for derogation; general opening clauses in agreements among sectors, and crisis hardship clauses in any kind of agreement. All these factors are combined into the indicator for the degree of wage bargaining centralization. See Visser (2019) for a more detailed description.

the share of population that is foreign-born, to control for the differences in immigration among the countries in our panel. This data stems from the OECD (2021c). Unfortunately, the data for this variable is limited to the years 2000-2015 and not available for Japan. Our regression model only includes the years for which all the requested data is available, lowering the number of observations.

4. Descriptive Analysis

This section gives descriptive insights into the main variables of interest. The first one is the wealth-to-income ratio itself. The second is the saving rate, of which the importance of its decomposition was previously discussed in Section 2.2.2. Last, our approach to define the return on capital will be discussed, where we emphasize our more complete definition of the return on capital with regard to Piketty and Zucman (2014) and Fuller et al. (2020), who only look at capital gains.

4.1 Wealth-to-Income Ratio

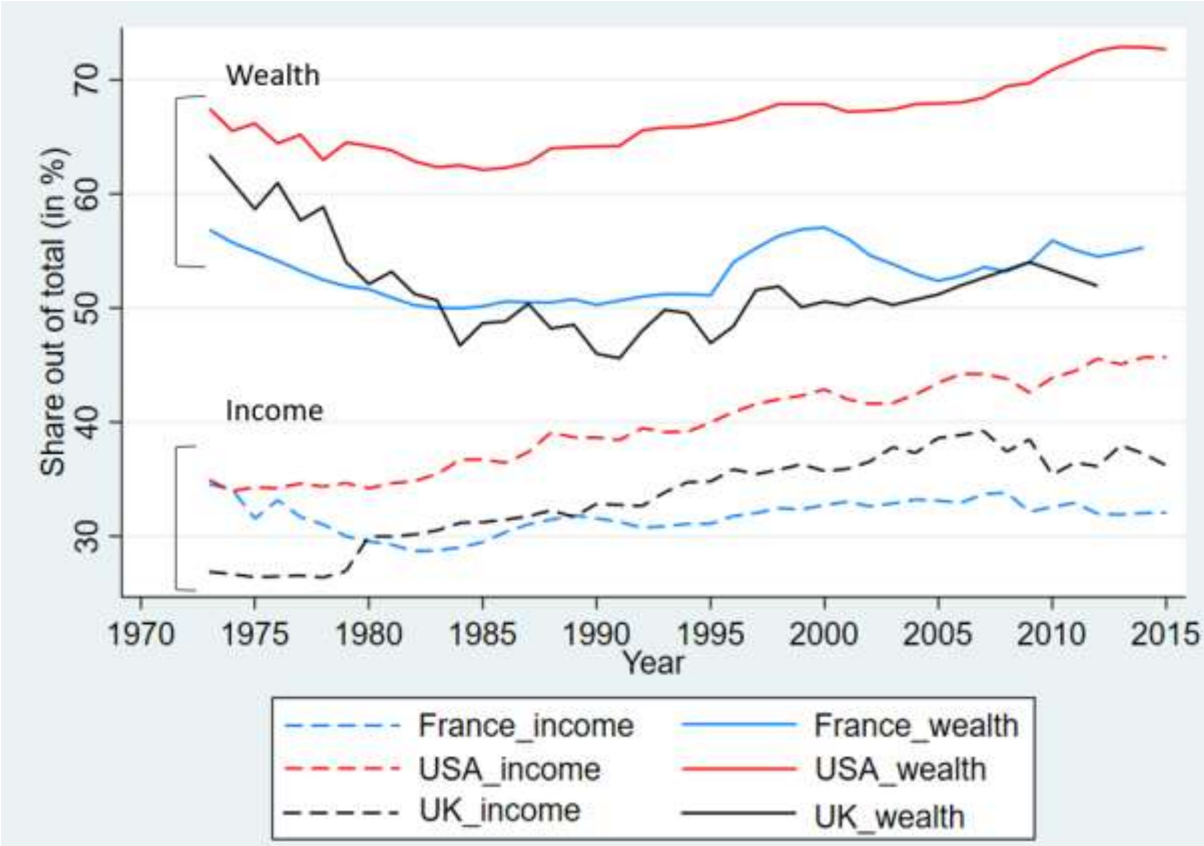
As mentioned in our literature review, availability of internationally comparable data on the distribution of wealth is very limited. Piketty and Zucman (2014), Piketty and Saez (2014) and Fuller et al. (2020) therefore look at the development of the wealth-to-income ratio. They argue that the wealth-to-income ratio can be used to describe changes in wealth inequality, but it also is an indicator for the relative overall importance of wealth in a given society. Moreover, Piketty and Saez (2014) argue that high steady-state levels of the wealth-to-income ratio go together with large financial instability and asset price bubbles. We will therefore also use the wealth-to-income ratio as the dependent variable in our quantitative analysis. Exploring what the drivers of the recently increasing wealth-to-income ratio are could give valuable insights in what is driving wealth inequality. The data for the wealth-to-income ratio that we use is sourced from the World Inequality Database (WID, 2021). As mentioned before, this is the most complete wealth accumulation database that is currently available and it also allows us to empirically examine the same countries that Piketty uses to develop his arguments.

Fuller et al. (2020) consider a set of conditions before regarding the wealth-to-income ratio as a plausible proxy for wealth inequality. Although these conditions seem to intuitively suggest that an increase in the wealth-to-income ratio automatically implies an increase in wealth inequality, Fuller et al. do not provide any empirical evidence that lead to these conditions. It is therefore hard to argue that based on these conditions one can argue that there is a direct causal relationship between wealth inequality and the wealth-to-income ratio. The limited availability of internationally comparable data on the distribution of wealth makes it very difficult to provide causal evidence for such a relation. We therefore argue that the conditions proposed by Fuller et al. (2020) are worthwhile to consider so that interpreting the drivers of wealth-to-income ratios could give more valuable insights. The conditions that Fuller et al. consider are the following: (i) the accumulation of wealth has to be more concentrated than the accumulation of income; (ii) the increase in wealth-to-income ratios is not driven by the accumulation of wealth among the poorest share of households; and (iii) the increase in wealth-to-income ratios is not driven by a relative decline in the growth rate of the relevant economies and incomes (denominator effect). If these conditions are met or controlled for, then Fuller et al. regard increases in the wealth-to-income ratio as an increase in wealth inequality. We believe that a causal relationship between the two is difficult to claim, and therefore mainly value the wealth-to-income rate as a reference point for increasing wealth inequality.

To verify whether the conditions by Fuller et al. (2020) might hold we look at data from the WID in France, the UK and the USA, since only for these countries the relevant data is available. The first (i) condition does seem to hold when looking at the share of the richest 10% in the wealth and income distribution in France, the UK and the USA (Figure 2). The richest 10% earn between 30% to 45% of total income but hold about 50% to 70% of the wealth in their countries.

Figure 2. Net Share of Richest 10% in Wealth and Income Distribution (1973-2015)

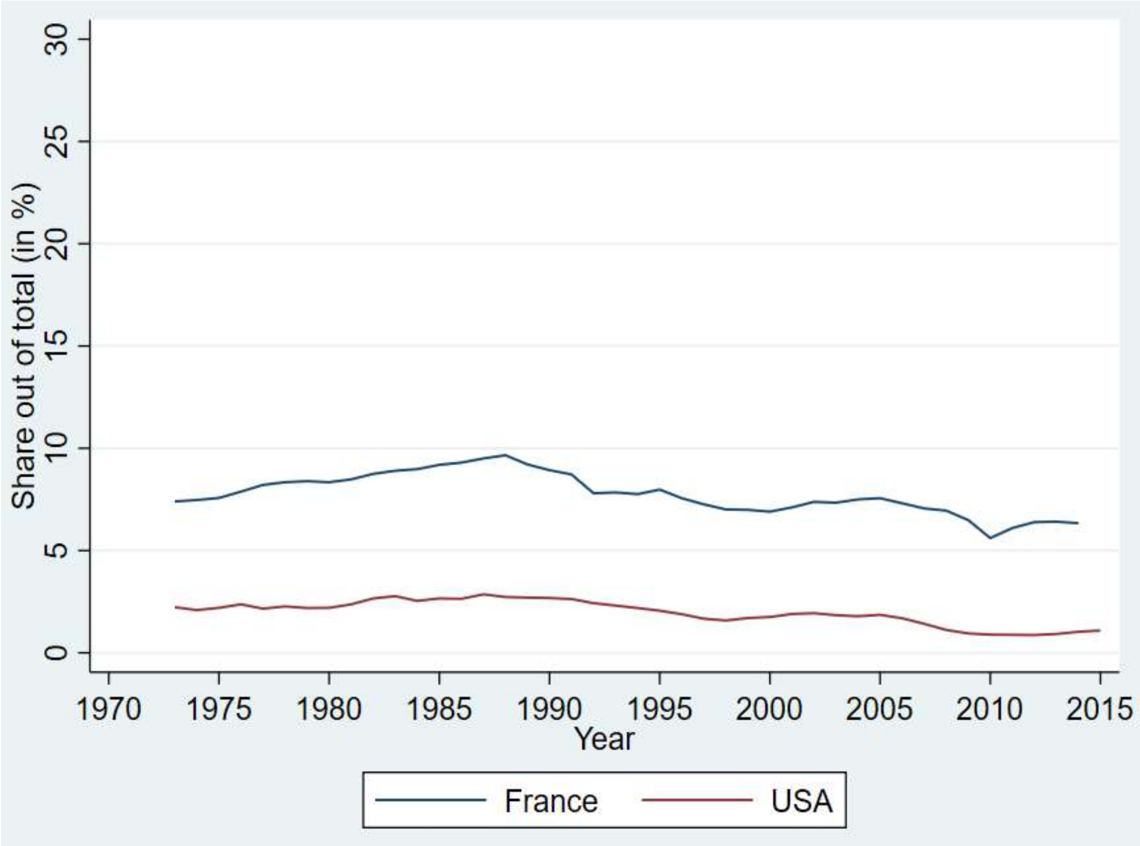
(Data source: WID, 2021)



When looking at the share of the poorest 50% out of the total wealth distribution, the second condition (ii) also seems to hold (Figure 3). Unfortunately, this data is only available for France and the United States. However, the share of the poorest people in these two countries has barely moved between 1973 and 2015, indicating that the increase in the total wealth-to-income ratio is not driven by the wealth of the poorest households.

