Socio-economic Analysis of Income Distribution: An Investigation of the Influence of Wealth Formation and Returns on Capital in Different Institutional Environments (Or simply - Analysis of Lateral Distribution)

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Socio-economic analysis of income distribution: An investigation of the influence of wealth formation and returns on capital in different institutional environments

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Abstract

The large increase in wealth and income inequality in the last decades can be attributed to several, often heterogeneous, effects. To explain the dynamics of wealth distribution we must investigate the complex link between income and wealth, considering not only the heterogeneity but also the feedback effects in this relationship. While economic models incorporate functional distribution and macroeconomic effects, dynamics of personal distribution have mostly been captured by empirical studies up until now.

This paper makes a methodological contribution by introducing the concept of a lateral distribution matrix, which combines income groups, income sources, savings behaviour, and rates of return. Lateral distribution describes the combination of the functional and personal view (Atkinson 2009). This perspective allows not only to differentiate between income from labour and wealth, but also to capture intra-country heterogeneity which is driven by a heterogeneous savings rate increasing with income (Späth & Schmid 2016), returns on capital depending on the type of assets, returns on capital increasing with on amount of wealth (Piketty 2014), and the heterogeneity of capital gains (Adam & Tzamourani 2016).

To capture the complexity of the relationship between wealth and income a standard linear approach does not suffice. One needs a more holistic method. Therefore, to illustrate how the lateral distribution matrix can be integrated into economic models, I suggest a fully empirical stock-flow consistent (Godley 1997, Godley & Lavoie 2007, Miess et al. 2019) agent-based (Caiani et al. 2016) systems dynamics model (Forrester 1961) disaggregated on a household level (Dafermos & Papatheodorou 2015, Carvalho & Rezai 2016). It is based on a framework developed in my previous work on the connection between distributional dynamics and comparative capitalism, which sees the economy as a circular flow system defined by institutions.

Thus, this ambitious proposal inevitably has to solve three theoretical problems at the same time: (1) the connection between wealth and income distribution, (2) the combination of the effects of functional and personal income distribution, and (3) the path dependence caused by the institutional environment of economies. From an empirical perspective, this paper combines the macro and micro levels by using data from the German national accounts, household survey data on income distribution (German SOEP) and survey data on wealth (HFCS, German PHF). Therefore, it contributes to empirical, methodological, and theoretical aspects of wealth distribution research.

Keywords: *functional income distribution, personal distribution, lateral distribution, complexity, system theory, macroeconomic model, stock-flow consistent, agent-based modelling*

JEL classifications: *D30, D31, D33, D39, D90, E02, E12, E17, E25, E70, H31,*

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1 Introduction

Inequality constitutes a topical subject not only from an economic perspective but also from a social and political point of view. For nearly half a century distribution has been a side issue in economics and did not receive much attention from cutting-edge research. The recent Great Recession and Thomas Piketty's "Capital in the Twenty-First Century" (2014) moved it back into the spotlight of the economic and public discussion and brought back the debate whether and to what extent the state should intervene in the market to achieve a higher level of equality in a globalized world.

Inequality is multidimensional, not only in its determinants and its manifestations but also from an analytical economic perspective. On the one hand, income and wealth distribution are intertwined through savings and returns on wealth. On the other hand, the division between the factors of production into profits and wages is a traditional core issue of economic theory. At the same time, economic policy started to focus on personal income distribution, the distribution among the members of the society, in the middle of the 19th century. Thus, economics differentiates between two concepts of income distribution which reflect different perspectives. While both perspectives are fruitful in distinct ways, the vast majority of the existing theoretical frameworks ignore the interaction between factor shares at the macro level and income and wealth inequality at the micro level and examine them separately.

The empirical observations provide us with a very fractured picture. Over the past decades, inequality of income and wealth has risen in many countries all over the world, reaching historic highs in some cases, causing a wide gap between poor and rich (cf. OECD 2015, p. 23). Since the 1980s one can observe a steady increase at least until the recent financial crisis in 2007. While the Great Recession stopped this development for a short time and even rolled it back up to a certain degree, the latest data shows that inequality is rising again and higher than before the crisis. The recent pandemic has made this even more visible (Huang 2020). The income inequality in wealthy industrialized countries is higher than it has been for a long time (Dabla-Norris et al. 2015). The current levels are comparable to those estimated for the 19th and the beginning of the 20th century (Piketty 2014). This observation is also robust in terms of different inequality measures. Discrepancies can only be found in the extent of the change. If we look for example at the measures for Germany: the Gini-coefficient of the real net income rose despite a short term reduction between 2007 and 2010 from 0.25 in 1980 to 0.3 in 2019, which is an increase of 20% (measures may vary slightly depending on the source, e.g. compare OECD 2020 and Panel 2022); the percentage of total income received by the top decile rose from 28.6% in 1980 to 37.1% in 2021, which corresponds to a 30% increase (cf. WID.WORLD 2022). A similar picture can be drawn for wealth inequality, even though on much higher levels and with smaller per cent changes. At first glance, the trend of an increasing income and wealth inequality, which can be observed in nearly all OECD countries (cf. OECD 2015, figure 1.3), seems to be independent of the historically specific political, social and economic system the respective countries (cf. Piketty 2014, OECD 2015, Deutsche Bundesbank 2016, Grabka & Westermeier 2014). It is often attributed to the dramatic rise in wage income of the top income earners. Among other things, the most popular explanations here are differences in productivity and technological progress (Lydall 1968, Tinbergen 1974, Goldin & Katz 2009, van Reenen 2011, Kleinknecht & Vergeer 2014) or the development of the so-called manager class at the top end of the distribution (Marris 1964, Krämer 2013, Duménil & Lévy 2015, Palley 2015, Dutt 2016).

However, the rise in inequality was also accompanied by a decrease in the wage share. (Daudey & García-Peñalosa 2007, Checchi & García-Peñalosa 2010, Krämer 2011). Piketty (2014) identified the capital-income-share as one of the main drivers of long term inequality. And while wage incomes, in general, have grown only moderately, capital incomes multiplied. The top incomes particularly profited from it because the higher the income, the higher the capital share of income (Goebel et al. 2010, Brenke 2011, Rehm et al. 2014), and the resulting growth in wealth leads to feedback effects. In general, capital incomes are more unequally distributed than labour incomes. Even though full-time employment is

responsible for the most part of the divergence, the influence of capital incomes is the most important driver in the recent development (Fräßdorf et al. 2011, García-Peñalosa & Orgiazzi 2013, OECD 2011, Rehm et al. 2014).

The empirical evidence already indicates the importance of household heterogeneity. Households differ not only in wealth and income and their shares of capital income and wages, their saving behaviour and wealth allocation will also vary depending on the income group (Klär & Slacalek 2006, Brenke & Wagner 2013, Späth & Schmid 2016, Deutsche Bundesbank 2016). The results are different rates of return and capital gains (Piketty 2014, Adam & Tzamourani 2016). All of this adds to the multidimensional interaction between functional and personal distribution, which can be denominated as lateral distribution.[1] There is still a lack of an integrated framework that can reproduce the complexity of lateral distribution and connect the macro and micro level in satisfactory way.

Furthermore, even the existing approaches to do not take into account the crucial effect of institutions which lead to country heterogeneity on various levels. Formal institutions are path-dependent and country-specific (Rodrik et al. 2004). Moreover, behavioural factors such as risk-aversion, financial market participation and investment behaviour will differ (Adam & Tzamourani 2016) as they are driven by formal institutions such as norms, customs or habits (Williamson 2000).

Starting from this point, this paper examines the relationship between personal and functional income distribution, taking into account the connection between income and wealth distribution and the role of capital incomes. The complexity of the problem is shown by the number of variables that have to be considered. The savings rate, the rate of return and the rate of interest form the focal point of the discussion. However, the heterogeneity of the empirical observations suggests that beyond that the institutional environment and the path dependence resulting from this play an essential role. Consequently, a holistic approach, which allows for a combination of theoretical approaches and empirical findings in a systemic framework, is required to solve the problem.

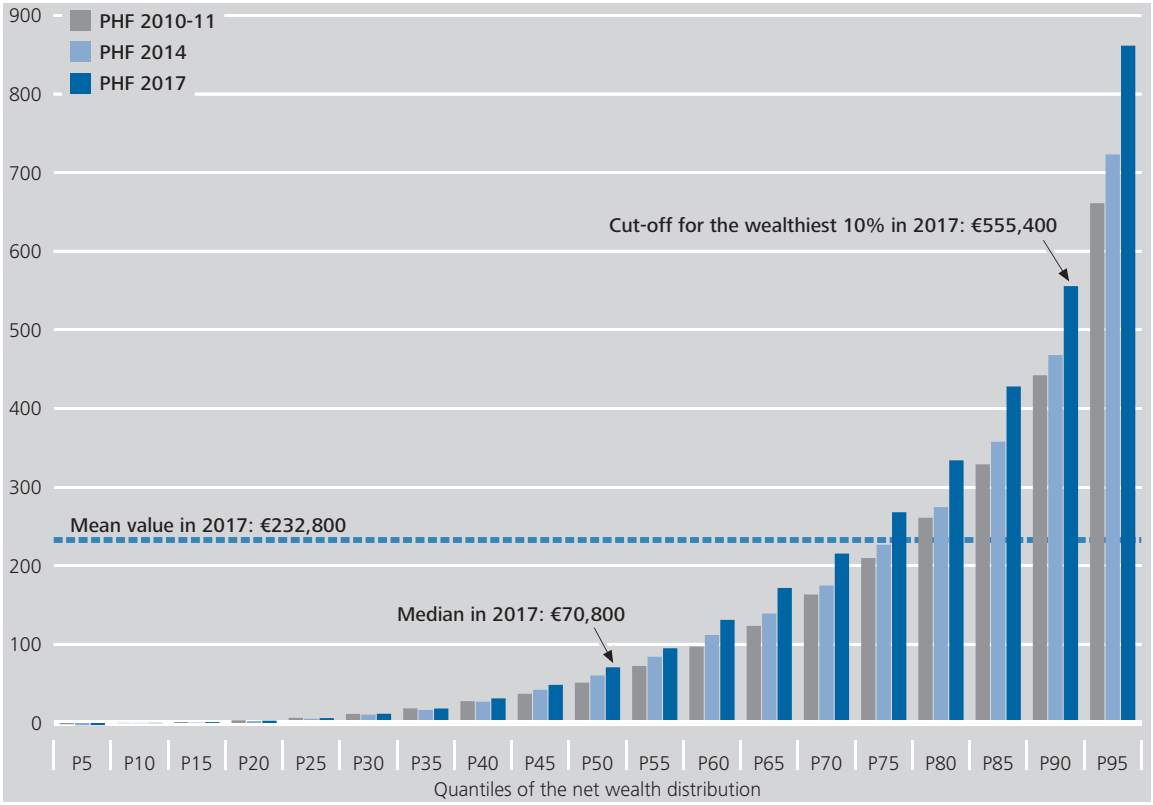
2 Current state of research

The empirical analysis of income and wealth distribution is crucial for the understanding of the structure and dynamics of inequality and the resultant social transformations. The influence of capital incomes on income and wealth inequality can be viewed from two different perspectives. Whenever addressing distribution, it is important to specify which concept is referred to. On the one hand, functional distribution, that has been the focus of economic theory since the classical authors, describes the distribution among different social classes according to the factors of production owned by them. On the other hand, the modern concept of personnel income or wealth distribution depicts the distribution of income and assets among the individual members of the society sorted in ascending order by groups according to the respective variable. Both perspectives can be identified as different dimensions of the same question. While the former is mostly discussed in theories, the latter is almost exclusively analyzed by empirical studies and policy discussions.

2.1 Stylized facts

A major part of inequality research addresses distributive questions in a purely empirical way. In particular, the dynamics of personal income and wealth distribution are mostly captured only by empirical studies. At the same time theory still has to account for the resulting facts these analyses. In the following, I will present the essential relevant observations for the question at hand are.

Figure 1: Distribution of German households' net wealth in 2010, 2014 and 2017. Minimum values for each quantile.



Source: Deutsche Bundesbank (2019).
Data: PHF 2010-11, PHF 2014 and PHF 2017 (Von Kalckreuth et al. 2019, Schmidt, Zhu, Le Blanc, Tzamourani, Altmann, Gabor, Werner & Pham-Dao 2019, Schmidt, Zhu, Le Blanc, Tzamourani, Altmann, Werner, Pham-Dao, Hebbat, Kothmayr, Bernard, Marek & Stender 2019), in thousand €, as at March 2019

(1) Income and wealth inequality

Over the last four decades, income inequality has increased in nearly all OECD countries (cf. OECD 2015, figure 1.3; OECD 2020). In this time, we could observe a profound transformation of the labour markets in conjunction with globalization, technological change and regulatory reforms. These changes left an undeniable impact on incomes (OECD 2011). While in the 1980s the richest decile of the population earned 7 times more than the poorest 10%, today the number increased to about 10 times more. Inequality is driven by a surge in incomes at the top and a much slower growth at the bottom (OECD 2008, 2011, Goebel et al. 2010, Hauser & Krämer 2011, Deutsche Bundesbank 2016).

Piketty (2014) illustrated the development and the extent of inequality by looking at the top-income shares. The share of the top 10% in total income has been rising sharply since the 1970s (WID.WORLD 2022). Between the 1950s and 1970s, the top decile income share was about 30-35% of total income in Europe as well as in the US. Starting from the late 1970s and 1980s[2], we can observe a rise of over 10% in the Anglo-Saxon countries and +/- 5% in Continental and Northern Europe. This development can to a large extend be attributed to the upper tail (WID.WORLD 2022). While in the Anglophone countries we clearly observe a nearly 10% rise for the top 1% and 5-6% for the top 0.1% highest incomes, in the other countries these shares increased ever so slightly. In general, the Scandinavian countries show a more noticeable increase than Continental Europe, while a case by case study reveals no visible pattern. A similar development can be observed for wealth distribution (WID.WORLD 2022), even though the long time series data is much harder to come by and less reliable. The development of the German wealth distribution since 2010 shows a more differentiated picture (cf. figure 1). A first glance shows a significant increase in net wealth which becomes visible at the upper end of the distribution. When analyzing the data, however, the ratio between mean and median decreased from 3.8 to 3.3, which indicates a decrease in wealth inequality. This trend is confirmed by other measures such as the P90/P50 ration (8.6. to 7.8) and the Gini coefficient (0.76 to 0.74). The share of total net wealth held by the wealthiest 10% fell from 59% to 55% and look at the full distribution reveals that wealth inequality decreased in favour of the upper middle class (50th to 90th percentile). So while we observe a relative improvement for this part of the population, the situation of the lower 50% remained the same. One explanation of this development could be that the rise in real estate prices in the last 10 years (cf. bulwiengesa AG 2020), which is reflected in higher real estate wealth, benefits this group the most (Adam & Tzamourani 2016).