The third condition (iii) is more difficult to verify by just looking at descriptive statistics. As mentioned in Chapter 3, we control for this condition by including the growth rate of real GDP per capita in our regression analysis. The growth rate of the wealth-to-income ratio is a decreasing function of the growth rate of income. Considering recent growth slowdowns in the European countries and Japan, wealth-to-income ratios could have been high due to low growth rates. When controlling for this possible denominator effect, we assume that all three conditions hold and that the wealth-to-income ratio could function as a reference point for wealth inequality.

Figure 3. Share of Poorest 50% in Wealth Distribution (1973-2015)
(Data source: WID, 2021)

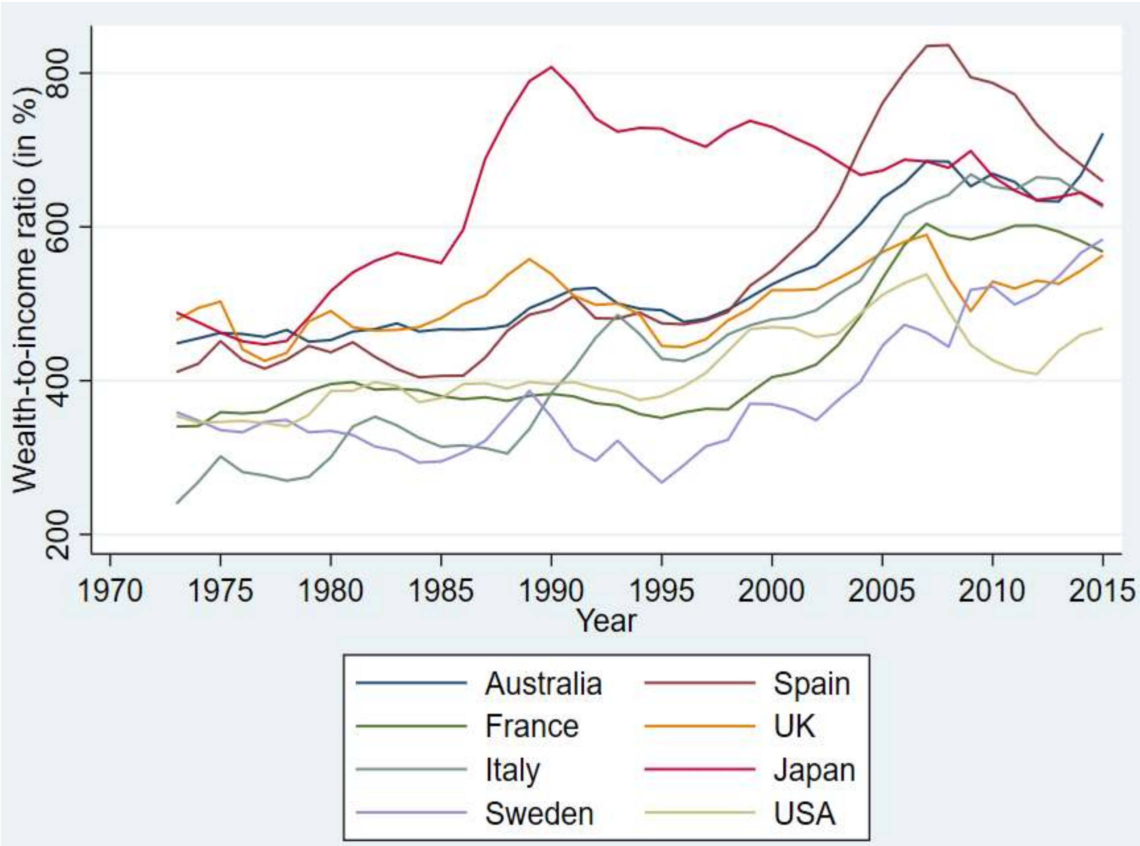


As mentioned extensively in our introduction and literature review, the wealth-to-income ratio has increased by a lot in the last decades: from approximately 200-300% in 1970 to 450-700% in 2015. In Figure 4, the development of these ratios can be seen for Australia, France, Italy, Japan, Spain, Sweden, the UK and the USA in the period 1973 to 2015. These are the countries that the WID has the most complete data for. In all these countries the wealth-to-income ratio has increased in this period, varying between an increase by 84 percentage points (UK) to an increase by 386 percentage points (Italy). It is remarkable that Japan reached its highest ratio in 1990 and decreased in the years thereafter. This can be explained by the collapse of Japan's asset price bubble in the early 1990s, which started a period of stagnation and what the Japanese refer to as the 'Lost Decade'. In all the other countries the wealth-to-income ratio increased continuously most of the time, only stopped by extreme events in 1990 and 2008-09. In 1990, many countries in the panel were affected by the fall of the iron curtain and the consequent massive migration, while in 2008-09 the Global Financial Crisis (GFC) struck and affected all countries negatively. Furthermore, the large increase of the ratio in Spain up to a level of

836.44%, followed by a sharp decrease is noteworthy. This shows the large impact that the financial crisis had on the Spanish economy, in particular the crash of the real estate market. The large decline of the wealth-to-income ratio in Japan and Spain, in respectively 1990 and 2008-09, seems to be in line with the findings by Piketty and Saez (2014). They argue that large levels of the wealth-to-income ratios go together with large financial instability and asset price bubbles. The quantitative analysis in the rest of this paper aims to give more insights in what the common factors were of the large increase in the wealth-to-income ratio in these countries.

Figure 4. Wealth-to-Income Ratio (1973-2015)

(Data source: WID, 2021)

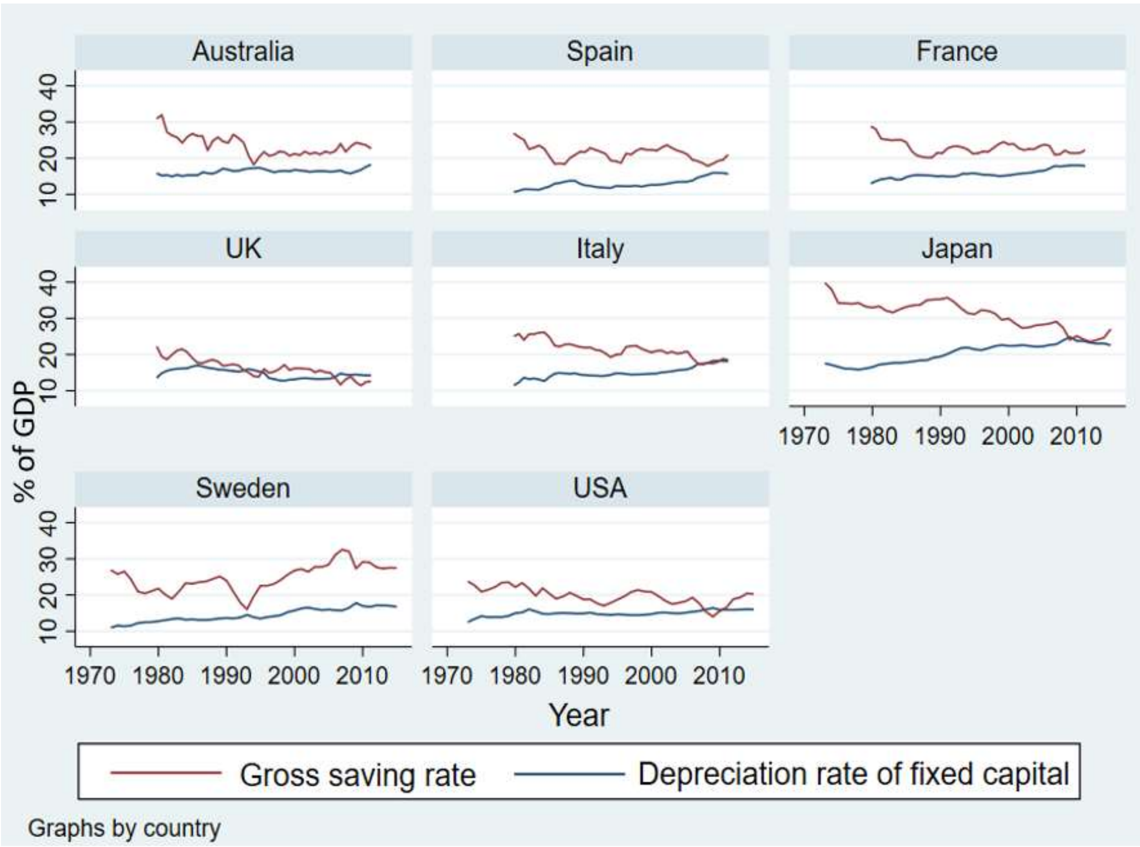


4.2 Saving Rate

In Section 2.2.2 we discussed the critique by Krusell and Smith (2015) on Piketty and Zucman's (2014) saving assumption. This highlights the importance of a careful decomposition of the saving rate. In our main models, we use the formula of Piketty and Zucman's for capturing the growth rate of the wealth-to-income ratio, $\frac{\tilde{s}}{g}$, where $\tilde{s}$ is the saving rate net-of-depreciation, which is defined as as 'gross savings (s) – depreciation rate (δ)'. As a robustness check we conduct a regression on the same baseline model, but then with the formula that textbook models and Krusell and Smith use for the growth rate of the wealth-to-income ratio, $\frac{s}{g+\delta}$. We replace the net saving rate with the gross saving rate and add the depreciation rate up to the GDP growth rate in this regression. If the other coefficients do not largely change, then we assume that our estimations are robust for this theoretical modification of the model.

Figure 5 shows the gross saving rate and the depreciation rate of fixed capital in the period 1973-2015[4]. The depreciation rate is growing slowly but rather continuously over time, while the gross saving rate seems to experience more volatility. After 2010, the saving rate and depreciation rate move closer to each other and in some countries even cross, implying a negative net saving rate.