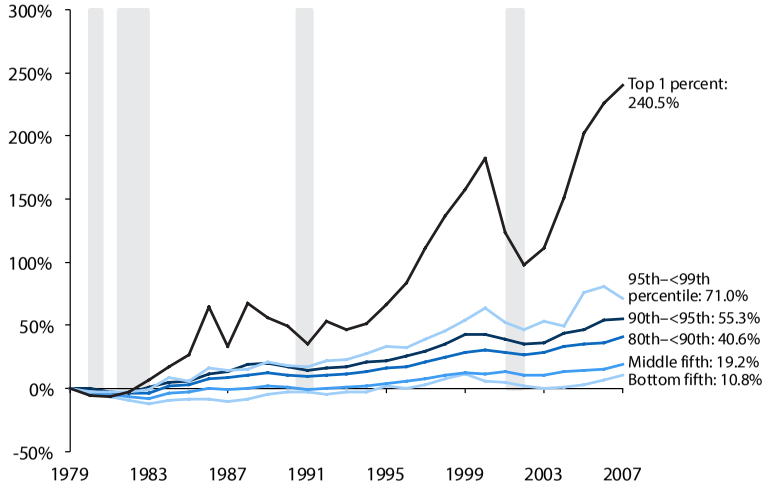
(2) Top wages

One source of this development are the income sources themselves. The large increase in income and wealth inequality in the OECD countries seen in the last decades is often attributed to the dramatic rise in wage income of the top income earners. Among other things, the most popular explanations here are differences in productivity and technological progress (van Reenen 2011, Kleinknecht & Vergeer 2014, Tinbergen 1974, Lydall 1968, Goldin & Katz 2009) and the development of the so-called manager class at the top end of the distribution (Marris 1964, Palley 2015, Dutt 2016, Duménil & Lévy 2015, Krämer 2013), which is particularly evident in the Anglophone developed economies (cf. Piketty 2014, p. 276–8, 302–03). New technological and financial developments demanded high skilled workers, such as the IT sector or the banking sector, and performance-based payment and bonuses become customary at the top end of the distribution (OECD 2015). At the same time, wages of low skilled workers could not keep up. Moreover, reforms of the tax systems have reduced marginal tax rates for high-income earners, and taxes and benefits tended to redistribute less starting from the mid-1990s, which had the most impact on the lower tail of the distribution.

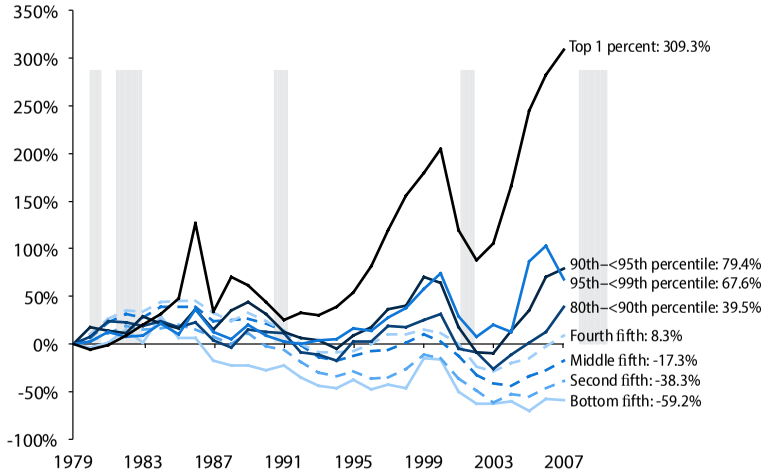
[1] This term is my own translation of the German term *Querverteilung*, which was introduced by to Strobbe (1962, p. 35).

[2] In Scandinavia, we can observe this development a decade later. It can be attributed to the political situation in these countries.

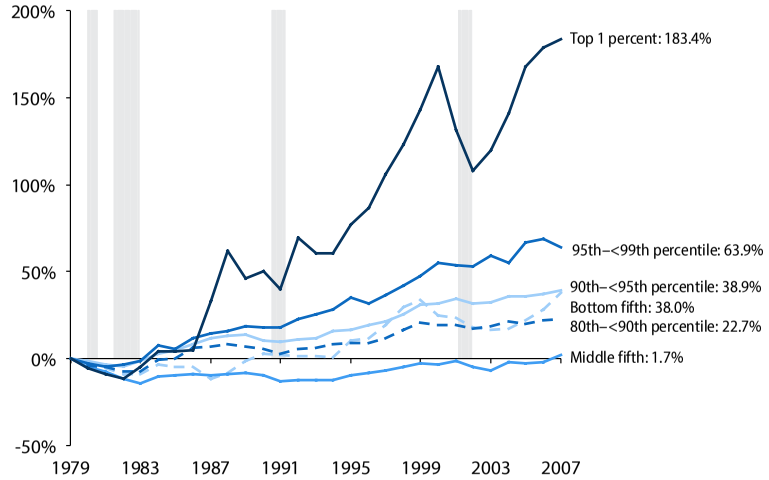
Figure 2: Changes in income components by income group, USA, 1979-2007.



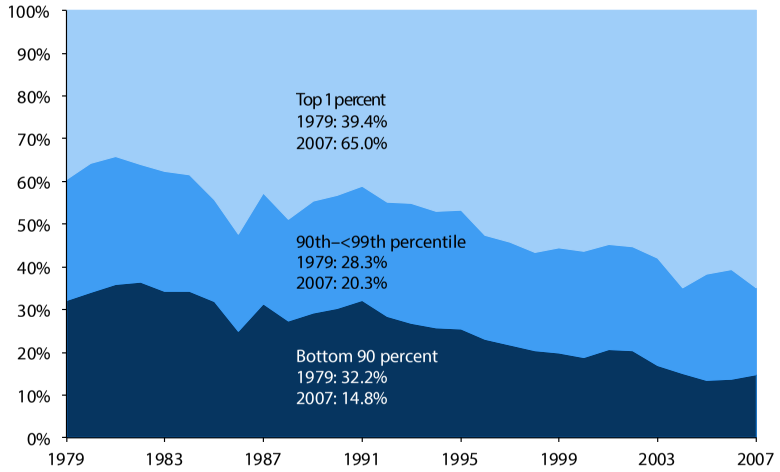
(a) Change in real annual household income.



(b) Change in real annual household wages.



(c) Change in real annual household capital income.



(d) Share of total household capital income claimed.

Source: Mishel et al. (2012, figure 2M, 2O, 2T, 2V). *Data:* Office (2010).

(3) Capital incomes

Piketty (2014) identified the capital-income-share as one of the main drivers of long term inequality. In general, capital incomes are more unequally distributed than labour incomes (cf. Goebel et al. 2010, Brenke 2011, Rehm et al. 2014). Moreover, while wage incomes grew only moderately, capital incomes multiplied. This can be illustrated exemplary on the development in the USA (see figure 2). We can observe a total income growth of 240.5% for the top 1% between 1979 and 2007. The top 1% account for 38% of total growth, which is more than the bottom 90% together. If we look at wages and capital income growth separately, the percentage for capital income is much higher, far above the above total income, than for wage, even though capital is the considerably smaller part of total income. The share of the top 1% in total capital income grew in this time from 40% to 65%.

Thus, in particular, the top incomes profited from this development because the capital share of total personal income increases with income (Piketty 2014, p. 274-303). Figure 3 illustrates how this effect intensified over time as capital income shifted more and more up the income distribution. The resulting growth in wealth of top incomes leads to noteworthy feedback effects, a self-reinforcing process where high not consumed capital incomes create wealth and wealth creates in turn capital income.

Rehm et al. (2014) shows the contribution of different components of income to inequality based on the German Socio-Economic Panel (see figure 4). Even though full-time employment is responsible for the most part of the divergence, figure 4b shows that the influence of capital incomes is the most important driver in the recent development. This reflects other results found in the literature (Fräßdorf et al. 2011, García-Peñalosa & Orgiazzi 2013, OECD 2011). It should not be overlooked, that capital incomes are sensitive to business cycles (Becker 2000, Fräßdorf et al. 2011, García-Peñalosa & Orgiazzi 2013, Horn et al. 2014). This becomes most obvious when we look at the decline during the Great Recession. As returns from entrepreneurial activity and assets are situated more at the upper tail of the distribution, one can argue that an upswing such as in the year 2005-2007 will tend to increase inequality of market incomes. The rising concentration of capital incomes increases this effect. Thus, the stagnation of inequality at the of the first decade of the 2000s can be explained by a business cycle related decline in capital incomes instead of a boom on the labour market (Horn et al. 2014).

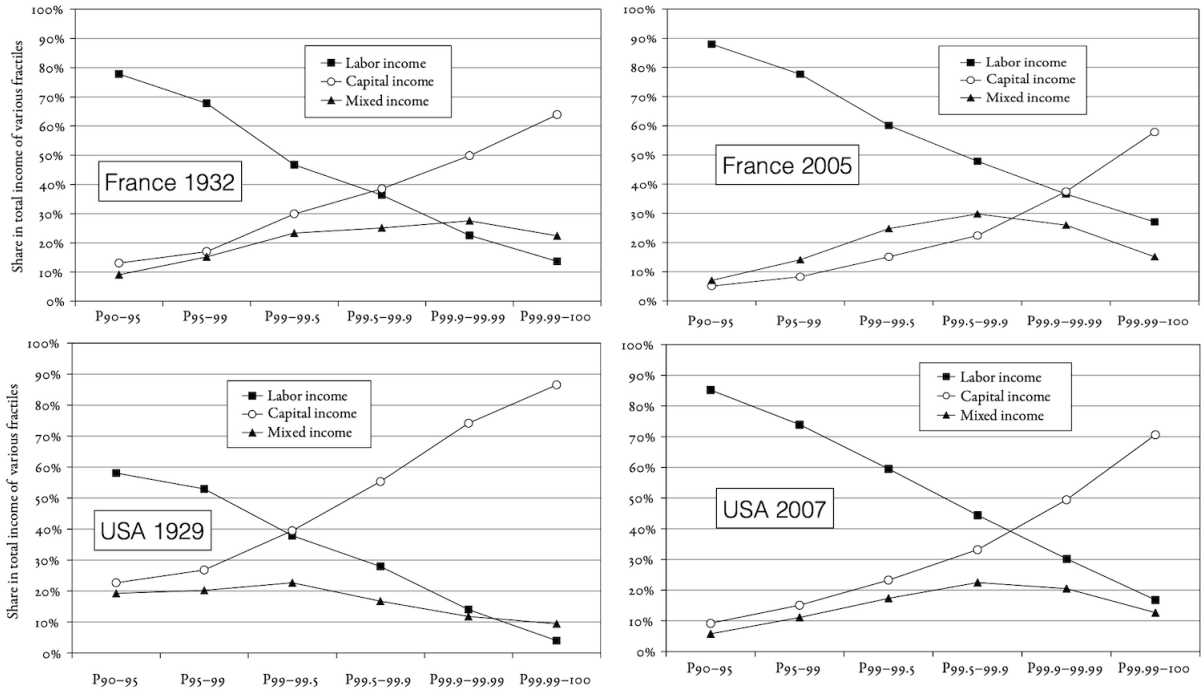
(4) The connection between functional and personal income distribution

As Atkinson (2009) points out, our understanding of inequalities could substantially be enhanced if the macro and the micro perspectives on income distribution were to be unified. Schmid et al. (2015) argue that neglecting this interaction could obstruct the analysis of personal inequality and ignore significant explanatory power. The influence of functional on personal income distribution is seen as relevant for the connection between macroeconomic development and changes in income distribution (Adler & Schmid 2013, Schmid & Stein 2013). For the research question changes on both levels of distribution, personal and functional, matter. Therefore, the interaction between those levels is also important. The latter poses a difficult task, as there is not much literature focusing on it (cf. Dagum 1999, Dutt 2014).Nevertheless, some empirical studies give valuable insights.

Over the last century, we can also observe a change in the share of different income source in total income, which among other things can be attributed to social and cultural changes (Piketty 2014). In most OECD countries, a shift in favour of capital incomes has taken place (Krämer 2011, European Commission 2020).

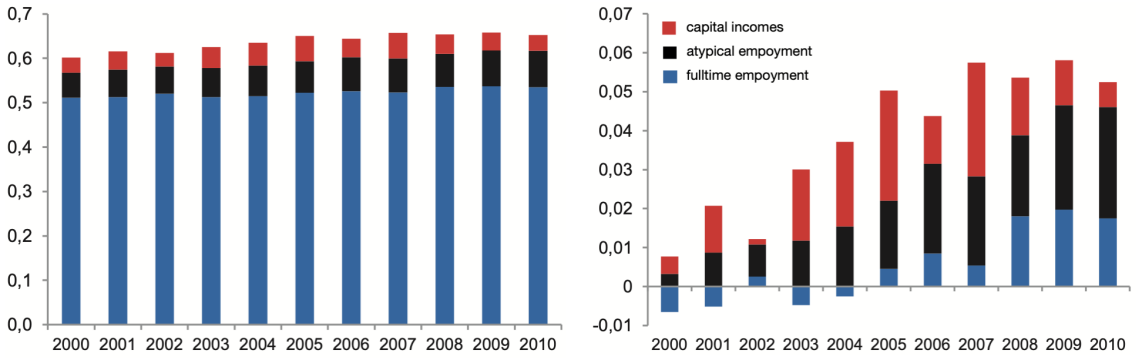
Daudey & García-Peñalosa (2007) emphasize that the functional distribution of income is a major determinant of personal income distribution. They illustrate this by a panel data analysis of a group of developed and developing countries which shows that high labour share is associated with a lower Gini coefficient. This can be explained by the fact that a larger labour share tends to decrease income disparities between workers and capital owners, while at the same time raises those between employed and unemployed (Checchi & García-Peñalosa 2010). The labour share itself is often seen as determined by technological factors on the one hand and institutional on the other, emphasizing the role of non-competitive labour

Figure 3: The composition of top incomes.



Source: Piketty (2014, figure 8.3, 8.4, 8.9, 8.10).
Data: Piketty (2001), Piketty (2003).