Figure 5. Gross Saving Rate and Depreciation Rate (1973-2015)
(Data source: World Bank 2021a, 2021b, 2021c)

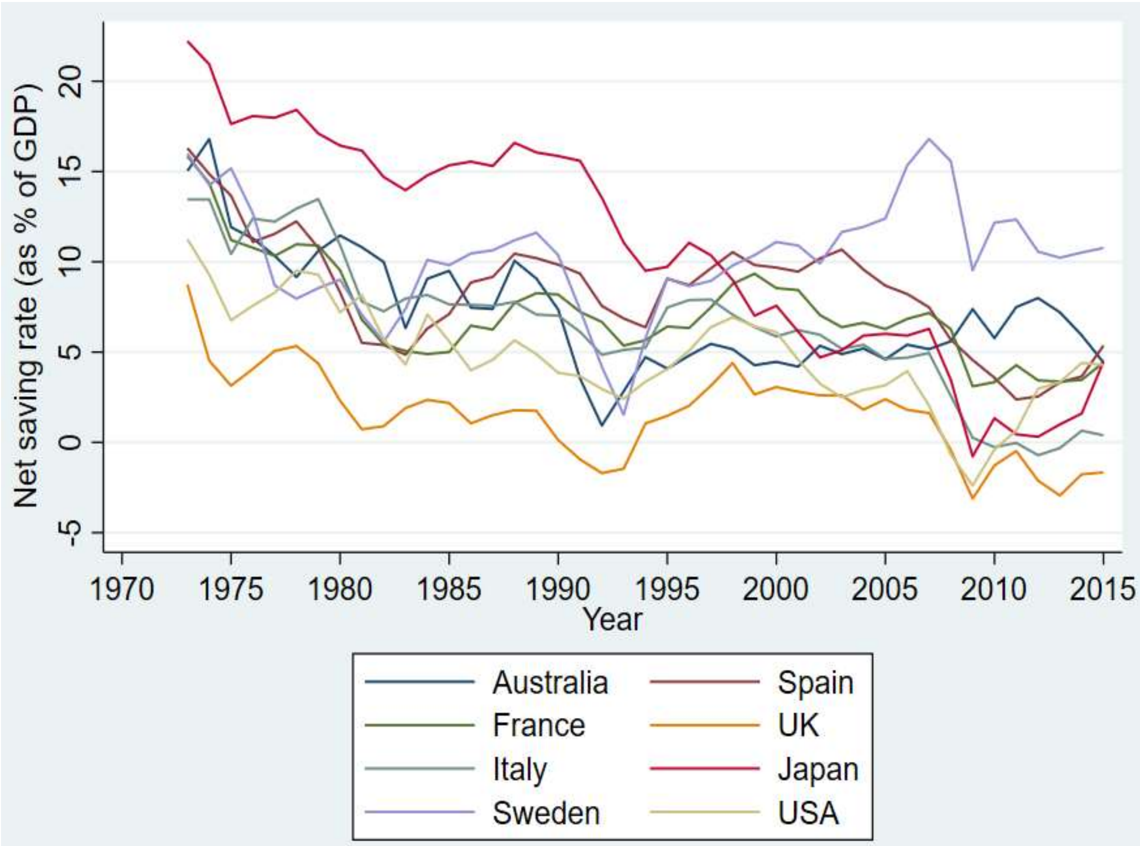


[4] For Australia (1973-1988) and Japan (1973-1995), the gross saving rate is defined as 'gross domestic saving rate' in a selection of years. This was the definition of gross savings of the World Bank in measures before 2006, which has not been replaced by the new definition in these years for Australia and Japan. The new rates do not differ a lot with the old ones in the other countries, so we decided to include these selected years with the old definition as well.

Figure 6 shows the development of the net saving rate in the same countries. In Sweden, the rate is still relatively high after 2010 with levels around ten percent. Most of the other countries have a net saving rate that is close to, or even below, zero at that time. In all countries, the net saving rate is at a lower level in 2015 compared to 1973. According to Piketty's formula for the growth rate of the wealth-to-income ratio, a lower saving rate would result in a lower wealth level. These descriptive statistics show that it is very unlikely that the saving rate has therefore been a common factor in the rise of wealth-to-income ratios.

Figure 6. Net Saving Rate (1973-2015)

(Data source: World Bank, 2021a, 2021b, 2021c; Gross saving rate – consumption rate of fixed capital as % of GDP)



4.3 Return on Capital

In order to examine what has driven the rise in the wealth-to-income ratio since the 1970s, we must look at the impact of the return on capital on increasing wealth. We divide the return on capital into three components: (i) the return on residential housing; (ii) the return on equity; and (iii) the return on government bonds. These components are selected because housing, equity and bonds represent nearly two third of investable assets in developed countries. Moreover, housing stock is approximately 50% of all the outstanding capital stock and together with equity also 50% of the total assets in the balance sheets of households (Jordà et al., 2019). We use the nominal rate of returns computed by Jordà et al. for our regressions later. They emphasize that by selecting these three components of capital, the main capital categories that are not covered are deposits, insurance and pension claims, corporate bonds, commercial housing, agricultural land and business assets. However, they argue that a large share of these categories are captured by the return on residential housing, equity and government bonds[5]. The return on foreign assets is not included, mainly due to limitations of data, but Jordà et al. mention that these only represent a small share of aggregate capital. Besides, the difference in domestic and foreign returns are relatively small. Overall, they argue that the returns on housing, equity and government bonds capture the total return on household wealth almost completely. We therefore assume that these three components are sufficient to give insights in the impact that the return on capital has on the increasing wealth-to-income ratio. We will shortly describe how Jordà et al. (2019) compute the three returns that we will use in this thesis:

i. The nominal return on residential housing is computed by combining the time-series data on house prices by Knoll, Schularick, and Steger (2017) with data on rents collected by Knoll (2017) of both owner-occupied houses as well as rented houses. The return consists therefore of capital gains from the increasing house prices and the rents received on houses.
ii. The nominal return on equity is computed based on a broad range of sources, such as academic journals, central bank yearbooks, stock listings, newspapers and annual reports of firms. The sample is weighted by the market capitalization of stocks and aims to be representative for the entire stock market. The return consists of capital gains, but also out of the dividend gains out of equity.
iii. The nominal return on government bonds is basically computed as the return on long-term government bonds that are traded and listed on local exchange rates. With this approach the return is more comparable with the other two returns, it creates a larger sample, and the bonds are more likely in possession of households in the respective

[5] Examples: Pension claims are usually invested in equity or government bonds, business assets are largely captured by listed equity, other housing assets largely develop the same as residential housing (Jordà et al., 2019).

country. The return consists of capital gains and the income out of coupons on government bonds.

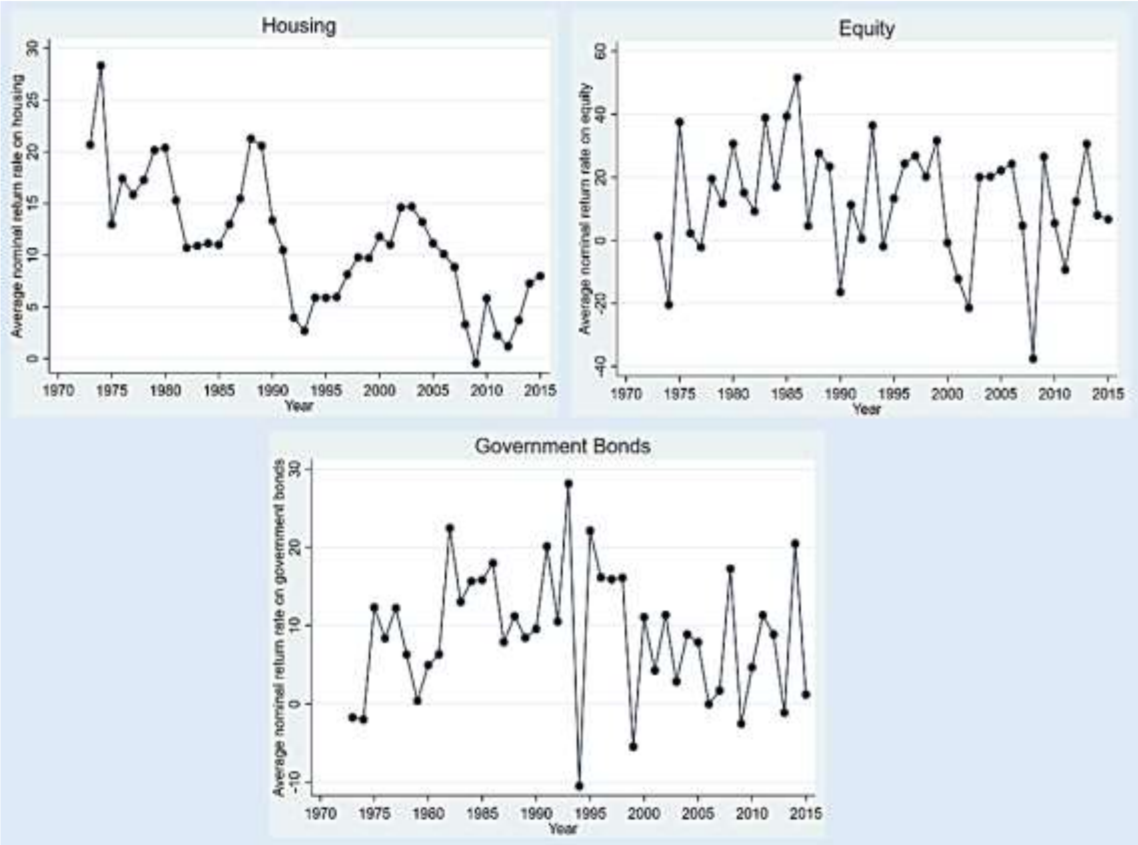
Note that in the decomposition of our return on housing, equity and government bonds, we do not only incorporate capital gains (relative price effect), but also rental, dividend and coupon yield. This is a more complete definition of the return on capital than the one that Piketty and Zucman (2014) and Fuller et al. (2020) use, since they only focus on capital gains.

Figure 7 shows the average of the three return rates in Australia, France, Italy, Japan, Spain, Sweden, the UK and the USA combined in the period 1973 to 2015. The returns within the individual countries develop in relatively similar trends, so the average return is able to give insights in its effect on the wealth-to-income ratio. In the regressions we use the country-specific returns and not the average rate that is used for Figure 7.