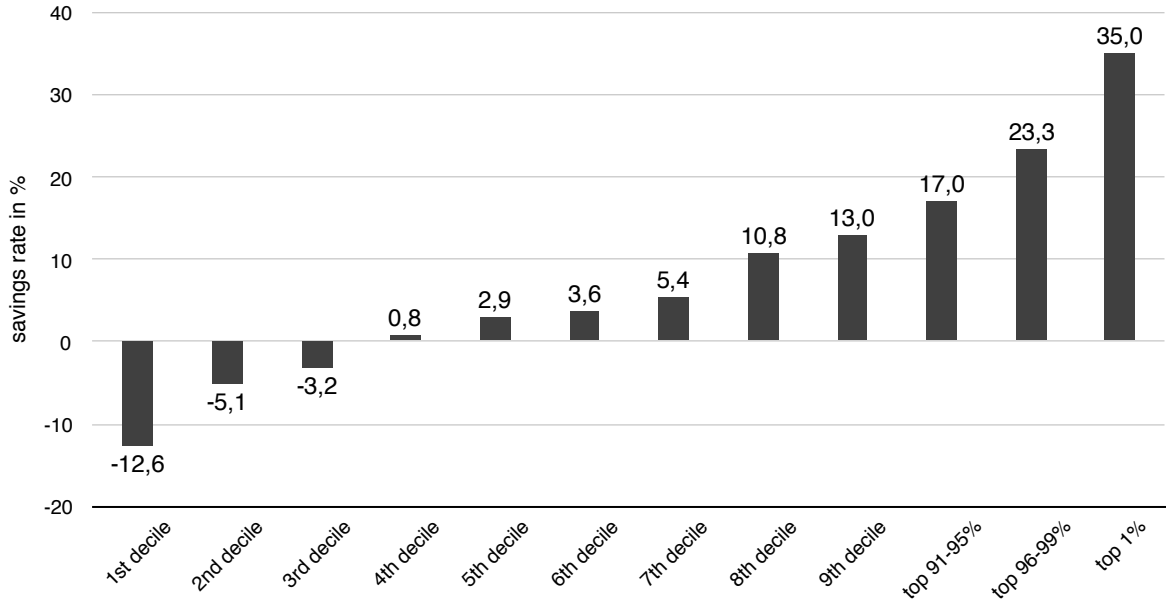
Figure 4: Contributions of income components to market income inequality (Gini).



(a) Absolute **(b) Indexed changes**

Source: Representation by Horn et al. (2014) based on Rehm et al. (2014, figure 5).
Data: SOEP v28l. Calculated using sample weights.

Figure 5: German savings rate by income group, 2013.



Source: Own representation based on calculations from Späth & Schmid 2016.
Data: Destatis (2013).

markets and differences in wage determination between skilled and unskilled labour (Acemoglu, Aghion & Violante 2001).[3] Checchi & García-Peñalosa (2010) find that the capital-labour ratio has large positive effect on the labour share.

A first comparison of the share of capital incomes of households and Adler & Schmid (2013) examine the relationship between changes in functional distribution and personal distribution of market income based on microdata from the German Socio-Economic Panel. They focus on how changes in income shares resulting from asset flows affect the concentration of market income. They find that a relative rise in income from asset flows, as reported by the German National Accounts statistic, has a significant effect on the micro data and rise in capital income shares is connected with an increasing concentration of market income.

Schlenker & Schmid (2015) find significant evidence for a positive connection between the macroeconomic capital share and the level of personal inequality. Since the 1980s we can observe the trend of an increasing capital share in many OECD countries is reflected by an increasing inequality of household incomes (Atkinson 2000, Daudey & García-Peñalosa 2007, Atkinson 2009, Adler & Schmid 2013). This could be explained by the fact that capital incomes are much more unequally distributed and have become increasingly important in driving inequality (cf. figure 4). The heterogeneity in the connection between the capital share and personal income inequality that is observed by Behringer & van Treeck (2015) could be explained with the previously mentioned sensitivity of capital incomes to business cycles.

(5) Household heterogeneity

The heterogeneity of the empirical observations is of great importance for personal distribution itself as well as for the interaction with functional distribution (Behringer & van Treeck 2015). Wealth formation and capital returns impact income distribution in a complex way. Household heterogeneity that impacts distribution surfaces on many different levels. The most crucial aspects are savings and return on capital. Both are equally essential for the connection between income and wealth. Higher savings imply higher wealth and higher wealth implies higher capital income.

[3] It is often assumed that unskilled workers are more likely to be part of union arrangements.

(a) Heterogeneous savings rate

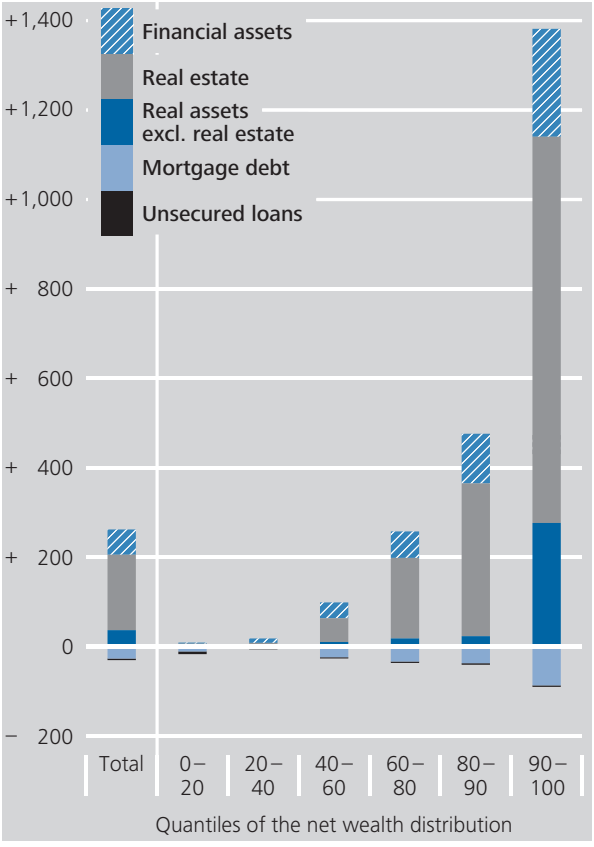
Data tells us that the relative amount households save varies by income, more specifically, it increases with income (Klär & Slacalek 2006, Brenke & Wagner 2013, Späth & Schmid 2016). Figure 5 illustrates this with German data. A special survey in 2016 found that some but not the majority of households modify their savings behaviour in response to low interest rates to a certain extent (Marek 2017). However, there is no evidence in the latest data that households who have been saving regularly did reduce their saving efforts (Deutsche Bundesbank 2016).

(b) Heterogeneous rate of return on capital

Returns on capital are heterogeneous in several ways. Most obviously, returns will vary with the type of assets households invest in: real estate, bonds, equity, and maturities as well. Wealth is not only more unequally distributed than income, but investment behaviour will vary depending on the household's position in the distribution (cf. figure 6). Between 2010 and 2017, this structure of wealth group portfolios barely (Deutsche Bundesbank 2019). In Germany, wealthier households tend to own more real estate and other real assets, while the lower half of the distribution almost exclusively invests into financial assets. The levels of outstanding debt also increase with net wealth.

One might argue that more affluent households tend to invest in riskier assets with higher returns. Piketty (2014) presents two examples which show how much faster wealth grows for the upper tail of the distribution. The first (Piketty 2014, table 12.1) shows the evolution of wealth owned by fixed percentages of the world's population (the wealthiest twenty-millionth and one-hundred-millionth) in comparison to

Figure 6: Breakdown of German households' wealth by size in 2017.



Source: Deutsche Bundesbank (2019).
Data: PHF 2017 (Schmidt, Zhu, Le Blanc, Tzamourani, Altmann, Werner, Pham-Dao, Hebbat, Kothmayr, Bernard, Marek & Stender 2019), in thousand €, as of March 2019

the overall development. The average wealth of the wealth group of the richest twenty-millionth increased form just $ 1.5 in 1987 to $ 15 in 2013, which results in an average annual growth rate of 6.4% per year above inflation, while at the same time world GDP increased by 3.3% and average wealth per adult by merely 2.1%. Even though the growth rate of those top incomes is quite heavily reliant on years chose, the difference remains large even if we exclude the outliers at the beginning and the end of the period.

Comparably high returns we find when looking at long term average returns of US universities. The university example gives a better understanding of unequal returns on capital as it provides us with one of the few very complete datasets on investments made and returns received over a relatively long period of time. The endowments of those institutions vary from some ten million dollars in the case of smaller community colleges and tens of billions of dollars for Ivy League universities. In general, the return on those endowments has been extremely high in recent decades. The interesting fact is that it can be observed that returns increase rapidly with the size of endowment Piketty (2014, appendix, table S12.2). On closer inspection of the investment strategies of different universities, one finds highly diversified portfolios independently from the endowment, all exhibiting a clear preference for national and international stocks and private sector bonds. However, the higher the endowment, the more common are so-called 'alternative investment strategies' with very high yields, which usually require considerable expertise.[4] Their share varies from only 10% in the portfolios of universities with endowments less than 50 million to 60% in the portfolios of institutions above 1 billion. It is these strategies that enable returns around 10% a year for larger endowments while smaller must make do with 5%.

In addition, the year-to-year volatility of these extremely high returns is not greater than that experienced by the less wealthy. Thus, we can assert that higher returns, in this case, do not result from greater risk-taking but from a far more sophisticated investment strategy which consistently produces better results (Piketty 2014, p. 449-51).

The study of distribution consequences of asset price inflation by Adam & Tzamourani (2016) shows how important the differentiation between asset classes is for the analysis. They simulate a 10% asset price increase for Euro Area households using data from the Household Finance and Consumption Survey (HFCS, HFCN 2013). From capital gains in bonds and equity profits only by one-fourth of the population, while three fourth of the respondents befits from capital gains in housing wealth. Nevertheless, gains from bonds are relatively low (below 1%) and equally distributed among the wealth and income classes, and thus leave the net wealth inequality mostly unchanged. From capital gains in equity, on the other hand, are far more concentrated in the upper 5% of the wealth distribution and the upper 30% of the income distribution. For the top 5%, a gain of 3% can be observed. Thus, capital gains from equity lead to a significant increase in inequality. The highest capital gains, though, result from increasing housing prices and the median households of the wealth distribution in the aggregated European perspective benefit the most with over 9%, while the tails of the wealth distribution, the poorest 20% and the richest 5% more specifically, achieve only 6%. Capital gains from housing wealth seem to be slightly negatively correlated with income distribution. However, for the insights on housing wealth, there exists considerable heterogeneity across individual countries, which will be addressed in the next paragraph.

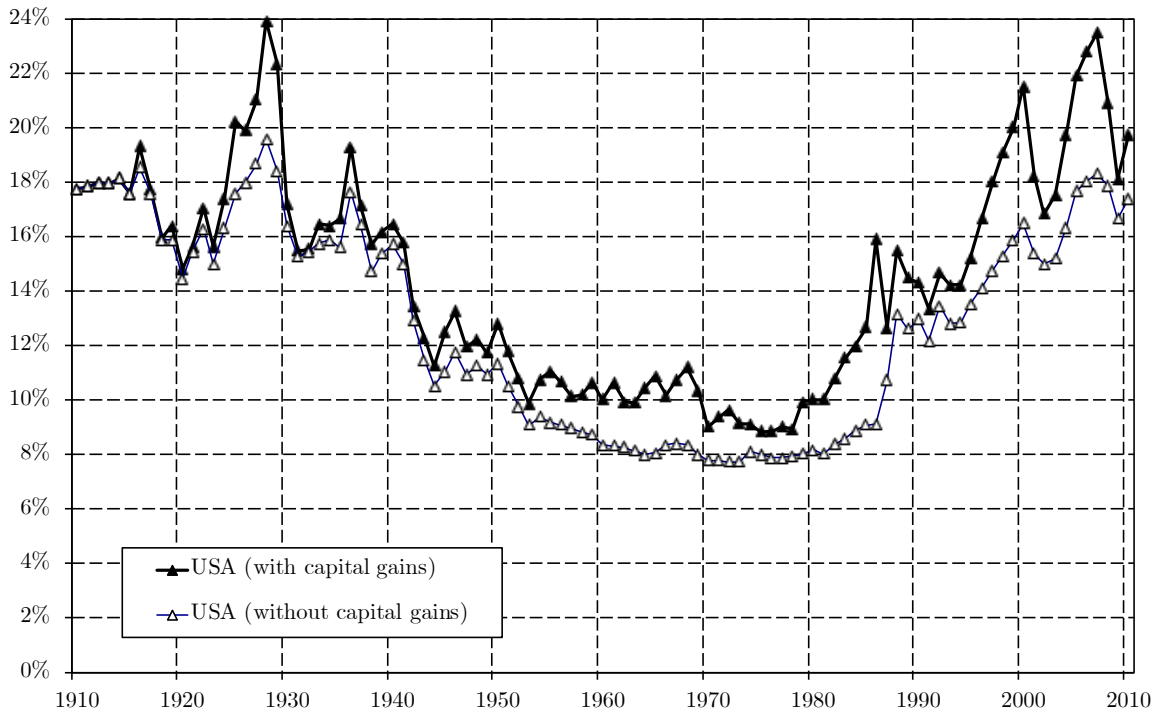
Furthermore, ignoring capital gains can lead to a significant underestimation at the top. Piketty (2014, appendix, table S8.2) shows for example that the share of the upper percentile in the USA is at least 2% higher, in upswings up to 6% higher, when capital gains are included.

(6) Cross-country heterogeneity

Not only household heterogeneity matters, but there exists a considerable cross-country heterogeneity in even seemingly very similar countries in the same state of development. This is reflected not only by their formal institutions, their welfare states and their differing approaches to regulation (cf. Rodrik et al. 2004,

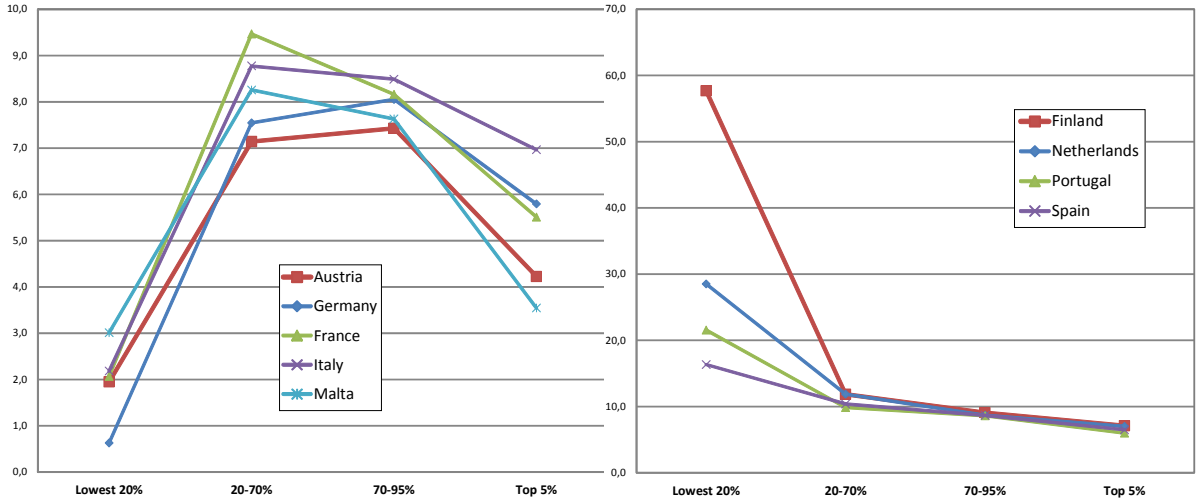
[4] The following investments are referred to as 'alternative': private equity funds and unlisted foreign stocks, hedge funds, derivatives, real estate, and raw materials, natural resources, and related products.

Figure 7: Share of top percentile in total income, USA, 1910-2010.



Source: Own representation in terms of gross income based on Piketty (2014, appendix, table S8.2).
Data: Piketty (2003).

Figure 8: Capital gain from 10% housing price increase (in % of net wealth) by wealth groups.



(a) Euro Area countries where low wealth HHs benefit least

(b) Euro Area countries where low wealth HHs benefit most

Source: Simulation by Adam & Tzamourani (2016, figures 7,8).
Data: HFCN (2013).

Acemoglu & Robinson 2015)[5] but also by informal institutions (norms, customs, habits) which provide the underlying justification for behavioural factors such as risk-aversion, financial market participation and investment behaviour of households (Williamson 2000).

This can be observed when revisiting the analysis of capital gains by Adam & Tzamourani (2016). The increase in housing prices generates a heterogeneous effects across the Euro Area. In some countries, such as Austria, Germany, France, Italy and Malta, poor households benefit relatively little from compared to the European average (see figure 8a). While in others, such as Finland, the Netherlands, Portugal and Spain, the opposite is true, and the lowest 20% of the net wealth distribution obtain disproportionately more capital gains (see figure 8b). In Finland, this gain is exceptionally high (57.6%). Thus, housing price increases can lead to a significant decrease in inequality. The observations can be explained that in the latter set of countries, poorer households are more likely to be the owner of their accommodation. Due to the fact that those households tend to be more heavily indebted, the increase in housing prices has a relatively larger effect on their net wealth. However, this observation indicates a potential fragility of the poor's net wealth position if housing prices were to decrease (Adam & Tzamourani 2016).

Let us look briefly in more detail into the example of Germany to get an understanding of the effects heterogeneity might evoke. It is commonly known that German savers are more risk-averse than other Europeans. Thus, in general, their wealth allocation is more conservative. In addition, while in some countries most households own their primary residence, in Germany the larger percentage of the population lives in rented accommodation. So on the one hand, the upper half of the distribution will profit much more in terms of capital gains from housing price increases. On the other hand, real estate constitutes a more substantial part of the overall portfolio of the upper decile and, thus, the return on investment from real estate is much more concentrated at the top compared to other European countries.

2.2 Conclusion to take away from the existing literature

The question of how functional and personal income distribution are connected cannot be granted a simple answer. The empirical results discussed in the previous chapter give us a first idea of the complexity of the relationship between the evolution of inequality, wealth formation and capital returns. The issue with purely theoretical contemplations consists in modelling only separate aspects of a complex interaction. They mostly focus on the functional distribution with minor attempts to incorporate the personal layer. A very brief summary of the most relevant approaches can be found in table 1.[6] In contrast, there exists an abundance of empirical evidence, which exhibits great heterogeneity between different countries as well as inside countries and implies that functional income distribution might have non-trivial effects on the way that income and wealth are distributed among the members of the society. The saving rate as the connection between both perspectives has been clearly identified, but, as the criticism of Piketty's

[5] Rodrik et al. (2004) show. for example, in connection to growth theory that institutions trump geography and trade in determining economic outcomes.

[6] A more extensive overview will be published in separate paper as part of my dissertation (forthcoming, December 2022).

Table 1: Overview of the main theoretical arguments

Macro-perspective:		**Micro-perspective:**	
Pasinetti (1962):	$S = s_p P + s_w W$	Epstein & Zin (1989):	stable wealth distribution iff.
	$s_p > s_w$		savings decrease with wealth
Samuelson (1966):	$s_w > \xi$	Piketty (2014):	$r_{top1\%} > r_{top10\%}$
Piketty (2014):	$r > g$	Aspromourgos (2015):	$s_{rich} > s_{poor}$
Carvalho & Rezai		Krämer (2015):	$s_{rich} - s_{poor} > \xi$
(2016):	$\frac{S_w}{K} = s_w(\sigma)\psi u$	Saez & Zucman (2016):	$sh^p_{W,t} = sh^p_{Y,t} \cdot \frac{s^p}{s} \cdot rel.APP$

postulates illustrates (Homburg 2015, Stiglitz 2015, Aspromourgos 2015), not fully exploited. It is this multidimensional nature that makes it difficult to capture the interaction in its entirety and why attempts are scarce. The existing theoretical models focusing on distribution are only partly capable reflect these multifaceted dynamics. Thus, monocausal explanatory approaches are not a suitable instrument, especial because they exclude complex relationships and feedback effects. It is at odds with the various empirical findings of a significant link between functional and personal income distribution that there still is a lack of an integrated framework that connects income inequality at the micro-level with factor shares at the macro-level (Dafermos & Papatheodorou 2015).

Unfortunately, the vast majority of the existing theoretical frameworks examines the two types of income distribution separately. However, based on empirical observations, some individual researchers inductively developed approaches that try to align the theoretical models with empirical evidence. The focus of this relatively small group of models varies, but they all constitute a first attempt to link functional and personal distribution. The picture drawn by class models[7] is still missing the intertwining causal effects, but it can be interpreted as an approximation of a society where incomes from different sources are concentrated at different ends of the distribution. A similar conclusion can be reached when distinguishing between two different saving rates (Kaldor 1956, Pasinetti 1962). Carvalho & Rezai (2016) are probably the first to take one step further by integrating an inequality measure into the saving function, but even though they model a disaggregation of incomes and savings, they are not able to draw a direct connection between micro and macro levels. In addition, Piketty (2014) himself points out that social inequality is multidimensional, and with this clearly refers to the institutional environment.

There still remain a number of findings relating to personal distribution which are solely captured by empirical studies and need to be integrated into economic models: **(a)** a fully heterogeneous savings rate which increases with income (cf. Klär & Slacalek 2006, Brenke & Wagner 2013, Späth & Schmid 2016), **(b)** returns on capital that differ either assets or/and wealth (cf. Piketty 2014), **(c)** heterogeneity of capital gains (cf. Adam & Tzamourani 2016), **(d)** cross-country heterogeneity reflected by household behavioural (risk-aversion, financial market participation, investment behaviour) (cf. Adam & Tzamourani 2016) which in turn are determined by informal institutional variables, i.e. norms, habits (cf. Williamson 2000) and formal institutional factors such as welfare state, regulation etc. (cf. Acemoglu & Robinson 2015).

This chapter outlined the complexity of modelling the connection between functional and personal distribution, income and wealth distribution. From this follows also the necessity for country specific modelling which will be explored further in the following chapter. The starting point of such a country-specific model should be the national characteristics of the economic system.

3 A comparative systemic institutional approach

The economic system essentially depends on institutions, therefore it is indispensable to take a more detailed look at the role of institutions in inequality dynamics. Human life in general is based on social interactions, from the moment a child is born to complicated political processes. The manner of these social interactions can be traced back hundreds or even thousands of years (cf. Williamson 2000). Institutions are not only tangible or physical but also norms and attitudes. They define how the market is organised, shape incentives, and describe the relationships between the players. These formal and informal institutions increase certain human capabilities and tendencies and dampen others, without fully stopping them (Höschele 2017, p. 15). The economy is only one part of these interactions and cannot be fully separated

[7] There exists a whole range of models which rely on the insight that we can observe a class patter even in modern western society (cf. Epstein & Jayadev 2004, 2005, Duménil & Lévy 2015). One can identify two main types of models. The first group relies on what became known as the Kaleckian growth model, going back to the modern interpretation of Rowthorn (1981), and adds an explicit third class of managers to the models featuring capitalists and workers (cf. for example Lavoie 2009; Dutt 2012; Tavani & Vasudevan 2014; Dutt 2016; Palley 2015). A second post-Keynesian strand of stock-flow-consistent models formulates personal and functional income distribution as part of the complete macro-economy (Dafermos & Papatheodorou 2015).

from its social context. But for questions of inequality it is more than that. Economic models usually look at market income, but what matters for consumption and aggregate demand is disposable income. And this is where the major welfare institutions come in. They are essential, as they restructure the economy.

3.1 Institutional patterns in inequality: typologies

Fortunately, what makes integrating institutions into systemic models a lot easier is the fact, that they shape so called Varieties of Capitalism (Hall & Soskice 2001) or certain Welfare Regimes (Esping-Andersen 1990, 1999). Countries can be grouped by the types of their institutions, which has been done countless times by qualitative and quantitative analysis. In comparative social science research these kinds of typologies are often used to explain institutional development of capitalist production and welfare regimes. In principle, typologies break down institutional complexities into clusters of similar countries to facilitate research. There exits a variety of typologies focusing on different types of capitalist institutions such as production or welfare regimes arriving at broadly similar classifications of countries using different methods (Schröder 2009). Hence, different lines of research look at the same research object from different perspectives. In connection with distributional questions from an economic as well as a sociological and political perspective this comparative capitalism research is of special importance. The literature essentially takes up the attempt of the German Historical School to compare economic systems and has been in development since the 1960s. Thus we find a broad range of concepts.

The approach that dominates the modern economic discourse was proposed by Hall & Soskice (2001).[8] In any economy firms will gravitate towards choosing the mechanism of coordination which is supported by the existing institutional framework. Following North (1990) and Williamson (2000), Hall & Soskice (2001) define institutions as a formal and informal set of rules. While in liberal market economies corporations will rely primarily on hierarchies and competitive markets as the main coordinating institutions for their endeavours (cf. Williamson 1985), in coordinated market economies corporations depend strongly on relationships outside market competition resulting in strategic interaction between firms and other agents.[9]

An important contribution of the *Varieties of Capitalism* literature is the aspect of complementarity of institutions that can be observed in all economies to some degree. Hall & Soskice (2001, p. 17) apply the concept developed by Aoki (1994) to institutions of political economy. Complementarity is given if the presence of one institution increases the returns from or efficiency of another. The character of coordination is reflected in practices and arrangements within each sphere. Institutional practices correlated across spheres. Countries with a certain form of coordination in one area tend to similar forms of coordination in other areas (Hall & Soskice 2001, p. 19). For these specific groups of liberal market economies (e.g. USA, UK, Canada, Australia, New Zealand) and coordinated market economies (e.g. Denmark, Finland, Norway, Sweden, Austria, Belgium, Netherlands, Germany) we can for example identify characteristic differences in distribution of income and employment (Hall & Soskice 2001, p. 22). In LMEs one can observe a tendency towards more hours on average and a relatively high inequality of income. CME exhibit the opposite manifestations. The chosen cluster in this case seems, however, slightly fuzzy and one might argue that not all economies can be describes as one of those two extremes (e.g. Japan, Italy or Spain). The tendency of countries to cluster, meaning that one institution of certain characteristic is often accompanied by other institutions of a similar characteristic, is confirmed by Hall & Gingerich (2009) in an in-depth empirical factor analysis where the latent variable is defined as the degree of coordination. The magnitude of coordination in one area is shown to correlate with a similar magnitude in another. They identify a distinctive set of countries (LMEs) that deploys extensively market

[8] It is most probable that it was also inspired by Michel Albert's (1992) very influential book "Kapitalismus contra Kapitalismus" (cf. Schröder 2009, p. 71) which introduces the distinction between Rhenish and Neo-American capitalism and made the two-type classification popular. A detailed overview of all four approaches mentioned up until now can be found in Schröder (2014). Ebbinghaus (2012) gives a comprehensive comparison.

[9] The specific categories based on which Hall & Soskice (2001) investigate the economies and their different manifestations will be discussed later in this chapter.

coordination and another set of countries (CMEs) that consistently make use of strategic coordination.[10] Hence, the *Varieties of Capitalism* literature captures effectively important differences between political economies. This clustering can also be seen as one possible explanation for the persistence of cross-national differences. The resulting institutional complementarities reinforce the typologies (cf. Hall & Soskice 2001, p. 17).

Even though the *Varieties of Capitalism* approach describes rather varieties of production (Schröder 2009)[11] and the countries of the CMEs are far from a homogeneous group, this differentiation already captures one major fact that stays true independent from the nature of the typology analysis: LMEs describe the type of capitalism that is the most distinctive (Amable 2003, p. 72-76). While purely analytical clusters have the advantage in predicting changes in regimes or including varieties of complex institutional aspects, empirical cluster analysis is able to validate and quantify the analytical clusters, and can be used to expand the knowledge to countries that are not studied as often (Chauvel & Bar-Haim 2016).[12] In Amable's in-depth empirical analysis the group of LMEs comes out specific and homogeneous, emerging close together in the cluster analysis for each institutional area and exhibiting the highest number of identified specific features. Certainly, this distinctiveness of the market-based model allows the two-type classification to act as a first approximation (ibid). However, to analyse a complete capitalist configuration one should above all integrate welfare arrangements which are an essential part of it (Estevez-Abe et al. 2001).