The developments of the return rates show large differences between them. The average return on housing is positive in all years, except for 2009 when the global financial crisis struck. Compared to the other two rates, the return on housing is relatively stable. The increase in the late 80s, late 90s and early 2000s seems to be in line with the large increase in the wealth-to-income ratio at those moments. The average return on equity seems to be very volatile on the other hand, since jumps of twenty percentage points are no exceptions. In six of the 43 years, the return on equity is largely negative, where the rate of approximately -40% in 2008 is the lowest point. The nominal return on government bonds is less volatile than the return on equity, but more than the return on housing. The large drop in 1994 is the most remarkable, but there are more sharp increases and decreases over the years. Based on these descriptive statistics, both the return on equity as the return on government bonds do not seem to explain the steady rise in the wealth-to-income ratio. However, the explanatory power of descriptive statistics is limited, and we should examine these variables with a more scientifically robust method.

Figure 7. Average Returns on Housing, Equity and Government Bonds (1973-2015)

(Data source: Jordà et al., 2019; Average weighted returns of Australia, France, Italy, Japan, Spain, Sweden, the UK and the USA combined. All returns expressed as % increase relative to previous year)



5. Methodology

In order to find any robust explanations of the large increase in the wealth-to-income ratio since the 1970s, we make use of regression models. We use the previously described wealth-to-income ratio as dependent variable, and we control for individual heterogeneity between countries and over time in our panel data. The individual heterogeneity between countries, such as cultural differences, policy differences, or differences in the (financial) climate, is controlled for by including country-fixed effects to make sure that those factors do not influence the coefficients of our variables of interest. The same goes for heterogeneity over time: by including time-fixed effects, any changes that occur in the dependent variable must be because of other factors than these 'fixed' variables (Stock & Watson, 2003, p.289-290). In the following sections, we describe our methods and explain why we are performing regressions on two different models.

5.1 Estimator

Since we expect that the wealth-to-income ratio at time t is largely dependent on its level at time $t-1$, we include the lag of the dependent variable as an explanatory variable to avoid omitted variable bias. However, this dynamic model will by definition create an endogeneity bias in the conventional fixed effects estimator, the Least Square Dummy Variable (LSDV). This bias is known as Nickell's bias (1981), where there is a bias in the estimate of the lagged dependent variable, and this is not reduced by increasing the N of the model[6]. This bias is typically negative, and therefore underestimates the persistence in the dependent variable. The dynamic structure of our model makes both the fixed effects as well as the random effects estimator inconsistent. Therefore it does not make sense to perform a Hausman test to decide between fixed or random effects in a dynamic model. We choose however to perform all of our regressions with fixed effects, because we assume that the time-invariant characteristics of a given country are unique to that country and are not correlated with the characteristics of other countries in the panel.

There are several estimators that are able to control for the bias in dynamic panel models. Often used are the General Method of Moments (GMM) and Instrumental variable (IV) dynamic panel estimators that are proposed in Anderson and Hsiao (1982), Arellano and Bond (1991) and Blundell and Bond (1998). However, the properties of these estimators require datasets where N tends to infinity, which is certainly not the case in our dataset ($N = 13$), otherwise the estimated coefficients will be severely biased. Moreover, in panel data with small N relative to T, such as ours, GMM and IV methods create too many instruments and introduce overfitting bias. We therefore apply the bias-corrected least squared dummy variable (LSDVC) estimator proposed by Bruno (2005a, 2005b). This estimator is suitable for datasets with small N, able to handle unbalanced panel data and also controls for cross-sectional dependence[7]. The LSDVC-estimator by Bruno is an adapted version of the estimators by Judson and Owen (1999) and Bun and Kiviet (2003), which are only suitable for balanced datasets. The LSDVC-estimator

[6] The demeaning process of the within transformation results in a correlation between the regressor and the error term. This regressor can by definition not be 'independent and identically distributed (i.i.d.). When N goes to infinity, the bias in the model is of order 1/T.

[7] Which is necessary according to our Pesaran test (Appendix B.2)

uses a technique that was first suggested by Kiviet (1995). Kiviet combines the LSDV estimation with the GMM, by replacing the inconsistent LSDV true parameters with estimates from consistent dynamic panel estimators such as the GMM. By conducting Monte-Carlo experiments, Bruno (2005b) and Judson and Owen (1999) show that this bias-corrected estimator (LSDVC) outperforms the GMM and IV estimators in most of the cases with regard to bias and the Root Mean Squared Error (RMSE). This is especially the case for panels with a relatively large T compared to N, which is the case in our panel ($T = 43; N = 13$).

Our baseline model for the LSDVC-estimations looks as follows:

$$WTI_{it} = \delta_i + \gamma * WTI_{it-1} + \beta_1 * netsaving_{it} + \beta_2 * equity_{it} + \beta_3 * housing_{it} + \beta_4 * bonds_{it} + \beta_5 * publicwealth_{it} + \beta_6 * incinequality_{it} + \beta_7 * inflation_{it} + \beta_8 * GDPgrowth_{it} + \eta_t + \varepsilon_{it} \;\; ; \; |\gamma| < 1; \; i = 1, \dots, N; \; t = 1, \dots, T$$

In this equation, the WTI (wealth-to-income ratio) is the dependent variable; δ_i is the unobservable country-specific intercept that captures the individual fixed effects for all the countries in the panel; γ captures the coefficient of the lagged dependent variable; the β's capture the coefficients of the explanatory variables; η_t is a year dummy that captures the fixed effects over time; ε_{it} is the error term and captures the unobserved white-noise with a constant variance σ_ε^2; i denotes a specific country and t denotes a time period. The explanatory variables follow from the previous chapter. The betas' interpretation is that they represent the change in the dependent variable if the independent variable changes by one unit over time for any country.

In the first step of our LSDVC regressions, the LSDVC-estimators are determined with the algorithm by Bruno (2005b) while using the GMM estimators by Arellano and Bond (1991) as the initially consistent estimators. In the second step, the bias in these GMM estimates is corrected for with bias approximations that are determined by adapting the within operator to be suitable for the dynamic structure of the model. This results in the final bias-corrected estimates. In our regressions, we use a bias approximation of $O(N^{-1}T^{-2})$, which is the highest bias-correction that Bruno suggests. Furthermore, we conduct 50 repetitions of the two-step LSDVC procedure to bootstrap the variance–covariance matrix in order to get the standard errors of our coefficients. As a robustness check for our final model, we also conduct a regression on our baseline model where we use the Blundell and Bond (1998) GMM estimator for our initially consistent estimates.

However, after conducting the first regressions, we notice that the coefficient of our lagged dependent variable is very close to one. We therefore suspect that there is a unit root present in the data for our dependent variable, which would mean that this data is non-stationary. Models in which the dependent variable is non-stationary could produce spurious regressions, where R^2 and t-statistics are likely to have large values even if the underlying variables do not have a true causal relationship (Granger & Newbold, 1974). Non-stationary data can follow a 'random walk', which means that it can be decomposed as follows:

$$y_t = y_{t-1} + \varepsilon_t\ ;\ \varepsilon_t \sim i.i.d.(0, \sigma^2)$$

This would make statistical inference of our model difficult to defend. Data that is non-stationary does not depend on the time at which the data is observed and therefore unpredictable. If there is a unit root present, then there is likely a trend present in the mean of the variable. Variables that are stationary in their levels are integrated of order zero, I(0). Variables that are nonstationary at their level but stationary at their first-difference are integrated of order one, I(1).

We use the unit root test by Pesaran (2007) to analyse whether a unit root is present in our data on the wealth-to-income ratio, or whether the series is stationary. We choose this test because of its ability to handle unbalanced panel data. The null hypothesis for this test is that there is a unit root present for all cross-sectional units, while the alternative hypothesis is that our data is stationary. This test produces the Cross-sectional Im Pesaran and Shin (CIPS) test statistic:

$$CIPS(N,T) = \frac{1}{N} * \sum_{i=1}^{N} t_i^P\ (N,T)$$

In this equation, N is the number of panel members; i denotes a specific country; t denotes a time period; p is the order of the time series augmentation; and T is the number of time periods in our panel. We observe that we cannot reject the null hypothesis and therefore conclude that there is indeed a unit root present in our dependent variable. As our main robustness check, we therefore also estimate our model with the first-differenced version of our dependent variable. The first-difference of a non-stationary variable is stationary most of the time. We test if the differenced version of our non-stationary variables is indeed stationary, which would mean that these variables are I(1). Granger and Newbold (1974) find strong evidence that non-stationary level-variables could indeed produce spurious correlations, but when these variables are differenced the probability of producing a spurious correlation is much smaller. Including these differenced variables resolves the issue of spurious correlations in 90-98% of the time. The mechanical inflation in R^2 is high with level-variables, but with differenced variables this inflation is near zero. Variables need to be matched in their order of integration for this mechanical inflation of statistical inference to disappear.

The unit root tests that we conduct can be found in Appendix A. We do this for all of our variables, since we need to make sure that we match our differenced dependent variable with stationary independent variables. We cannot reject the null hypothesis of non-stationarity for the variables for income inequality, public wealth, union density and progressive taxation. We can reject the null hypothesis of non-stationarity for these variables when they are first-differenced, and therefore we include the first-differenced version of those variables in our second regression model. We again use the same procedure by first forming our baseline model. Then, we add the other variable one-by-one and separately to our baseline model. We cannot include the variables elderly share, immigration share and wage centralization due to various complications[8]. Since we first-differenced our dependent variable, the earlier mentioned Nickell's bias is less problematic (Baum, 2013). We can now use a static fixed effects model, where we include the levels of our stationary variables and the first-difference of our non-stationary variables (to make those stationary as well). We will use the standard LSDV-estimator for these regressions.

[8] For elderly share, the unit root test on both the level-variable and the differenced-variable cannot be rejected. Since therefore we cannot include a stationary variable for this indicator, we exclude it from the second model. For immigration share, the amount of data is too small and unbalanced to perform the Pesaran test. For wage centralization, we cannot perform the Pesaran test because the data for this indicator is not normally distributed.

Our second baseline model looks as follows:

$$\Delta WTI_{it} = \delta_i + \beta_1 * netsaving_{it} + \beta_2 * equity_{it} + \beta_3 * housing_{it} + \beta_4 * bonds_{it} + \beta_5 * \Delta publicwealth_{it} + \beta_6 * \Delta incinequality_{it} + \beta_7 * inflation_{it} + \beta_8 * GDPgrowth_{it} + \eta_t + \varepsilon_{it} \quad ; i = 1, \dots, N;\ t = 1, \dots, T$$

The Δ indicates that a variable is first-differenced and the other notations are the same as in our first baseline model. By conducting regressions on this second model, we can be more confident that our estimations are robust.