Esping-Andersen (1990, 1999) provides such a comparative study of welfare states. He bases his ideas on a critique of a purely quantitative evaluation of welfare states, which by reducing the analysis to such simple numbers as social spending in relation to GDP demonstrates a lack of interest in the welfare state itself (Esping-Andersen 1998, p. 32). It does not examine the concept of the welfare state and bypasses essential questions defining social policy such as whether it supports market mechanisms or levers them out. It simply assumes that the level of social spending sufficiently reflects the welfare commitment of a state. But social spending is an accompanying factor of what is the theoretical substance of a welfare state. Esping-Andersen's starting point constitutes the influential essay of Titmuss (1974) which forced research to let go of the black box of social policy and turn towards the substance of welfare statehood: categorial versus universalistic programs, access requirements, quality of benefits, and the extent to which the state provides citizenship rights in connection to employment.Further inspiration is drawn from Marshall's (1950) historical analysis of the development of citizenship which encompasses the evolution of civil, then political, and then social rights and describes important stages of development in the course of the capitalistic industrialisation and formation of the modern welfare state. Esping-Andersen (1998) sees his own approach in the tradition of classical political economy. The analysis is made based on the role of the three most important agents (families, market and state), the type of welfare regime resulting from the degree of de-commodification of the individual from the market, and the mode and locus of solidarity. Utilizing a deductive technique applied to the social policy history of 18 OECD countries, he arrives at a Weberian ideal type three-fold differentiation of welfare states: liberal (Anglo-Saxon countries), conservative or corporatist (continental Europe and Japan), and social-democratic (Scandinavia).Typologies of production and Esping-Anderson's (1990, 1999) welfare regimes can be combined (Schröder 2009).[13] The congruence of the different typologies is illustrated by figure 9 where the similarities become apparent. This matroshka doll like theoretical interlocking reflects at the bottom the dendogram of the hierarchical cluster analysis

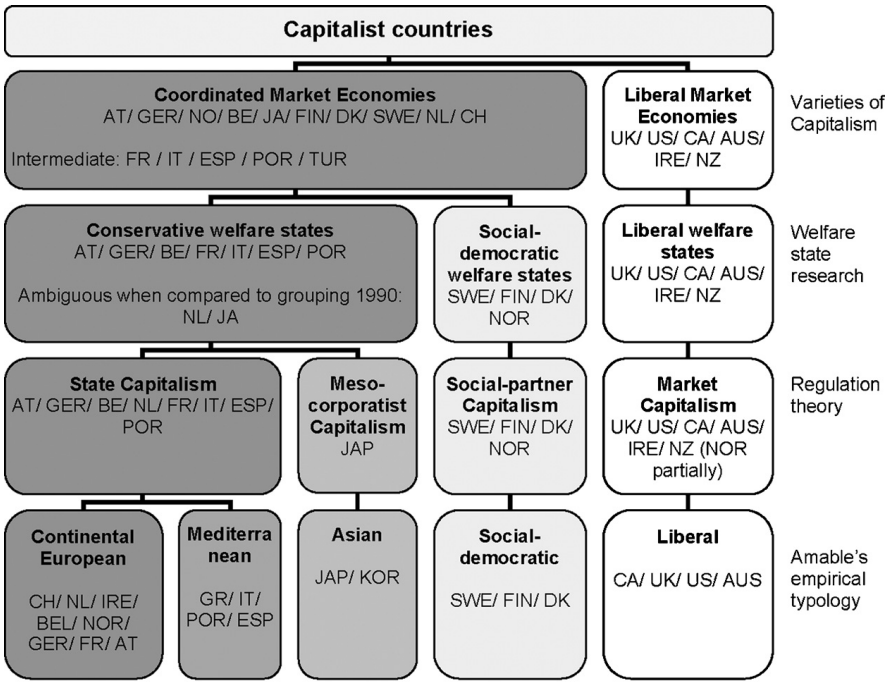
[10] A more detailed analysis how different specific institutions complement each other can be found in Schröder (2014, p. 49-59).

[11] Thus, henceforth the term varieties of capitalism will be used in general for all comparative capitalism typologies if not specified otherwise.

[12] A prime example for the later is the evaluation of post-Soviet countries, which are considered only by few studies (cf. Fenger 2007).

[13] Schröder (2009) was not the first to point this out. Previous literature also stressed complementarity between liberal welfare states and production regimes, as well as coordinated production regimes and more extensive welfare states (Ebbinghaus 2001, Estevez-Abe et al. 2001, King & Wood 1999, Manow 2001*a*,*b*, Mares 2001*a*,*b*, Iversen & Soskice 2001, Swenson 2002, Vogel 2001, Wood 2001). However, he is the first to show a comprehensive complementarity.

Figure 9: Typologies and their congruence.



Source: Schröder (2009, figure 3).
Based on: Amable (2003, p. 73), Esping-Andersen (1999, p. 77-83), Hall & Soskice (2001, p. 20f), and Boyer (2005).

(Schröder 2009).[14]

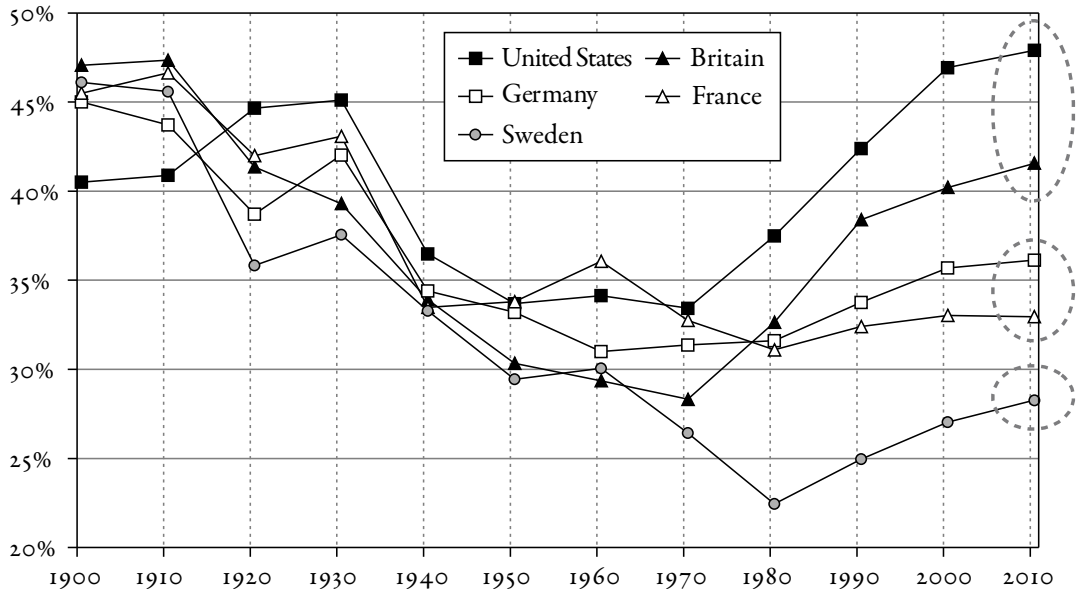
What stands out in connection to distribution is that these observed groupings in comparative capitalism studies coincide with a differentiation by level of inequality measured by the share in income of the top 10% (see figure 10). Piketty (2014, p. 323-4) divides countries into three groups: very inegalitarian countries such as the USA or UK (the top 10% earn over 40% of total income), egalitarian countries like Sweden (under 30%) and countries in the middle such as Germany or France (around 35%). Which actually corresponds to the typology proposed by the *Welfare Regimes* literature (Esping-Andersen 1990, 1999). Goodin (1999) already pointed out that welfare regimes can be sorted by their level of inequality.

However, one may argue that these measures are one dimensional in terms of capturing the whole spectrum of inequality and, therefore, do not give a fully significant insight. They disregard that behind the same number there could lie different shapes of distribution.[15] The representation by strobiloids on the contrary can illustrate the full shape of income distribution and give us a far better understanding of inequality then one-dimensional measures like the top income share or the Gini coefficient (Chauvel 2016). Strobiloids picture the income hierarchy (on the vertical axis), where 1 on the vertical axis represents the median income of a society. The larger the curve on the horizontal axis, the higher is the density at this level of income. Therefore, a larger 'belly' indicates a larger middle class with a more equal distribution. The strobiloids in figure 11 show the shape of the income distribution for two liberal countries (UK and US), two Nordic countries (Sweden and Denmark) and two conservative central European countries (Germany and France) in two different years, one in about 1980 and the other more recent one around 2010. Countries that have previously been sorted by comparative capitalism studies in the same groups exhibit similar overall patterns of inequality. This suggests that there are some kind of '*Varieties of*

[14]The clusters were determined by a simple principal component analysis without rotation of the factors. The principle component analysis is a statistical data reduction method to condense dimensions based on the relational structure of a set of observable variables. In this case first four factors together explain 71% of the variance within the dataset. See Schröder (2009) for the details of the analysis. The method itself is comprehensively described by Dunteman (1989) and Jolliffe (2002).

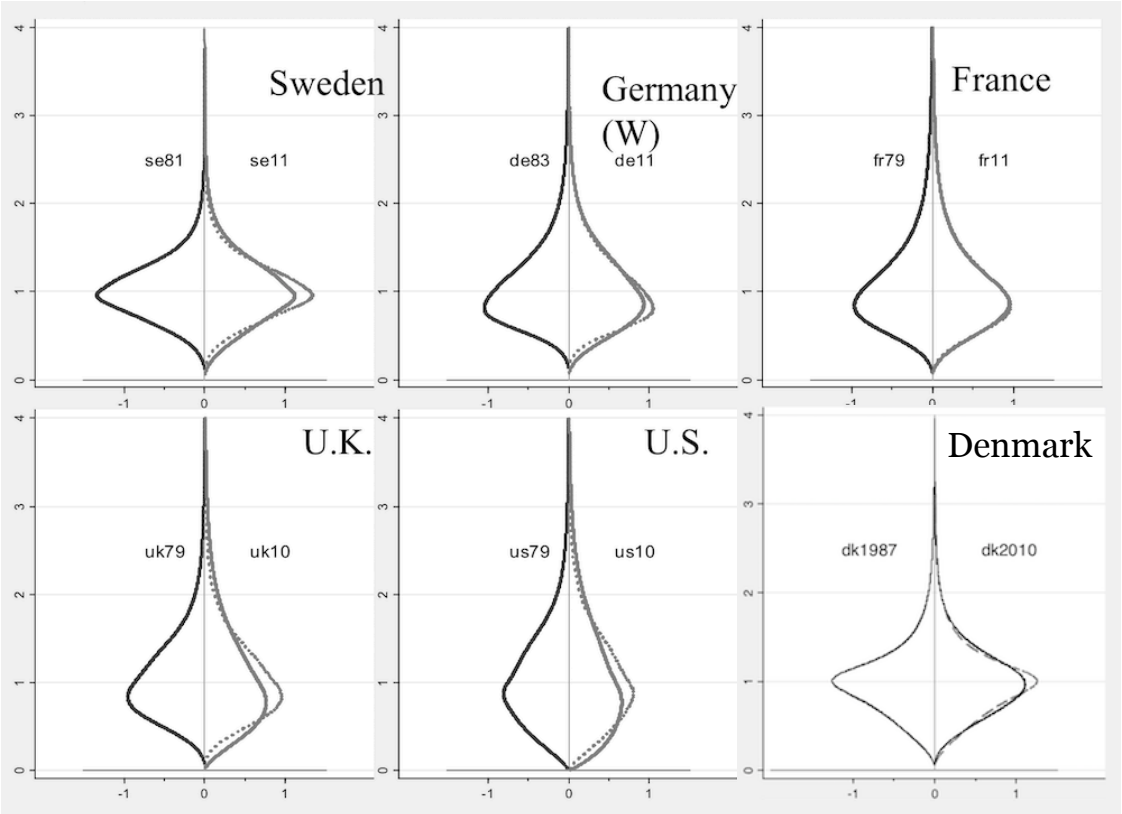
[15]In addition, different institutional arrangements can also lead to similar outcomes in terms of distribution. This aspect is disregarded at this point.

Figure 10: The top decile income share in Europe and the United States, 1900–2010.



Source: Piketty (2014, figure 9.7).
Data: Piketty (2001), Piketty (2003) and WID.WORLD (2019).

Figure 11: Six typical distribution strobiloids based on disposable income



Source: Chauvel (2016).
Data: in Luxembourg (2019).

Figure 12: What do we know about the economic system?

Social System	Welfare System	Production System	Financial System
composition of society	tax system	organisational structure	banking regulations
normativ foundations	transfer payments	sectoral composition	financing structure
solidarity (family, community)	social benefits	market structure	stock market capitalisation
education	pension system	market orientation	stock market participation
labour market	public goods	innovation environment	investment behaviour of HH

comparative capitalism studies household surveys (LIS, HFCS, …)

comparative capitalism studies & household survey (LIS)

Data sources of the different variables are indicated by shades.

Distribution' which coincide with the Varieties of Capitalism.[16] Upon a closer look it can be observed that Sweden and Denmark are generally more egalitarian than the other countries. It stands out that those countries have poor households but lack households with very high income and the curve is relatively wide just below the median compared to Germany for example. The German strobiloid reflects that politics made an effort to create a relative homogeneity beneath the median with an implicit high minimum income, while in higher levels we can observe more inequality. The liberal countries in contrast exhibit a high share at the bottom end. We see high polarisation trend, the clear erosion of the middle class and extreme values at the top, the US being more extreme in the observations than the UK.

The qualitative assessment of the grouping can be verified by hierarchical clustering derived from a principle component analysis of the shape of inequality based on isographs[17] considering tree stages of distribution of equalised disposable income: before and after redistribution (i.e. taxes and transfers) and the shape of the redistributing effort (Chauvel & Bar-Haim 2016).[18] Hoeller et al. (2012) have conducted a similar investigation by looking at different inequality indicators instead and came up with the comparable result. The resulting clusters coincide, as expected, with the varieties of capitalism. Similar to Amable (2003) and Ebbinghaus (2006), four consistent groups are detected, clearly in contrast to each other: liberal, socio-democratic, conservative (corporatist) and Mediterranean (conservative-Christian) countries.[19]

3.2 Attributes differentiating inequality typologies

Previous research on the *Varieties of Production*[20] and *Welfare Regimes* provides us with a variety of institutional parameters. Not all of them are central for distributional analysis as inequality questions were not the main target of these studies. Moreover, some essential factors are missing. The characteristics important for inequality can be subdivided according to the role they play in the economy. If we see the economy as a system, it is composed of four main subsystems - a social system, a production system, a

[16] This analysis of distribution is restricted to the working group of the population (age 25-54), excluding pensioners and students and thus neglecting aspects of disparity between socio-demographic groups. In addition, there is no differentiation between household arrangements, gender etc. due to the focus on the hierarchical shapes of income distribution.

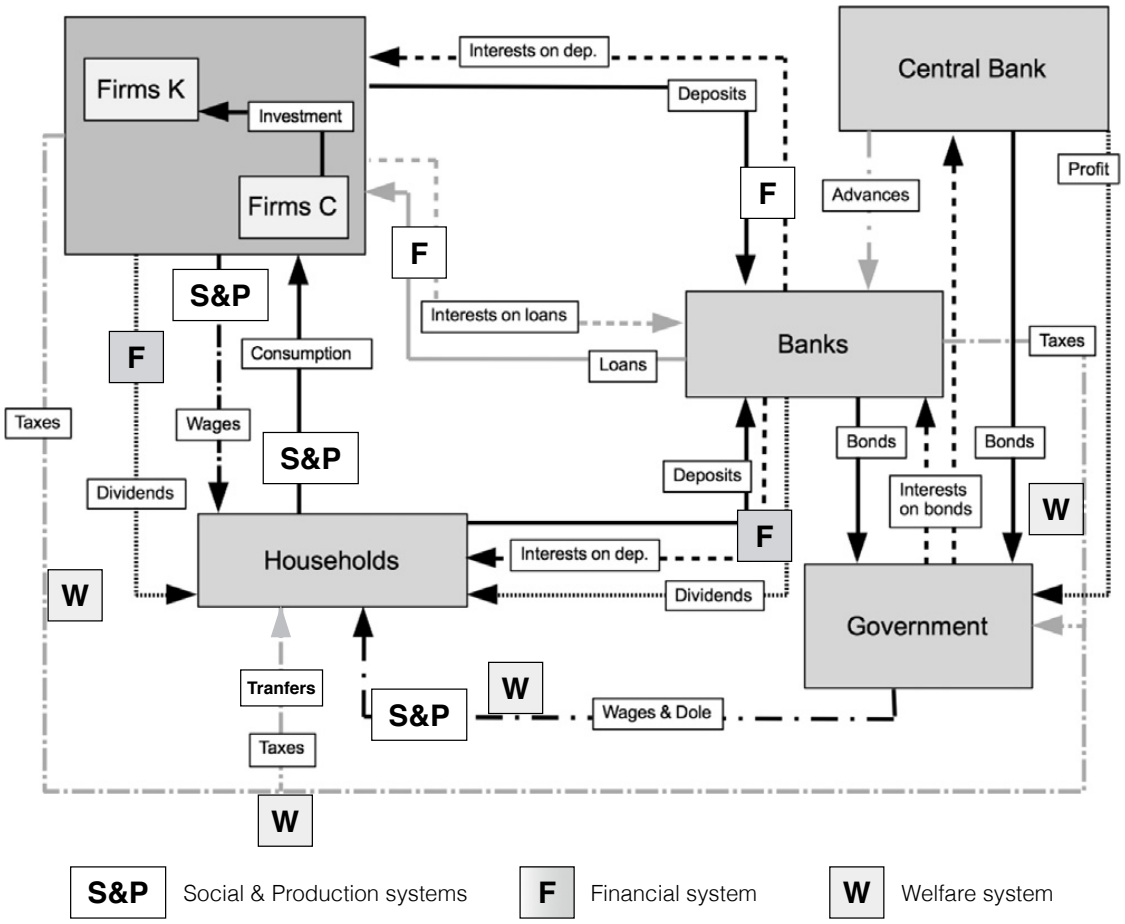
[17] See Chauvel (2016) for more technical information on isographs.

[18] In their approach Chauvel & Bar-Haim (2016) follow Powell & Barrientos (2004) by using a continuous range instead of discrete categories. Countries are ranked by their distance from the ideal type representation in each cluster. See Vis (2007) for different possibilities in determining analytical clusters. The analysis is conducted on country information from 36 countries for the time period 1967 to 2013, with 183 unique country-period samples in total taken from the Luxembourg Income Studies data set.

[19] It stands out that the shape of distribution in Mediterranean countries is nearer to liberal countries, while the institutional arrangements place it usually nearer to the Central European countries.However, as these countries will not be as important for the later analysis, there will be no further investigation of this effect.

[20] As already mentioned before, this is the suitable term for what the literature calls the *Varieties of Capitalism*.

Figure 13: Flow diagram of the economic system depicting monetary flows.



Source: adapted agent-based model suggested by Caiani et al. (2016) with addition of institutional markers.

financial system, and a welfare system - which in turn are described by a number of different characteristics (cf. table in figure 12). Each subsystem is defined by the main economic agent which, while not being the only agent relevant, is its central active participant.

Previous research already delivers specialised insights in several areas. The given framework regroups these aspects and makes several significant additions. The reorganised systemic perspective ensures a holistic approach and structures the analysis specifically for questions of distribution. Variables that are adopted from previous research remain unmarked in the table, others that need a more detailed analysis of their practical implications due to heterogeneity by income groups are marked light grey, and a few that need to be integrated from household finance research based on household surveys are marked dark grey.

The social system revolves around households, their compositions and characteristics, their motivations and their actions. The welfare system lies in the hands of the elected government. Comparative capitalism studies have covered the different aspects of this extensively. The *Varieties of Production* with their focus on firms first and foremost contribute to aspects of the production system such as organisational structure of firms (i.e. corporate governance), the sectoral composition of the economy, the general market structure and the market orientation of firms (here especially industrial relations such as the form of coordination between firms and their long-term relationships), and the innovation environment firms operate in. Beyond the productions system, the *Varieties of Production* give also insight on all aspects where firms interact with other subsystems. In the social system they interact on the labour market and influence education, and the financial system has a major impact on firms' financing structure and vice versa. Esping-Andersen's *Welfare Regime* add to the aspects of the social system connected to solidarity in society (de-commodification, stratification) and some normative foundations. At the same time they describe qualitative characteristics of the welfare system.

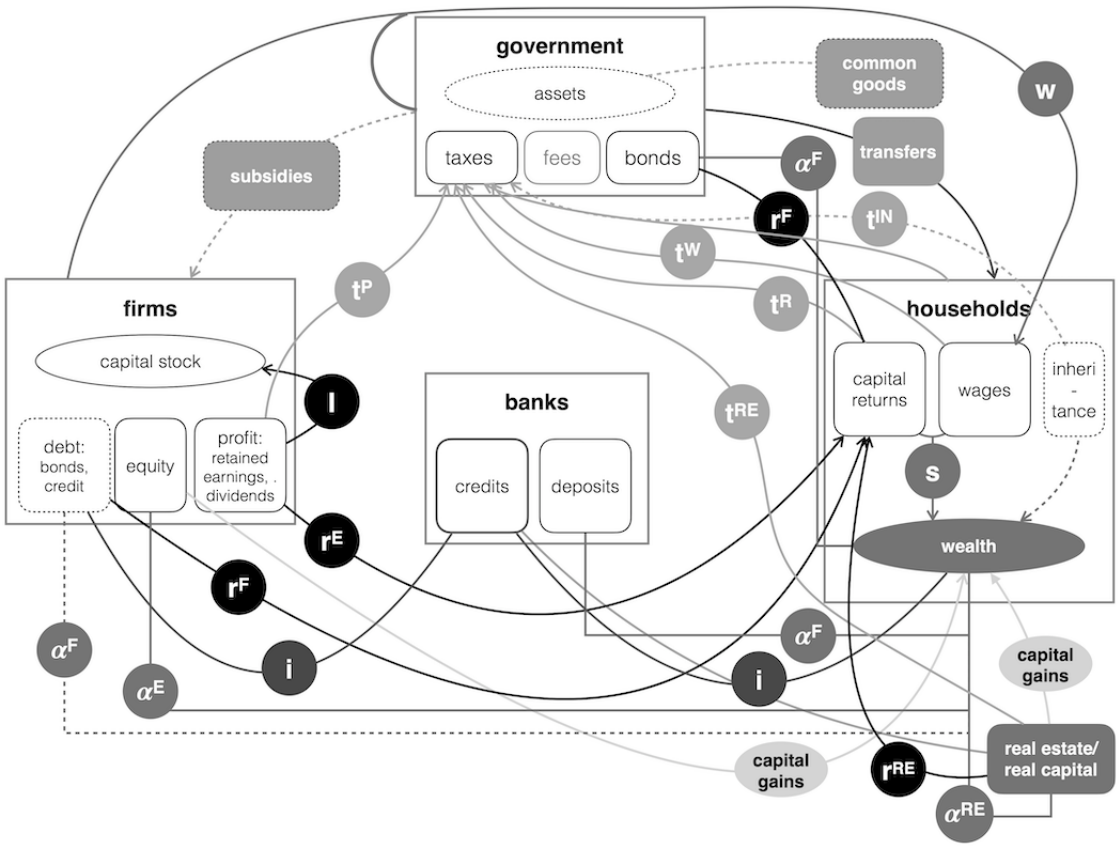
Even though some variables have already been covered extensively by previous research in comparative capitalism studies, in order to develop a formal model integrating institutions of distributional dynamics an additional detailed quantitative analysis of the welfare system is inevitable due to its heterogeneous impact on income groups. The composition of society as well as the other incomplete aspects can be obtained from household surveys and household finance research. Moreover, two important issues pertaining to the financial system play also an essential role for distribution: stock market participation and investment behaviour of households.

Figure 13 illustrates where the different institutions interact with the economic cycle. This is particularly relevant for the modelling process. The flow diagram adds the institutional perspective into a network of interacting agents. Looking at it from a household perspective presents us with complex relations: many income sources, many observable money flow and many different unobservable influences. The social and production system influences wages and consumption decisions. The financial system not only impacts the financial structure of firms but also investment decision of households and the resulting returns. The direct effect of the welfare system is observable through the taxes paid to the state and transfers received. But its indirect effect cannot be depicted straight from the flow. It is connected with the social and production system and their normative foundations, and can manifest in a variety of ways such as employment rates of women, education or social and income mobility.

The focus of the analysis shall be distributional dynamics from a modern perspective. Its core is the heterogeneity. From a purely analytical perspective, it is the complex interaction of personal distribution, functional distribution, the direct impact of welfare system as well as the differentiated behaviour of households. This intertwining will be unique depending on the specific institutional arrangements in the economic subsystem and the shape of the flow diagram of the overall economy. Figure 14 illustrates those interlaced dynamics for a representative household (i.e. without differentiation on a personal level). On this primary level we already encounter a number of heterogeneities. While the households can be assumed to receive a single wage (w)[21], the sources of capital income are manifold and will generate

[21] Or at least we assume an aggregated wage even if several people work or one person takes on two jobs. This is justifiable as long as we suppose that the sectoral differences in wages, even though correlated with personal wage distribution and impacting the general wage level, are not the major explanatory variables in the shape of income distribution but simply

Figure 14: Illustration of lateral distribution



Source: own representation.

different rates of return (r). The households saves part of its income in order to invest it into those different types of capital. The overall return on each asset class will depend on the amount invested in each asset class (α). In addition, the household receives transfer payments, which will be a sum of different welfare arrangements resulting from the specific welfare regime, and pays different types of taxes.

Unfortunately, the heterogeneity goes one additional deeper level. Obviously, trough progressive taxation and means-tested or income based benefits the welfare system will impact the market distribution of income different for every income group. Beyond that, the percentage of income a household saves will depend on the disposable income available (cf. Klär & Slacalek 2006, Brenke & Wagner 2013, Späth & Schmid 2016). Further, investment behaviour will differ significantly with the amount invested and even the returns are higher for top income groups (cf. Piketty 2014, Adam & Tzamourani 2016). The form and extent of this heterogeneity will depend on various informal and formal institutional influences and, thus, differ from country to country. It can be described by a table as presented in figure 15. As it essentially interlaces functional and personal distribution it shall be called the *matrix of lateral distribution*.

Income is sorted by income groups and income sources. w_i represents the income group (i) specific wage and $r_{i,j}$ the corresponding return on capital in form of an investment type specific yield. The share of wealth invested into financial assets α^F, equity α_i^E and real estate α_i^{RE} will also vary by income group, as well as the savings rate s_i.[22] To fill this table with the necessary information different data sources have to be combined. More specific sources can have to be defined on a country by country basis. Most variables will rely on national household surveys with different focuses. For saving rates often several

reflect the level of qualification necessary and the profitability. Those able to acquire the required education will simply end up in higher income groups.

[22] This is the simplest form of the matrix. At this point we abstract from hoarded money. Investment is assumed to be net investment, thus ignoring the leverage effect of credits.

Figure 15: Matrix of lateral distribution

sources of income	wage income	capital income			savings rate
income groups		financial assets	equity	real estate	
1st quantile	w_1	α^{F}_1, r^{F}_1	α^{E}_1, r^{E}_1	α^{RE}_1, r^{RE}_1	s_1
2nd quantile	w_2	α^{F}_2, r^{F}_2	α^{E}_2, r^{E}_2	α^{RE}_2, r^{RE}_2	s_2
3rd quantile	w_3	α^{F}_3, r^{F}_3	α^{E}_3, r^{E}_3	α^{RE}_3, r^{RE}_3	s_3
4th quantile	w_4	α^{F}_4, r^{F}_4	α^{E}_4, r^{E}_4	α^{RE}_4, r^{RE}_4	s_4
5th quantile	w_5	α^{F}_5, r^{F}_5	α^{E}_5, r^{E}_5	α^{RE}_5, r^{RE}_5	s_5
6th quantile	w_6	α^{F}_6, r^{F}_6	α^{E}_6, r^{E}_6	α^{RE}_6, r^{RE}_6	s_6
7th quantile	w_7	α^{F}_7, r^{F}_7	α^{E}_7, r^{E}_7	α^{RE}_7, r^{RE}_7	s_7
8th quantile	w_8	α^{F}_8, r^{F}_8	α^{E}_8, r^{E}_8	α^{RE}_8, r^{RE}_8	s_8
9th quantile	w_9	α^{F}_9, r^{F}_9	α^{E}_9, r^{E}_9	α^{RE}_9, r^{RE}_9	s_9
top 10%	w_{top10}	α^{F}_{top10}, r^{F}_{top10}	α^{E}_{top10}, r^{E}_{top10}	α^{RE}_{top10}, r^{RE}_{top10}	s_{top10}
top 1%	w_{top1}	α^{F}_{top1}, r^{F}_{top1}	α^{E}_{top1}, r^{E}_{top1}	α^{RE}_{top1}, r^{RE}_{top1}	s_{top1}
top 0,1%	$w_{top0,1}$	$\alpha^{F}_{top0,1}$, $r^{F}_{top0,1}$	$\alpha^{E}_{top0,1}$, $r^{E}_{top0,1}$	$\alpha^{RE}_{top0,1}$, $r^{RE}_{top0,1}$	$s_{top0,1}$

Source: own representation.

sources are available. For the investment shares we have to look for data on wealth distribution such as the Household Finance and Consumption Survey (HFCS, HFCN 2013). The extent to which income group-specific capital return rates of the respective investments can be approximated has to be examined.

Not every aspect of the empirical analysis will be equally important for the modelling procedure of distributional dynamics and the factors may vary from country to country. However, a basic analysis of each of those factors, ideally in a historical perspective, is necessary in order to achieve a holistic picture and not to miss crucial variables.

Moreover, Williamson's (2000) twenty-year-old assertion prevails today: even though the past fifty years have witnessed enormous progress in the study of institutions, we are still very ignorant about them. The study of institutions is of special relevance for inequality.[23] The consideration of institutions helps to explain economic and social phenomena, which exceed the explanatory power of standard neoclassical theory. More specifically, institutions serve as a critical variable in the analysis of long-run economic trends.

The multicausal nature of the evolution of distribution is described insufficiently by the theoretical approaches and empirical studies, even though leading researches in that field repeatedly emphasize this fact and stress the importance of the institutional environment. A model that fully integrates lateral distribution has not yet been developed. From the previous analysis we can draw three main conclusions: (1) savings are the central link between income and wealth, (2) the dynamics that need to be studied are complex, and (3) different levels of institutions might be responsible for the observed heterogeneity and have to be integrated. To capture these interactions a standard linear approach does not suffice. The *one model fits all* idea, as proposed by state of the art neoclassical macroeconomic models, which look

[23] The literature on this topic is extensive. On the general relevance of institutions for the economic system consult Rodrik (2003), Rodrik et al. (2004), Easterly & Levine (2003), Dollar & Kraay (2003), Acemoglu, Johnson & Robinson (2001), Acemoglu et al. (2002), Alvaredo et al. (2013), Hall & Soskice (2001), Berens & Gelepithis (2019), Beramendi & Rueda (2007). How institutions, more specifically, impact distribution Acemoglu & Robinson (2015) and Checchi & García-Peñalosa (2010) give the most relevant insights.

almost similar to one another in structure, irrespective of the research question addressed (Delli Gatti et al. 2011, pp. 7-8), might not be useful. One needs a more capable holistic method. We are in need of a categorial apparatus to describe and analyze the manifold dynamics of distribution. From the empirical observations, we can draw the conclusion that an applicable model should have two essential features: it should be able to link functional and personal income distribution and connect income and wealth. So essentially a reasonable approach would be to look at elements and frameworks that are able to capture complexity. There exist three fields in economics which can make a very fruitful contribution to answering this questions, all of which are very heterogeneous and would not count as exclusively economic research but are rather interdisciplinary fields mainly focused on questions from social science: institutionalism, systemic analysis and complexity economics. Interestingly, even though this conclusion is an original independent result of the research question at hand and the arguments that will follow now, the complementarity of these three approaches has already been pointed out by Gräbner & Kapeller (2015), Gräbner (2016), Gräbner & Kapeller (2017).