5.2 Results

Our results are presented in Table 1 and Table 2. The first model (1) is our baseline model, where we include our main variables of interest and the variables that we regard as necessary to control for. As mentioned in the previous section, our estimator in the Table 1 is the LSDVC-estimator as proposed by Bruno (2005a, 2005b), where we use the Arellano-Bond estimator for our initially consistent estimates. Our robustness checks suggest that the differences between choosing the Blundell-Bond estimator instead for our initially consistent estimators does not largely affect our estimates (Appendix B.5). In Table 2 we show the regressions that we performed on our static model with the LSDV-estimator. We will first discuss our results in Table 1.

As expected, the wealth-to-income ratio at time $t-1$ has a large and statistically significant impact on the wealth-to-income ratio at time t. The coefficient does not differ a lot across the different models and does not lose any statistical significance. Its value is very close to one, which is why we conducted the unit root tests that we discussed in the previous section.

The net saving rate does not seem to have any statistically significant effect on the wealth-to-income ratio across the models in our sample. This is remarkable, since Piketty (2014) argues that the net saving rate is responsible for about 60% of the increase in wealth-to-income ratios. This could of course still be the case in his sample of about 300 years but does not seem true for the period 1973 to 2015. The sign of the coefficient is nonetheless positive in most of the regressions, and the statistical insignificance could perhaps be explained by the limited observations in our sample. Note that for model (5) and (6) the sign turns negative. These are the models where respectively the share of foreign-born individuals (Immigration) and the share of elderly individuals out of the total population are included. For model (5), the statistical inference is very limited due to the small number of observations ($n = 183$. Moreover, the immigration variable is only available for the period 2000 to 2015, which explains why many of the coefficients are different compared to the other models. Moreover, data for the immigration variable is not available for Japan, which means that Japan is excluded in model (5). For model (6) however, this is not the case, and the negative sign of the saving rate does seem interesting. When we control for the share of elderly individuals, the saving rate becomes negative. This could indicate that individuals under the age of 65 have a negative net saving rate over the period 1973 to 2015, while individuals of 65 and older have a positive net saving rate and thereby increase their wealth.

Table 1. Final Regressions with LSDVC-Estimator on the Wealth-to-income Ratio

VARIABLES	(1) LSDVC - AB	(2) LSDVC - AB	(3) LSDVC - AB	(4) LSDVC - AB	(5) LSDVC - AB	(6) LSDVC - AB
Wealth-to-income (t-1)	0.971***	0.978***	0.977***	0.976***	0.892***	0.978***
	(0.0207)	(0.0203)	(0.0167)	(0.0232)	(0.0477)	(0.0218)
Net Saving Rate	0.364	0.249	0.238	0.390	-0.641	-0.0767
	(0.278)	(0.348)	(0.285)	(0.329)	(0.628)	(0.353)
Return on Equity	0.0824*	0.0899**	0.0950**	0.0940**	0.172	0.0888*
	(0.0480)	(0.0397)	(0.0415)	(0.0389)	(0.156)	(0.0477)
Return on Housing	1.028***	1.251***	1.062***	1.078***	1.753***	1.059***
	(0.132)	(0.150)	(0.126)	(0.112)	(0.288)	(0.138)
Return on Government Bonds	-0.159	-0.141	-0.156	-0.146	-0.0593	-0.166
	(0.119)	(0.147)	(0.105)	(0.114)	(0.269)	(0.119)
Public Wealth	0.111***	0.121***	0.102***	0.109***	0.305***	0.105***
	(0.0380)	(0.0340)	(0.0294)	(0.0329)	(0.0783)	(0.0376)
Income Inequality	-1.289***	-1.129*	-1.660***	-1.453**	-3.709**	-1.276***
	(0.483)	(0.615)	(0.465)	(0.617)	(1.860)	(0.494)
Inflation	-1.751***	-1.717***	-1.593***	-1.834***	2.861*	-1.760***
	(0.448)	(0.585)	(0.397)	(0.445)	(1.617)	(0.448)
Real GDP per Capita Growth	-2.219***	-2.519***	-2.445***	-2.379***	-2.078*	-2.165***
	(0.613)	(0.768)	(0.780)	(0.596)	(1.098)	(0.606)
Progressive Taxation		-0.686				
		(0.565)				
Wage Bargaining Centralization			-3.219**			
			(1.444)			
Union Density				-0.167		
				(0.178)		
Immigration					0.599	
					(1.863)	
Elderly Share						-1.337**
						(0.559)
Observations (n)	452	434	449	448	183	452
Number of Countries (N)	13	13	13	13	12	13
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results on our proxies for the return on capital yield some interesting insights. The nominal return on equity seems to have a relatively low positive impact on the increase in wealth-to-income ratios. According to our baseline model, an increase in the nominal return on equity by 1% leads to an increase in the wealth-to-income ratio by 0.0824%. The coefficients for the return on equity are statistically significant with p-values between 0.05 and 0.1 across the regressions, with the exception of model (5), which is likely due to the limited number of observations. The most remarkable result is the impact that the nominal return on housing has on the wealth-to-income ratio in our sample. This coefficient is >1 in all of the models and also highly statistically significant. Our baseline model (1) suggests that an increase in the nominal return on housing results in an increase of 1.028% in the wealth-to-income ratio. When looking back at our descriptive analysis from Chapter 4, the continuously positive housing-returns in the period 1973 to 2015, with the exception of 2009, seem to have been an important driver of the large increase in wealth-to-income ratios. The nominal return on long term government bonds does not show any significant impact on the wealth-to-income ratio in our sample. If there is any, the sign of the impact is negative across all models. This could be explained by the relatively low (and even negative) interest rate on safe assets that the countries in our sample experienced in the last twenty years.

When we look at our control variables, we see that all of them are highly statistically significant in all models. The share of public wealth seems to have a positive impact on the wealth-to-income ratio in our sample, although a relatively low one. An increase in the share of public wealth out of the total wealth by 1% in a country leads to an increase in the total wealth-to-income ratio by 0.111%, according to our baseline model. Furthermore, income inequality has a relatively large negative and highly significant impact on the wealth-to-income ratio in our sample. The coefficients vary between -1.129 and -1.660 in our models, except for model (5) where the number of observations is much lower and the time period is different. These results suggest that a higher income inequality is related with a lower wealth-to-income ratio in our panel. As mentioned before, this could possibly be due to the denominator effect, where higher income inequality could imply higher aggregate income as a result of the large incomes of top earners. It could also be explained by the possibility that a more equal distribution of income is mainly driven by smaller differences between low-and middle-incomes. This could impose restrictions to middle-income households in their ability to invest, compared to a less equal distribution where middle-income households can use part of their income to catch up with the top percentiles of the wealth distribution

Inflation also has a relatively large negative and highly significant impact on the wealth-to-income ratio in our sample. According to our baseline model, a 1% increase in the growth rate of the Consumer Price Index ('Inflation' in the model) results in a 1.751% decrease in the wealth-to-income ratio. This coefficient does not differ much across our models, except again for model (5). It is remarkable that the sign of the inflation coefficient flips from negative to positive in model (5). Note that in model (5), Japan is excluded and the time period is from 2000 to 2015. In the other models, the negative impact makes sense according to basic economic reasoning: a decrease in the value of a currency results in a decrease in assets valued by that currency.

The last variable of our baseline model, the real GDP per capita growth, also has a negative and relatively large impact on the wealth-to-income ratio in our sample. This result is highly statistically significant in all models, except in model (5) only significant at the $p<0.1$ level. Our baseline model suggests that a 1% increase in GDP per capita results in a -2.219% decrease in the wealth-to-income ratio. This is in line with Piketty's (2014) reasoning, who argues that growth slowdowns in the last decades have contributed to increases in the wealth-to-income ratios. It does give some more insights however, since it indicates that economic growth functions as a repressive factor with regard to the wealth-to-income ratio. The denominator effect likely plays the largest role in this repressive factor, as economic growth increases incomes in a well-functioning society. The fact that economic growth has been relatively low compared to the return in capital, and according to our model in particular the return on housing, confirms Piketty's theory that wealth-to-income ratios have increased because r has been larger than g.

As mentioned in Section 3.2.2, we add several other variables to our baseline model that might give some valuable insights. The first is the degree of progressivity of income taxation, which does not seem to have a statistically significant impact on the wealth-to-income ratio. If it has any, then it is a negative impact. This is in line with the reasoning that a higher degree of progressive taxation would lead to lower post-tax income and wealth inequality. The negative sign would therefore indicate that a more progressive income tax system lowers the wealth of the richest households.

Our model suggests that the wage bargaining centralization variable has a large negative impact on the wealth to income ratio, which is statistically significant at the 5% level. The coefficient indicates that an increase of one in the zero to five scale by Visser (2019) results in a decrease in the wealth-to-income ratio of 3.219%. This is likely a denominator effect, since strong bargaining power for labourers should result in a higher income for them. This result emphasizes the importance of strong bargaining power for labourers, since it allows (low) wages to increase on a similar scale as the inflation and economic growth in a country. The same explanation holds for the union density variable, although this variable is not statistically significant.

As mentioned before, including the immigration variable (share of foreign born out of total population) results in a model that covers a different time period and that has a much lower amount of observations. This makes it difficult to allow any statistical inference for this model. The coefficient for the immigration variable is positive, but statistically insignificant. The positive sign suggests that a larger share of foreign-born individuals increases the wealth-to-income ratio. The other coefficients differ a lot in this model (5) compared to the other models, which could again be explained by different time period that is covered.

When we include the share of elderly individuals out of the total population to our baseline model, most of the other coefficients are almost the same as in model (1) to (4). Except for the net saving rate, which changes its sign from positive to negative, as we explained before. The coefficient for the elderly share variable suggests that a 1% increase in the share of elderly individuals decreases the wealth-to-income ratio with 1.337%. This coefficient is highly statistically significant. The result could be explained by the denominator effect, since a higher share of elderly individuals likely leads to a higher share of retired individuals. These individuals lose a part of their income, which explains the increase in the wealth-to-income ratio.

In Table 2, we show the results of our static model where we use first-differenced and level independent variables to explain our first-differenced wealth-to-income ratio. Most of the variables in our baseline model that had a statistically significant impact in Table 1, still show to have a statistically significant impact on the change in the wealth-to-income ratio in Table 2. Except for the return on equity and income inequality. The signs of the coefficients are also the same as in Table 1, except for the net saving rate, return on government bonds and union density. It is remarkable that the net saving rate now seems to have a negative impact on the change in the wealth-to-income ratio in our sample, although this impact is still not statistically significant. The return on equity is not statistically significant in any of the three regressions and the coefficient is slightly smaller than in Table 1. The return on housing still shows a relatively large, positive and statistically significant coefficient in all three models, which confirms our results in Table 1. The return on government bonds now shows a low positive impact on the first-differenced wealth-to-income ratio, although still not statistically significant Furthermore, the coefficient of the change in the share of public wealth is much larger in Table 2 when comparing it to the level-coefficient in Table 1. This suggests that changes in the first-differenced share of public wealth have a stronger relationship with changes in the first-differenced wealth-to-income ratio than the levels of these two variables. The coefficients and p-values for inflation and GDP growth in Table 2 are relatively similar to those in Table 1. Both the union density variable and the progressive taxation variable do not seem to have a statistically significant impact on the first-differenced wealth-to-income ratio.

The results of our robustness check in Table 2 indicate that we need to be careful with ascribing statistical inference to some of our coefficients in Table 1. However, the coefficients for the return on housing, inflation and GDP growth seem to be rather robust.

Table 2. Final regressions with LSDV-estimator on the ΔWealth-to-income Ratio

VARIABLES	(1) LSDV	(2) LSDV	(3) LSDV
Net Saving Rate	-0.160	-0.167	-0.344
	(0.231)	(0.229)	(0.241)
Return on Equity	0.0305	0.0454	0.0533
	(0.0384)	(0.0385)	(0.0407)
Return on Housing	0.867***	0.875***	1.028***
	(0.107)	(0.107)	(0.128)
Return on Government Bonds	0.165	0.181	0.137
	(0.110)	(0.111)	(0.114)
Diff. Income Inequality	-2.369	-2.435	-3.191
	(1.921)	(1.902)	(2.001)
Diff. Public Wealth	1.729***	1.726***	1.694***
	(0.116)	(0.115)	(0.118)
Inflation	-1.938***	-2.056***	-2.126***
	(0.377)	(0.394)	(0.438)
Real GDP per Capita Growth	-1.792***	-1.798***	-2.085***
	(0.533)	(0.528)	(0.547)
Diff. Union Density		0.0515	
		(0.359)	
Diff. Progressive Taxation			-2.300
			(1.402)
Observations (n)	451	447	426
R-squared	0.621	0.626	0.641
Number of countries (N)	13	13	13
Country FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3 Other Robustness Checks

We perform another series of regressions and tests on our first baseline model to ensure that the coefficients are robust and do not differ too much over the various estimation methods. All of these robustness checks can be found in Appendix B.

5.3.1 LSDV and Time-Fixed Effects

The first regression that we perform uses the conventional LSDV estimator. We then conduct a Wald-test to jointly test whether the year dummies, our control for time-fixed effects, for all years are equal to zero. The F-statistic with 41 numerator and 389 degrees of freedom is 2.25, which means that we can reject the null hypothesis at the 1% level (Appendix B.1). We reject the null hypothesis that for all years the coefficients are jointly equal to zero and conclude that we should indeed include time-fixed effects in our regression models.

5.3.2 Cross-Sectional Dependence

We use the Pesaran (2004) test to test for cross-sectional dependence in our panel data. This tests whether the residuals are correlated across the entities, which could introduce bias in the estimation coefficients. We use the Pesaran test because it is able to handle unbalanced panel data such as ours, while other similar tests are not. The Pesaran test uses the Lagrange Multiplier (LM) test statistic, which is calculated as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}} * \left(\sum_{i=1}^{N-1} \sum_{t=i+1}^{N} \hat{p}_{ij} \right)$$

In this equation, T is the number of periods and N is the number of countries in our panel. The $\hat{p}$ measures the extent of local dependence. Our test statistic is -3.954, which means that we can reject the null hypothesis at the 1% level (Appendix B.2). We reject that the null hypothesis that the residuals are not correlated and therefore have to control for cross sectional dependence. The LSDVC-estimator that we use for our main results controls for this.

5.3.3 Autocorrelation

Even though the Arellano and Bond (1991) and Blundell and Bond (1998) estimators are known to be biased for panels with a low N such as ours, we use these estimators with robust standard errors as an additional robustness check for our coefficients. Moreover, with these estimators we are able to test for serial correlation in the first-differences of order one, AR(1), and two, AR(2). The Arellano-Bond test uses the null hypothesis of no serial correlation. The null hypothesis of no serial correlation at order one is rejected, which is as expected and necessary since this is the case when our idiosyncratic errors are i.i.d. The null hypothesis of no serial correlation at order two is also rejected (Appendix B.3), which implies model misspecification. Roodman (2009) suggests that the solution for AR(2) is to include lags of the dependent variable of higher orders until the AR(2) test is not rejected. For this we use the *xtabond2* function in Stata that is introduced by Roodman, which uses the Blundell and Bond (1998) GMM. When we include up to three lags of the dependent variable, the test for AR(2) is not rejected. Some of the coefficients slightly change in this regression (Appendix B.3), but the statistical significance of most variables does not change. Moreover, the coefficient of the return on housing seems robust, since it does not differ much across the different regressions and is statistically significant in all of them.

5.3.4 Savings Decomposed

As mentioned in Section 4.2, we conduct a regression on our baseline model where we control for the different definition of the wealth-to-income ratio's growth rate that textbook models use. This takes into account the critique by Krusell and Smith (2015), who emphasize the inconsistencies in Piketty's growth model that we discussed in Section 2.2.2. By replacing the net saving rate with the gross saving rate and adding the depreciation rate up to the GDP growth rate, the model controls for this theoretical modification.

We observe that the decomposition of the saving rate does not affect the other coefficients in the baseline model largely (Appendix B.4), which suggest that those coefficients are robust with regard to this theoretical modification. The gross saving rate does not seem to have a statistically significant impact on the wealth-to-income ratio, which is also the case for the net saving rate. The size of the coefficient for the GDP growth rate is smaller now that the depreciation rate is added.

5.3.5 Comparison

We compare the results of the estimations on our baseline model across the three different estimation methods (Appendix B.5). As mentioned before, the Blundell-Bond estimator (1) is inconsistent due to its inability to handle panels with a relatively low N compared to T. This inconsistency is minimized in the second regression (2) that uses the LSDVC-estimator, where the initially consistent estimates are calculated with the Arellano-Bond estimator. This is the estimation technique that we use for our main results that we present in Section 5.2. The third

(3) regression also uses the LSDVC-estimator, but here the initially consistent estimates are calculated with the Blundell-Bond estimator.

The results do not differ a lot across the three regressions. There are some differences when comparing the first (1) regression with the last two regressions. However, these differences are not that large and could be explained by the inconsistency of the estimator in regression (1). The largest differences between the first (1) regression and regression (2) and (3) is in the coefficient for the net saving rate, public wealth and income inequality. Since the other estimates between these two consistent estimators are rather similar, we regard our main results, obtained with the LSDVC - AB estimator, as robust. However, we need to take into account that some of the coefficients and their p-values changed in the robustness check in Table 2 of Section 5.2.

6. Discussion and Policy Implications

Our estimation results provide some valuable insights, in particular into the important role that housing has played in the last decades with regard to wealth accumulation. Although similar results have been found in earlier academic literature (Fuller et al., 2020; Jordà et al., 2019; Rognlie, 2014), our thesis emphasizes the impact of not only the capital gains out of housing on wealth accumulation, but also the impact of incomes that are generated through rental yield. By including both income out of capital gains and out of rental yields in our return on housing, we show that housing returns have played a very large role in the recent increase of the wealth-to-income ratio. Although it is difficult to prove a causal relationship between the wealth-to-income ratio and wealth inequality, the studies by Piketty and Saez (2014), Piketty and Zucman's (2014) and Fuller et al. (2020) argue that a high level of the wealth-to-income ratio goes together with higher degrees of wealth inequality. Our results complement these studies by emphasizing the large role that housing returns have played in the recently increased wealth-to-income ratios.