3.3 The economy as a complex system

Distribution is characterized by multilateral and in different dimensions dynamic process - dynamic in the distribution process itself and in the rules which this process follows. A systemic view provides in this context several advantages. Not only makes it possible integrate relevant institutions as well as all involved agents, but it also allows to depict the variety of complex interaction such as the mutual interdependence between stock and flow variables and the connection between functional and personal distribution. The economic process, of which distribution is only one part, is in itself embedded into a complex system of the society as a whole. The research question discussed in this paperencounters problems which actually constitute defining features of complexity. Systems theory and complexity theory are closely connected. The perception of the economy as a complex system not only verbalized in the works of leading economists of the 20th century such as (Hayek 1967*a*,*b*) but also is clearly visible in classical economic authors such as Adam Smith when they describe how aggregate patterns form from individual behaviour and individuals, in turn, behave reacting to these aggregate patterns (Arthur 2014). The gap between empirical analysis and purely theoretical models may be filled with applications of complex system studies (Mesjasz 2018).

From sociological system theory (cf. Parsons 1969, Luhmann 1977) we know that by functional differentiation the social system can be divided into different subsystems. Those subsystems may follow their own distinct logics[24] and interlock in different ways. The interaction between economy, politics, and society is what defines the “rules of the game”, as institutional economist would call it, and shapes distributional dynamics .[25] Thus the economy is part of a full system that defines a country, and at the same time, it is split into subsystems which define the different spheres of economic interaction. One of those subsystems determines distribution.[26]

The first application of a systemic approach to economics goes back to Jay Forrester’s (1961) system dynamics. He transferred his discoveries from unusual behaviour in supply chains to the infamous world model in the "Limits of growth" study. The idea of complexity became more explicit for economics only in the late 1980s, most prominently at the Santa Fe Institute, where it was prompted by interdisciplinary scientific exchange (Arthur 2010). Conceptually, on Castellani’s map of complexity science (Castellani 2018), the approach that would tackle the challenges of lateral distribution in different institutional environments can be situated between feedback loops of system dynamics, the heterogeneous interacting agents of agent-based modelling and the institutional perspective of a social system - a mixed-methods

[24] Which means that they function according to different underlying mechanisms such, e.g. as a power struggle, a perfect market or different behavioural assumptions.

[25] Depending on the underlying theory, the economy can either be seen as a part of superordinate systems (Costanza et al. 2001), as one of relatively stable equal side by side coexisting systems (Luhmann 1998), or as a dominant system whose capitalist logic penetrates all spheres of life - the so-called *intrusion* (Bourdieu 1999, Schimank & Volkmann 2008). Whichever theory applies shall not play a role in the further discussion.

[26] Such complex systems are called ‘hierarchical’. The nested hierarchy of complex systems describes lower-level systems existing within the context of higher-level systems in a hierarchy of levels of complexity (Colander & Kupers 2014, p. 50).

case. Complexity should not be seen as new a economic theory but rather a different way of thinking, a new perspective (Arthur 2014). The specific properties that make the research question a complex systemic problem are to be discussed in the following paragraphs. The complexity resulting from the theoretical and empirical discussion in the previous chapter is mainly based on the following two reasons: (1) Due to uncertainty, behaviour is not determined by rational decisions but instead by bounded rationality or habits. (2) Assuming behaviour is relatively stable, i.e. abstracting from actual historical cultural change, leaves us with path-dependent processes which are connected with the chaotic character of systems of difference or differential equations. That way, chaotic developments result not from the number of variables, which nonetheless might complicate the process, but as a result of non-linearity.

Heterogeneity, behaviour and emergence

The economy consists of a variety of interacting entities that are related to each other in specific ways. They not only can be split into functionally differing sectors such as firms, banks, households and government but also into agents heterogeneous in their behaviour, preferences, skills, knowledge, social networks, wealth, income, etc. The interaction between the parts or elements of the system can be described by a set of rules, and this is what macroeconomic theory usually does for the interaction between the functional sectors. The microeconomic perspective defines the behaviour of the individual agents, e.g. firms or households and potentially the relations between them. Up until here, there is nothing complex about it, even though the problem may become complicated due to a large number of agents exhibiting heterogeneous behaviour.

The defining feature that advances it to a complex question are the emergent properties of the system (Colander & Kupers 2014, p. 116-118, 128-130, 136-137). The elements of a system arranged in structures which are often the outcome of a process of self-organization, a spontaneous rather than a designed order (Harper & Lewis 2012), exhibit an interacting and macro behaviour that is different from the isolated individual micro behaviour (Holland 1995, p. 3-12). Emergence can be described as the development of often unexpected novel and coherent properties, patterns or relations. Simply put, *the whole is more than the sum of its elements*. Thus, macro-level properties of the system as a whole are qualitatively different from those of their individual component and cannot be reduced to the properties of its parts, i.e. the individual micro-level (Axtell 2007). The source of the emergence is not only a result of the macro-structure and micro-interaction but also an interaction between the parts and the whole (Colander & Kupers 2014, p. 128-130), how individual behaviour itself adapts in reaction to the pattern (Arthur 2014). Therefore, the emergent behaviour of the system is not easy to predict or deduce from the agents in it and appears only in simulations (Anderson 1972). Even simple rules can produce outcomes of high complexity (Wolfram 2002). This makes the system irreducible.[27]

As Harper & Lewis (2012) point out, the genesis of emergent properties in systems is a source of radical uncertainty in the sense of Keynes or Knight. Their appearance may be a genuine surprise as the occurrence lies outside of what the agents up until now have experienced or even imagined. This has major consequences for the standard rational choice assumption. If possibilities the previously well-defined decision problem faces an unknown, the probability distribution of consequences of actions and therefore acting according to utility maximization becomes impossible (Shackle 1972). Institutions can be seen as a result of such emergent phenomena and enable people to deal at least partly with radical uncertainty.[28]

Despite that, while reducing heterogeneity leads to a significant analytical advantage in general equilibrium models, in a systemic approach, such as agent-based models, the computational burden is not substantially affected by different levels of relevant characteristics of individuals such as a heterogeneous savings rate (Delli Gatti et al. 2011, p. 20). Specifying a distribution for each characteristic is a common procedure.

[27] A more elaborate discussion on the relationship between emergence and irreducibility can be found in Miller & Page (2007, p.41-45, 50-51), Jepperson & Meyer (2011), and Lawson (2012).

[28] Harper & Lewis (2012) show in table 1 of their paper the contrast of different notions of emergence depending on the theoretical economic perspective in terms of definitions of the term, focal characteristics, and examples.

Non-linearity and feedback effects

Dispersed and non-linear interactions between a large number of autonomous, heterogeneous agents are one of the main sources of complexity in the lateral distribution problem (Delli Gatti et al. 2011, p. 25). Mathematically non-linearity means that the change in the output of a system is not proportional to changes in input. Most natural, technical and social systems are inherently non-linear by nature. For the distribution question, this means not only that individuals adjust, for example, their consumption choice according to their income group, which depends relatively on the income of all other individuals in the economy, but that there is also an interaction between the micro and macro level, such that functional distribution plays into the problem. Non-linear terms are inevitably created by feedback effects from the whole system onto individual agent behaviour, resulting in the problem being not solvable analytically (Colander & Kupers 2014, p. 128). In addition, dependencies between periods described by difference equations lead to feedback effects. Thus, a non-linear dynamic system described by changes in variables over time can appear unpredictable, chaotic, sensitive to initial conditions and even counterintuitive in contrast to a simple linear system. Feedback effects can be represented by feedback loops. These can be either positive describing reinforcing, amplifying or exploding behaviour or negative and thus diminishing. It is the connection of several loops that makes outcomes unpredictable (Arthur 2014).[29]

Furthermore, a difficulty can arise from differing behaviour depending on the situation of the economy. This can be associated not only with a so-called regime shift between different phases of the business cycle but also with institutional change.

Moreover, real-world systems with feedbacks can be driven by the tails of the distribution instead of their averages (Anderson 1997, p. 566). These autocatalytic dynamics are especially likely to arise for income and wealth distribution, which results in averages missing the point or making the analysis completely meaningless (Colander & Kupers 2014, p. 122).[30] In such a case, the use of the representative agent becomes very problematic.

Irreversibility: time, path dependence and historicity

The concept of time is relevant in two ways. Robinson (1980) differentiates between logical and historical time. Logical time describes the order of events, capturing chronological and causal relationships. This concept is often associated with computer algorithms but is essential for models describing a series of events and interactions. The events which let the different parts of the system communicate with each other, even if they cannot be fully synchronized, are defined by logical time (Lamport 1978). The role of time is central for economic dynamics, even if we only want to describe the path to equilibrium (Robinson 1980, p. 220).

In addition, time is essential in capturing the causality between events.[31] Even though logical time is a necessary component of a complex system, incorporating the consequences of historical time leads to a characteristic property - irreversibility (Biggiero 2001). We can find a precise definition of this notion of time in Luhmann et al. (1982, p.307). In terms of a model, the past is a set of state variables that are inherited in each period from the previous period, and the dynamics of the model produce new states that are the inheritance of the subsequent period. Simulations make it possible to track down transition and explain why the sequences occur as they do (Godley 1997). Such events as bankruptcy and market exits illustrate irreversibility of historical time. The sense of history that creates new structures and makes real, irreversible changes was one of the main strength of political economy. Therefore, incorporating historical

[29] In particular, the literature on increasing returns since Marshall (1890) has recognized the importance of positive feedbacks (Arthur 1989, 1994).

[30] An elaborate discussion on the role of diversity in complexity can be found in Page (2007). Mathematically this property scale-invariant and thus is results in the emergence of power laws at an aggregate level (Delli Gatti et al. 2011, p. 20). This makes scale-free distribution especially relevant for economics (Brock 1999, Mantegna & Stanley 2000, Delli Gatti et al. 2008)

[31] From a philosophical point of view, causality cannot be defined in this simple way. Epistemologically it is not simple to connect two events, and the cause does not necessarily have to produce the outcome. This discourse goes back to Aristotle's discussions in *Physics* II 3 and in *Metaphysics* V 2 (Falcon 2019) and is beyond the scope of this paper.

time takes up a classical tradition which is missing neoclassical models.[32]

Path dependence plays an essential role in understanding real economic dynamics, as the economy at all levels and at all times is path-dependent (Arthur 2014). For the analysis of the economic system, the initial state of the system is crucial (Robinson 1974). It matters whether the economy starts in equilibrium or not. And it does not just come down to initial conditions, endowments, starting values and the process of movement. Regulatory frameworks and patterns in dynamics develop over time. Therefore, there are time and space restrictions. Piero Sraffa (1960) pleaded for open models, that allow for a historical-materialistic interpretation (Schefold 1989). The starting point of such models should be the characteristics of the economic system, which are independent of the volume of production and factor proportions, and directly connected with the distribution problem. In these theories, distribution is not mechanistically determined.

A systemic approach integrating institutional factors can be classified as a compromise between mechanistic models and real historicity. If we overcome the materialistic determinism, this leads us to the opposition between "rational" theory (today described as "pure" theory) and "visual" theory as described by Edgar Salin (1929). Pure theory can only provide partial findings, while the visual theory, on the other hand, exceeds rational theory and was born from the desire to capture cultural development by comprehension (Schefold 1994, 2004). The contrast is similar to the one between materialistic and idealistic historiography. The basis for such an economic approach can be found be found in the works of the authors of the youngest generation of the German Historical School (cf. Schmoller 1900, 1998, Sombart 1925), who out of the tradition of the this school of economics laid the foundation for institutional analysis while at the same time combining it with a profound empirical analysis, thereby creating a unique amalgamation allowing understanding and creating the means to enable to identify motivations.

Tools for the analysis of complex adaptive systems such as agent-based modelling can be described as a third way of doing science (Axelrod 1997) as it lies between formal deductive reasoning and inductive empirical research because it uses inductive and deductive methods. This is one of the points where the parallels to the German Historical School and institutional economics become apparent. A combination of these approaches bears the potential of increasing the explanatory power of computational models. Hence, understanding arises from a combination of knowledge of the system and its history (Colander & Kupers 2014, p. 130).

4 Ingredients for a modelling framework

Path dependence, historicity and the influence of institutions have epistemological consequences for the modelling approach. In general, these properties would imply that not every theory may be applicable to every real economic system at any point in time. Thus, this challenges the neoclassical claim of universal validity and being the general case compared to other theories. However, theoretical approaches can be distinguished by their specific endogenous and exogenous variables, which would imply that a theoretical approach by itself is incapable of being the general case (Sen 1963).[33] From the choice of the closure and, thus, the implicit causality results the tacit assumption about the influence of power (Betz & Ehret 2019, Richters & Glötzl 2020).

Martin & Schlüter (2015) show how the macro perspective of system dynamics and the micro perspective of agent-based can be combined by constructing to interacting submodels. The variety of existing models

[32] How poorly neoclassical economics handles time has received much criticism from different directions (cf. e.g. Robinson 1973, 1980, Smolin 2009, 2013). As Harris (2003) points out, time largely disappears at equilibrium as an outcome simply persists, while in dynamic models it is reduced to a parameter that can simply be slid back and forth. For Joan Robinson (1973) this aspect has serious consequences: *"Once we admit that an economy exists in time, that history goes one way, from the irrevocable past into the unknown future, the conception of equilibrium ... becomes untenable. The whole of traditional economics needs to be thought out afresh."*

[33] The discussion on which theory is the general and which the specific case has come up time and time again (see, e.g. Sraffa 1960, Hahn 1982).

shows that the macroeconomic theoretic construct of a post-Keynesian stock-flow consistent model (PK-SFC) and the structure of system dynamics are a natural match (Jackson et al. 2016). In addition, institutional economics, post-Keynesian economics and system dynamics have a strikingly similar view of the world and can be seen as three strands of one braid (Radzicki 2008). This chapter will discuss the theoretical basis for combing these modelling ideas.