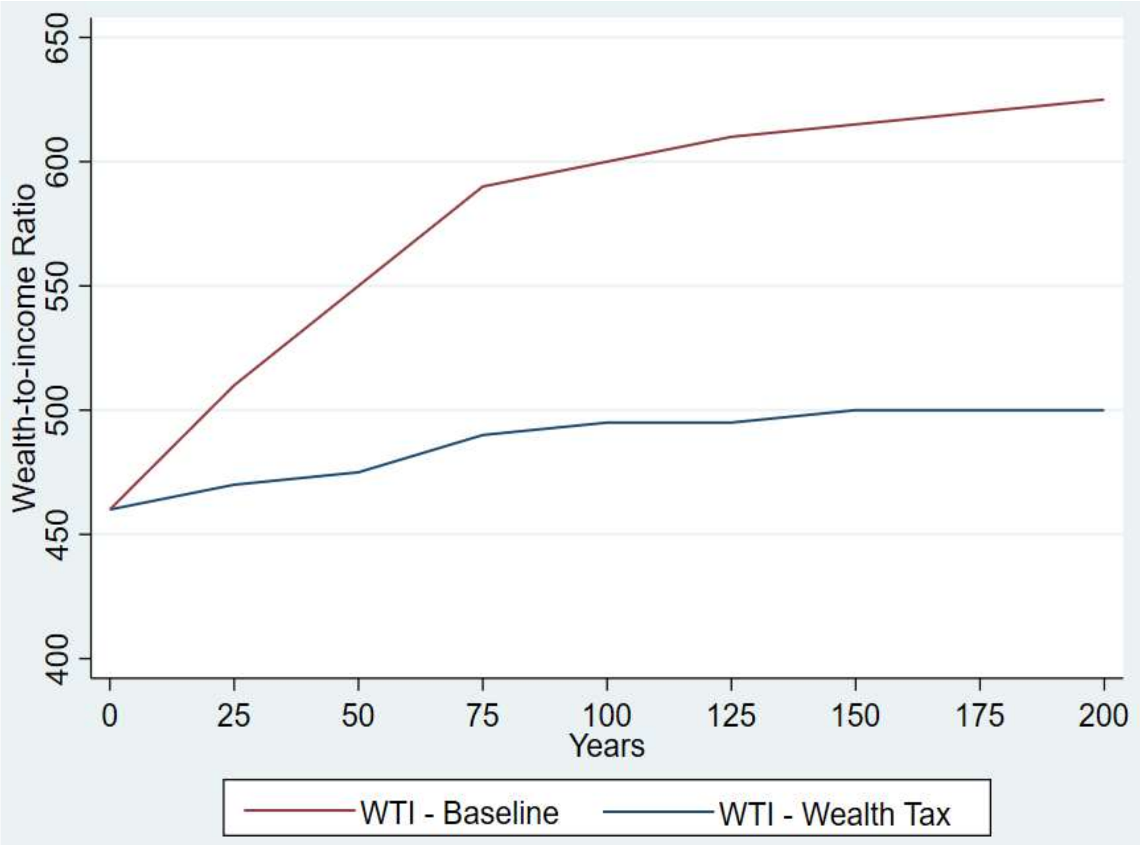
Furthermore, our results confirm the large negative impact that economic growth has on the wealth-to-income ratio. This is consistent with Piketty's (2014) findings that are the basis for the central relationship in his book that defines capital's share of income: $\alpha = r * \frac{s}{g}$. Our results highlight the importance of economic growth (g) in keeping the capital's share of income stable, because periods of low growth can largely increase the relative importance of capital. If economic growth will continue to be low in the next decades, as Piketty predicts, then its large mitigating effect on the wealth-to-income ratio will not be present and the wealth-to-income ratio will increase due to the relatively high return on capital (r). As Piketty and Zucman (2014) argue, the likelihood of increasing wealth-to-income ratios raises questions regarding inheritance and wealth taxes. Piketty and Saez (2014) emphasize that wealth-to-income ratios go together with large financial instability and asset price bubbles, which is in line with the descriptive graphs in Chapter 4, where crashes of asset markets in Japan and Spain occur at points when the wealth-to-income ratio is around 800%. Piketty and Saez argue that with imperfect capital markets and home portfolio bias, high levels of wealth-to-income ratios increase domestic bubbles of asset prices. They show that the crashes of these asset markets are larger when the wealth-to-income ratio is between 600 to 800%, relative to a level of 200 to 300%. Moreover, Piketty and Saez also find that high levels of wealth-to-income ratios go together with high degrees of wealth inequality. As we mentioned in Section 2.1, high degrees of wealth inequality lead to high social costs. These observations can help to design financial and monetary policy that are aimed at keeping the wealth-to-income ratio at a certain level, or at least aimed at preventing the wealth-to-income ratio from increasing even further. In the absence of other reference points regarding the accumulation and distribution of wealth, the wealth-to-income ratio can provide an (imperfect) reference point for policy makers to indicate whether the development of the relative importance of wealth and capital have gone too far (Alvaredo, Piketty, Saez, Chancel, & Zucman, 2018).

Government policies that could lower the level of the wealth-to-income ratio are amongst others taxes on wealth and inheritance. These options are widely discussed in recent literature. Piketty (2014) suggests a tax of 0.1% on wealth up to 200.000 euro, 0.5% up to 1 million euro, 1% up to 5 million euro, 2% up to 1 million euro and 5% on wealth larger than 1 billion euro. Ederer and Rehm (2020) calculate the impact that such a wealth tax would have on the wealth-to-income ratio with a Post-Keynesian wealth model. Figure 8 shows a replication of the predictions of their model in the coming 200 years. They find that without any policy interventions the wealth to income ratio will continue to rise, which is consistent with the other literature that we discussed in Chapter 2. With the wealth tax that is proposed by Piketty (2014), they predict that the wealth-to-income ratio will reach a much lower steady-state level in about 75 to 100 years. The wealth tax redistributes income from those who earn income out capital to those who mainly earn labour income. Ederer and Rehm show that the wealth tax raises the utilization of capital, while simultaneously lowering the wealth-to-income ratio. Moreover, the increase in the share of wealth of the richest households will be mitigated, thereby reducing wealth inequality. As long as the wealth tax is imposed periodically, the reduction in the share of wealth of the richest households is permanent. Ederer and Rehm argue that an inheritance tax or a tax on income out of capital would have similar effects on the wealth-to-income ratio. In their Post-Keynesian model, they find that an inheritance tax of 60% should have the same impact on the wealth-to-income ratio as a yearly wealth tax of 2.4%, which is the average of the wealth tax proposed by Piketty (2014). They also find that the tax on income out of capital should be about 30% to realise the same impact on as the wealth tax.

The results from this thesis suggest that policy interventions aimed at reducing or stabilizing the wealth-to-income ratio could also target a single component of capital that is a main driver of the wealth-to-income ratio: the return on housing. Based on our quantitative analysis, capital gains and rental yields out of housing seem to have had a large positive impact on wealth-to-income ratios in the past decades and especially the impact of rental yields has been underestimated in earlier literature. This is however in line with the findings by Aalbers, Hochstenbach, Bosma and Fernandez (2020), who argue that the Private Rental Sector (PRS) is making a comeback. Their study focuses on the Netherlands, but they list several studies that notice an increase in the PRS for Australia, Belgium, Spain, Ireland, the United Kingdom and the United States. Aalbers et al. find that the policies that the Dutch government uses to increase homeownership rates, such as the mortgage interest deduction or the temporary removal of transfer taxes, only expand the mortgage market and practically drive up the prices in both the market price of houses as their rents. Various policies to promote homeownership arguably led to an overstimulation of the demand-side in the housing market in developed countries (Aalbers et al, 2020). The results of our estimations on the impact of the return on housing on the wealth-to-income ratio, could be a reason for governments to consider stimulating the supply-side of the housing market. This could in time mitigate the continuously increasing housing prices in OECD countries.

Figure 8. Development of the Wealth-to-income Ratio in Europe with a Wealth Tax in the Coming 200 Years

(Source: Replication of figure 3 in Ederer and Rehm (p.212, 2020): "Effects of a wealth tax on short- and long-run dynamics of the Post-Keynesian wealth model in Europe".)



7. Conclusion

In this thesis, we quantitatively examined the main drivers behind the recently increasing wealth-to-income ratios in a selection of OECD countries. Earlier literature has shown that high wealth-to-income ratios go together with high degrees of wealth inequality, large financial instability and asset price bubbles. We conducted a series of regressions with the bias-corrected least squared dummy variable (LSDVC) estimator on our baseline model with the wealth-to-income ratio as our dependent variable and the net saving rate and the returns on housing, equity and government bonds as our main explanatory variables. Furthermore, we control for income inequality, the growth rate of real GDP per capita, inflation and the share of public wealth. We perform these regressions on an unbalanced panel of 13 OECD countries in the period 1973-2015.

When we look back at our research question, our quantitative analysis suggests that capital gains and rental yields have been an important driver of wealth-to-income ratios. While economic growth seems to have a large negative effect, the level of economic growth has not been high in the past decades. We find that in particular the return on housing has a relatively large positive significant impact on the wealth-to-income ratio in our sample. The coefficient of housing stays statistically significant and large in all robustness checks. The return on equity has a small positive impact on the wealth-to-income ratio, but this results seems to be less robust as its coefficients differs across our robustness checks. Furthermore, we find that saving behavior might not have played a large role in the recent increase of wealth-to-income ratios in the countries of our panel. This contradicts the prediction by Piketty and Zucman (2014), who argue in their descriptive analysis that the increase in wealth-to-income ratios is for 60% due to increased savings and for 40% to capital gains. This might be due to our different, and more complete, definition of the return on capital. Where Piketty and Zucman define this as only 'capital gains', we include capital gains but also other income out of capital such as rental yields, dividend yields and coupon yields.

Our estimations do confirm the large mitigating role that economic growth plays in the determination of wealth-to-ratios that Piketty and Zucman mention. This is likely a denominator effect, since real GDP usually grows on a similar level as incomes. For the other indicators that we included in our analysis, such as the degree of progressivity of income taxation, union density and wage bargaining power, we do not find that they have any statistically significant impact on the wealth-to-income ratio. Although our baseline model suggests a statistically significant impact for some of these variables, we cannot confirm this in our robustness check where we control for the non-stationarity of our dependent variable.

Our results suggest that the capital gains and rental yields out of housing are playing a large role in the increasing wealth-to-income ratios in developed countries. Moreover, the important mitigating effect of economic growth confirms Piketty's predictions that if $r > g$ in the coming decades, wealth-to-income ratios will continue to rise. Besides considering the implementation of wealth or inheritance taxes, governments could also target policies at stabilizing the continuously increasing housing prices. Government policies in the previous decades were mainly focused at stimulating homeownership, and thereby the demand side of the housing market, which contributed to the increasing housing prices. Governments should consider whether continuing to stimulate the demand side of the housing market is doing any good, as it just helps to drive up the prices and increase the financial gap between homeowners and non-homeowners.

We are aware that despite our extensive statistical analyses, our models still have several limitations. One of those is that with our LSDVC-estimator we only minimize the bias that exists in dynamic fixed effects models and do not fully exclude it. Furthermore, ideally the number of countries in our panel would be higher than 13, but we are not able to include other countries due to the limited availability of the data that we use for the return on capital. Moreover, the lack of data on the distribution of wealth makes it difficult to argue that there is a causal relationship between any of our variables and wealth inequality. We therefore think that the wealth-to-income ratio can at most function as a reference point for wealth inequality. If internationally comparable data on the accumulation and distribution of wealth were available, more insights on the drivers of wealth inequality could be found. Future research, in particular on a micro-level, should be able to give additional insights in the exact impact of the returns on the various kinds of capital on wealth inequality. This should become easier in the near future, since the data collection on the accumulation and distribution of household wealth is extending by the year.

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Appendix

A. Unit Root Tests

We conduct the Im-Pesaran-Shin unit root tests on all of our variables individually to test their order of integration and determine whether their level or first-difference is stationary. This test is the only unit root test that is able to handle unbalanced panel data in *Stata*. For the variables of the wealth-to-income ratio, public wealth, income inequality, progressive taxation and union density we cannot reject the null hypothesis that the data could be non-stationary and that there is a unit root present. We difference these variables and test those first-differences again for unit roots. In these tests, we can reject the null hypothesis and conclude that the first-differences are stationary. The order of integration for these variables is therefore one, I(1). For all other variables the null hypothesis that there is a unit root present is rejected at the level, which means that those variables are of order zero, I(0).

Variable	CIPS-statistic - Level	CIPS-statistic – First-Difference	Order of Integration
Wealth-to-income Ratio	4.73	-6.97***	I(1)
Net Saving Rate	-2.37***	-	I(0)
Return on Equity	-11.85***	-	I(0)
Return on Housing	-4.88***	-	I(0)
Return on Government Bonds	-13.43***	-	I(0)
Public Wealth	5.52	-4.81***	I(1)
Income inequality	3.05	-5.47***	I(1)
Inflation	-1.50*	-	I(0)
Real GDP per Capita Growth	-8.94***	-	I(0)
Progressive Taxation	-0.83	-8.20***	I(1)
Union Density	0.26	-9.00***	I(1)
Wage Bargaining Centralization	-	-	-
Immigration	-	-	-
Elderly Share	-	-	-

*** p<0.01, ** p<0.05, * p<0.1

B. Robustness Checks

B.1 Regression with LSDV: Testing Year-Fixed Effects

First, we need to perform a regressions with the conventional LSDV-estimator on our first baseline model in order to be able to perform the Wald test. The output of the regression with the LSDV-estimator on our first baseline model is as follows:

VARIABLES	(1) LSDV	(2) LSDV with Year Dummy
Wealth-to-Income (t-1)	0.983***	0.932***
	(0.0146)	(0.0175)
Net Saving rate	0.608**	0.263
	(0.288)	(0.303)
Return on Equity	0.163***	0.0823*
	(0.0315)	(0.0462)
Return on Housing	1.233***	1.008***
	(0.124)	(0.129)
Return on Government Bonds	-0.190**	-0.168
	(0.0866)	(0.132)
Public Wealth	0.104***	0.145***
	(0.0328)	(0.0328)
Income Inequality	-0.451	-1.531***
	(0.398)	(0.493)
Inflation	-2.457***	-1.989***
	(0.307)	(0.461)
Real GDP per Capita Growth	-2.166***	-2.309***
	(0.481)	(0.639)
Observations (n)	452	452
R-squared	0.964	0.971
Number of Countries (N)	13	13
Country FE	YES	YES
Year FE		YES

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Test for year-fixed effects:

Walt test: H0: all years are jointly equal to zero

F(41, 389) = 2.25

Prob > F = 0.0000

H0 is rejected, so we reject that the coefficients for the years are jointly equal to zero, therefore we will need time-fixed effects to control for the heterogeneity over time.

B.2 Cross-Sectional Dependence

We use the Pesaran (2004) test to test for cross-sectional dependence in our panel data.

Pesaran test: H0: residuals across entities are not correlated.

Pesaran's test of cross sectional independence = -3.954, Pr = 0.0001

Average absolute value of the off-diagonal elements = 0.203

We reject H0 and conclude that the residuals across entities are correlated and our panel data therefore suffers from cross-sectional dependence. We control for this with our LSDVC-estimator.

B.3 Autocorrelation

VARIABLES	(1) Arellano-Bond	(2) Blundell-Bond	(3) Blundell-Bond	(4) Blundell-Bond
Wealth-to-Income (t-1)	0.932***	1.012***	1.331***	1.352***
	(0.0153)	(0.00928)	(0.0410)	(0.0440)
Wealth-to-Income (t-2)			-0.339***	-0.482***
			(0.0423)	(0.0717)
Wealth-to-Income (t-3)				0.130***
				(0.0446)
Net Saving Rate	0.218	0.572***	0.261	0.315
	(0.746)	(0.218)	(0.238)	(0.234)
Return on Equity	0.0903	0.0884**	0.110***	0.126***
	(0.0558)	(0.0375)	(0.0410)	(0.0435)
Return on Housing	1.064***	1.074***	1.147***	1.286***
	(0.131)	(0.106)	(0.137)	(0.140)
Return on Government Bonds	-0.169	-0.0535	-0.0474	-0.101
	(0.125)	(0.106)	(0.117)	(0.116)
Public Wealth	0.154***	-0.0294*	-0.0130	-0.0167
	(0.0416)	(0.0174)	(0.0170)	(0.0154)
Income Inequality	-1.787**	-0.746**	-0.178	-0.411
	(0.774)	(0.372)	(0.393)	(0.361)
Inflation	-1.989***	-1.075***	-1.369***	-1.468***
	(0.594)	(0.339)	(0.380)	(0.393)
Real GDP per Capita Growth	-2.441**	-2.452***	-2.813***	-2.837***
	(1.012)	(0.512)	(0.570)	(0.576)
Observations (n)	439	452	439	426
Number of Countries (N)	13	13	13	13
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
AR(1) Z-value	-2.54***	-4.64***	-3.42***	-5.99***
AR(2) Z-value	-2.65***	-5.43***	-2.86***	-1.09
Sargan Overidentification Chi2		622.94***	449.47***	433.27***

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

These are the regressions with the Arellano and Bond (1991) and Blundell and Bond (1998) estimators. As discussed, since our N is not tending to infinity, these estimators are biased. Moreover, the GMM technique that these estimators use lead to overidentification when N is small relative to T. The Sargan test for overidentification shows that this is indeed the case in all of the Blundel and Bond estimations. As mentioned in Section 5.3.3, we do think that it is useful to perform these regressions for two reasons: (i) it allows us to perform the Arellano-Bond test for autocorrelation of higher orders; and (ii) we are able to compare these coefficients with those of our final model with Bruno (2005a, 2005b) estimations as an extra robustness check.

The Arellano-Bond test for zero autocorrelation in first-differenced errors has 'no autocorrelation' as null hypothesis. This test is rejected for autocorrelation of the first order in all of our regressions. This is necessary, since it indicates that the idiosyncratic errors are i.i.d. The test is also rejected for autocorrelation of the second order in regression (1). This is problematic, but can be solved by including more lags of the dependent variable. This is what we do in (2), (3) and (4). In (4), where we include up to three lags of the dependent variable, the test for autocorrelation of the second order is not rejected. The coefficients differ for some of the variables, but the statistical significance and sign of the coefficient stay relatively the same.

B.4 Savings Decomposed

VARIABLES	(1) LSDVC - AB	(2) LSDVC - AB
Wealth-to-income (t-1)	0.971***	0.984***
	(0.0207)	(0.0205)
Net Saving Rate	0.364	
	(0.278)	
Gross Saving Rate		0.0030
		(0.381)
Return on Equity	0.0824*	0.0780*
	(0.0480)	(0.0478)
Return on Housing	1.028***	1.006***
	(0.132)	(0.132)
Return on Government Bonds	-0.159	-0.129
	(0.119)	(0.117)
Public Wealth	0.111***	0.118***
	(0.0380)	(0.0367)
Income Inequality	-1.289***	-1.366***
	(0.483)	(0.481)
Inflation	-1.751***	-1.515***
	(0.448)	(0.412)
Real GDP per Capita Growth	-2.219***	
	(0.613)	
GDP Growth + Depreciation		-1.692***
		(0.426/)
Observations (n)	452	452
Number of Countries (N)	13	13
Country FE	YES	YES
Year FE	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Both regression are estimated with the LSDVC-estimator, where the Arellano-Bond estimator is used for the initially consistent estimates. The first regression (1) is our baseline model, with the net saving rate ($\tilde{s}$) defined as 'gross savings (s) – depreciation rate (δ)' included. In the second regression, the gross saving rate is included and the depreciation rate is added up to the real GDP per capita growth rate, as explained in Section 4.2 and 5.3.4. Krusell and Smith (2015) mention that Piketty does not take into account the depreciation rate in his estimation of the wealth-to-income ratio. We show here that using the definition by Krusell and Smith and textbook models for the growth rate of wealth-to-income ratios, $\frac{s}{g+\delta}$, instead of Piketty's formula, $\frac{\tilde{s}}{g}$, barely affects the coefficients of the other variables, indicating that the results are robust for this theoretical modification of the model.

B.5 Comparison

VARIABLES	(1) Blundell-Bond GMM	(2) LSDVC - AB	(3) LSDVC - BB
Wealth-to-income (t-1)	1.352***	1.273***	1.273***
	(0.0440)	(1.38e-05)	(1.41e-05))
Wealth-to-income (t-2)	-0.482***	-0.448***	-0.447**
	(0.0717)	(0.0470)	(0.227)
Wealth-to-income (t-3)	0.130***	0.106**	0.105
	(0.0446)	(0.0454)	(0.304)
Net Saving Rate	0.315	0.0457	0.0462
	(0.234)	(0.328)	(1.111)
Return on Equity	0.126***	0.120**	0.120
	(0.0435)	(0.0488)	(0.0887)
Return on Housing	1.286***	1.176***	1.176*
	(0.140)	(0.147)	(0.605)
Return on Government Bonds	-0.101	-0.172	-0.173
	(0.116)	(0.121)	(0.709)
Inflation	-1.468***	-2.061***	-2.062**
	(0.393)	(0.460)	(0.935)
Public Wealth	-0.0167	0.130***	0.129
	(0.0154)	(0.0375)	(0.150)
Income Inequality	-0.411	-1.285***	-1.283
	(0.361)	(0.408)	(7.739)
Real GDP per Capita Growth	-2.837***	-2.670***	-2.676*
	(0.576)	(0.746)	(1.466)
Observations (n)	426	426	426
Number of Countries (N)	13	13	13
Country FE	YES	YES	YES
Year FE	YES	YES	YES

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

These regressions are a comparison of our Bruno LSDVC-estimator (2005a, 2005b) and the Blundell and Bond GMM estimator (1998) with three lags of the dependent variable. In regression (2), the Arellano-Bond estimator is used for our initially consistent estimates and in regression (3), the Blundell-Bond estimator is used for our initially consistent estimates. With regard to statistical significance, the most remarkable differences are the results for public wealth, the return on equity and income inequality. For the return on equity and housing, which are some of the main variables of interest for our thesis, the result seem rather robust across the different regressions. The coefficient for the net saving rate becomes much lower in model (2) and (3) compared to model (1).