4.1 Modelling the macroeconomy: SFC vs. DSGE approach

The framework I propose to use is not considered a standard model, even though it is well established in the heterodox post-Keynesian community. It was developed by James Tobin and Wynne Godley in the 1980s and 1990s and links decisions on real variables to credit creation in the financial sector and asset allocation.The popularity of the stock-flow-consistent (SFC) approach increased drastically after the Great Recession.[34]In addition, stock-flow-consistent modelling can be regarded as a mere tool without a predetermined theoretical foundation. The choice of behavioural equations, the assumptions about causality and the closure of the model determine its theoretical background.[35] Nevertheless, it is most commonly applied in the post-Keynesian tradition of economics.

SFC models can be used to study the evolution of balance sheet position, especially financial assets and liabilities, and the corresponding financial flows by sector. The framework allows for feedback effects from the financial side to the real economy and thus to decision making, as its main characteristic is that it integrates the real and the financial sides of the economy, which is essential for the understanding the complex and interconnected behaviour of a modern capitalist economy (Nikiforos & Zezza 2017).[36] Most prominently, money, credit and banks are focal points of the models and, thus, the financial sector is often modelled in a more realistic way. Moreover, especially if combined with agent-based modelling, they typically adopt more realistic assumptions for expectations, behaviour and heterogeneity than traditional DSGE models.[37]

Albeit DSGE models being more clearly linked to economic theory, agent-based SFC models (cf. Caiani et al. 2016) can combine macroeconomic identities from the system of national accounts and specific studies on economic behaviour without relying on economic agents solving optimization problems. This opens the door for including country-specific institutions and actual micro-foundations in the model. Moreover, post-Keynesian theory has often been used to describe the development of complex dynamics in economics and some of its key ideas such as non-ergodicity and fundamental uncertainty necessarily result in complex interactions (Rosser 2006).[38]

Even though the SFC model seems an obvious choice, it bears some difficulties, which have to be kept in mind. The framework is not as well-established as the DSGE model. Thus, it is harder to take on board insights from other work. Moreover, the models are very complicated by themselves and often have a large number of equations. This makes it hard to explain the primary economic mechanism at work. Integrating an agent-based submodel does not ease the understanding. In addition, those models are difficult to take to data as the data requirements are large compared to standard DSGE models (Burgess et al. 2016). Validation and verification can take an extensive amount of time, and the method will depend on the specific type of model. On the positive side, those models are open in nature and can integrate not only institutions and submodels with different behavioural assumption, but their national accounts

[34]One of the factors that played a significant role in that is undoubtedly the recognition that models based on the post-Keynesian SFC (PK-SFC) framework (e.g. Godley 1999) were able to predict the crisis which caught the majority of the economics profession by surprise (Nikiforos & Zezza 2017).

[35]In fact, the early attempts to construct such a de-facto stock-flow consistent model were of a neoclassical nature (Denizet 1968, Turnovsky 1977, May 1970, Meyer 1975, Malinvaud 1982), even though they did not succeed to publish a coherent method based on a fully consistent accounting framework.

[36]This became particularly evident during the recent crisis and the slow recovery that followed (Nikiforos & Zezza 2017). As a consequence, for example, the Bank of England introduced a new SFC model to its tool kit of economic analysis (Burgess et al. 2016).

[37]In addition, accounting constraints allow to identify relationships in the short and the long run. Thus variables within the model will react differently to policies depending on the speed they are imposed.

[38]Rosser (2006) gives an elaborate overview of the inherent complexity in the different strands the post-Keynesian literature.

structure allows to take them directly to System of National Accounts data, which is a major advantage when looking at historicity in models.

4.2 The systemic tool kit

This section will look briefly into the specific modelling techniques that can be used to introduce complexity on different levels.

Agent-based models and stock-flow consistency

Agent-based modelling (ABM), also referred to as agent-based computational economics (ACE), brings in the necessary micro foundation needed to model lateral distribution. *Heterogeneity* and *interaction* are the characteristics distinguishing agent-based modelling from other approaches. As has already been discussed, the representative agent in standard DSGE models cannot approximate aggregate regularities resulting from heterogeneous behaviour (cf. Kirman 1992, Gallegati & Kirman 1999). The inconsistencies arise, for example, from the distribution of real-world data which in many cases takes the shape of a power law instead of a Gaussian distribution. Therefore the average behaviour does not represent the system, resulting in a fallacy of composition. Even though efforts exist to introduce heterogeneity into those models, the direct interaction among the heterogeneous agents is still out of the scope of the standard modelling framework (Riccetti et al. 2015). This feature is best illustrated by envisioning interaction of relatively simple animals in zoological models.[39]

The roots of the '*bottom-up*' approach can be found in the microsimulation works of Bergmann (1974), Bennett & Bergmann (1986), and Eliasson (1977, 1984). These two models are generally recognized as the inspiration for economic agent-based modelling (Neugart & Richiardi 2018). How economic organization can emerge from decentralized interaction, i.e. bottom-up, is shown by Howitt & Clower (2000). The economic agent-based models that have been developed based on these microsimulations keep a similar heterogeneous focus as their predecessors .[40] The basic model proposed by Delli Gatti et al. (2011) has become a consensus and a starting point for most macroeconomic bottom-up models. Due to the interdisciplinary roots of those models, it is not surprising that the topic of climate change is a key area of application.[41] Dosi et al. (2006, 2010, 2013, 2015) analyze the effect of economic policies in different distribution regimes, defining functional distribution by size of the mark-up.[42] The more comprehensive models reproduce a significant number of micro- and macroeconomic stylized facts (cf. e.g. Dosi et al. 2015, Riccetti et al. 2015, Assenza et al. 2015, Caiani et al. 2016). Also, they often outperform DSGE models in policy questions as they have more flexibility, are more 'data-friendly' and more intuitive due to the more realistic assumptions and the clear algorithmic structure (Fagiolo & Roventini 2012).

As in the general agent-based community, the specific branch of stock-flow consistent agent-based models has been highly heterogeneous in the beginning, not only the choice of research questions but also in the implementation of stock-flow consistency, and relatively small on top (Kinsella et al. 2011, Seppecher 2012, Riccetti et al. 2015, Assenza et al. 2015). Usually, the agent-based part of the model is in the feature that is under investigation. Only two models exist which implement interactions from the very bottom layer and therefore can be described as fully agent-based models of the whole economy. One of those models is the EURACE project (Deissenberg et al. 2008, Cincotti et al. 2010, Raberto et al. 2012, Dawid et al. 2012, 2014, Van der Hoog & Dawid 2015), which is an extremely large-scale massively parallel economic model of the economy of the European Union.[43] The alternative is the ground-braking work by

[39] Kirman (1993) uses this type of illustration to show similarities between the behaviour of ants and the dynamics of financial markets.

[40] For a more in-depth overview consult Dawid & Neugart (2011), Fagiolo & Roventini (2012, 2017) and Riccetti et al. (2015).

[41] See Balint et al. 2017 for a full survey.

[42] They find that higher profit margins lead to the economy being exposed to more severe business cycle fluctuations, higher unemployment, and a higher probability of crises. However they allow also fiscal policy to be more effective.

[43] Unfortunately, the size of the model, its amount of features and the resulting complexity make the model not very

Caiani et al. (2016), which has become the benchmark model of the literature. Their fully decentralized model is reasonably simple and flexible compared to the previous one as it does not aim to match real economies one-to-one, and can easily be replicated and extended.[44] It not only implements several features important for assessing financial fragility, such as credit networks but also proposes a comprehensive calibration and validations technique in line with the requirement of stock-flow consistency, which makes it a good candidate for policy analysis.[45]

While the mentioned models give a very good overview of the applicability of agent-based modelling to economic problems and the compatibility with the stock-flow consistent framework, none of them disaggregate the economy on the way that would be needed to model lateral distribution, i.e. personal distribution, a variety of behaviour resulting from it and the two-sided interaction with functional distribution. The discussed models are fully disaggregated in the firm and banking sector, while households are only heterogeneous by being employed or unemployed and receiving a stochastic wage. This is the gap that needs to be filled.

In addition, to show the dynamics invoked by lateral distribution it is not necessary to model a fully agent-based economy, it might even be counter-productive for understanding distributional dynamics as the source resulting emergent outcome becomes harder to determine. Therefore, the macroeconomic dynamics can be integrated by PK-SFC system dynamics model. On the other hand, such an approach comes with restrictions in terms of prediction, as it would ignore such aspects as financial fragility and innovation dynamics on the firm side. Nevertheless, this implication is not as serious, as the agent-based submodel of lateral distribution can easily be added as a module to any open model such as Delli Gatti et al. (2011), Caiani et al. (2016) or the EURACE project.

System dynamics perspective and stock-flow consistency

System dynamics describes a simulation modelling technique originally developed in the 1950s to answer supply chain questions in corporate systems (Forrester 1961). Its intellectual roots lie in control engineering and servomechanisms development (Radzicki & Sterman 1994). It became more present in economics through ecological questions posed by the Club of Rome's ground-breaking 'Limits to Growth' study (Meadows et al. 1972). From a mathematical point of view those models consist of a conventional system of differential equations, and thus typically are formulated in continuous time. The feedback dynamics created by those equations describe the physical structure of the system, represented by a network of stocks and flows. From a theoretical perspective, these are structural, behavioural, disequilibrium models (Radzicki & Sterman 1994).

There are parts of the economy, such as the general macroeconomic dynamics, where an approximation is enough and that do not necessarily need to be broken down into interacting agents to understand the dynamics of lateral distribution. They can either be modelled in a traditions post-Keynesian stock-flow consistent way or by the integration of system dynamics into the modelling framework.[46] The latter would put more emphasis on the feedback effects. Modelling-wise, system dynamics separates incoming and outgoing flows which is in line with the SFC perspective that all transactions matter and netting can result in serious misspecification of the model, especially in the context of financial fragility. Another feature of system dynamics is that stocks are usually conceptualized as having limits. Real socio-economic processes have many limiting factors, including physical limits, cognitive limits, and financial limits (Radzicki 2011). This property influences, for instance, the behavioural assumptions and can, in addition, be translated into identifying property of SFC models, stock-flow consistency determines that all transactions of one type between the sectors and all transactions inside a sector respectivelysum to zero at each point in time. From the previous history of system dynamics, it is not surprising that it has already been combined with

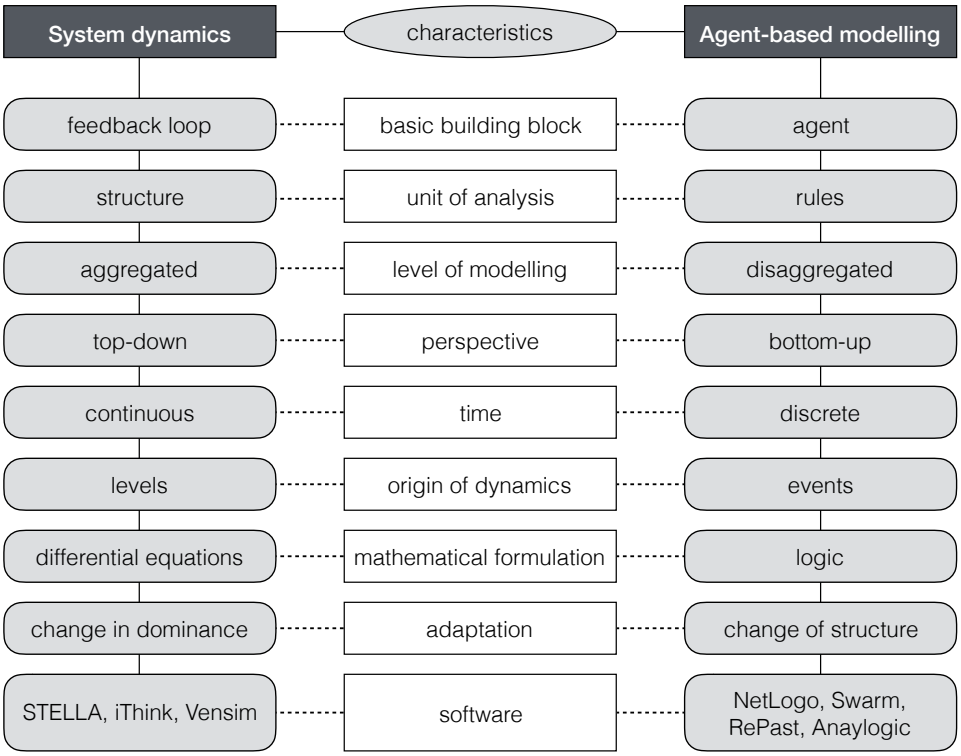
accessible.In addition, it requires tremendous computing power, not even available at every university.

[44] The model is fully accessible over the Java Macro Agent Based (JMAB) programming tool suite.

[45] Implementations of the model can be found in Burgess et al. (2016), Caiani et al. (2018), and Caiani et al. (2019).

[46] The post-Keynesian stock-flow consistent macroeconomic model and the methodology of system dynamics have common grounds which make it easy to combine both approaches (Jackson et al. 2014).

Figure 16: System dynamics and Agent-Based Modelling



Source: Own representation based on Macal (2010), Guerrero et al. (2016), and Ding et al. (2018).

a PK-SFC model in an effort to explore the possibilities of socio-economic transition to sustainability, which produced several models with different emphasis (Jackson et al. 2016). A project that was funded by the European Union.

The integration of multiple feedback loops leads to complex non-linear interactions, and thus system dynamics models often exhibit a persistent disequilibrium. For exploring scenario development over time, system dynamics is especially useful, as it facilitates visualization of the model structure as well as the scenario result (van den Belt 2004, Jackson et al. 2014). Non-linearities are particularly important in an institutional context. They contribute significantly to a system's evolutionary behaviour.

Integrating system dynamics environment and agent-based submodel

While the methodology of system dynamics goes intuitively with stock-flow consistent modelling, the fusion of system dynamics and agent-based modelling faces many hurdles. Despite both approaches being used to study complex interactions in dynamic systemsand researches repeatedly advocating for their integration[47], up until the 2010s system dynamics (SD) and agent-based modelling (ABM) have been isolatedly developed as separate paradigms (Pruyt 2015).

As their modelling perspectives are fundamentally different and the application of each technique is more suited for distinct situations (cf. Scholl 2001, Guerrero et al. 2016, Ding et al. 2018), they do not appear as an obvious match and sometimes are even considered antagonists. Figure 16 contrasts their different characteristics.[48] Most obviously, the models differ in their structural perspective. While SD maps top-down an aggregate world with feedback loops, ABM starts with bottom-up with the individual heterogeneous agent. Thus, while SD focuses on the resulting feedback effects, ABM is more concentrated on emergent dynamics. In SD modelling is conducted in continuous time by differential equations on

[47] See, e.g. Scholl (2001), Lättilä et al. (2010), Macal (2010) and Guerrero et al. (2016).

[48] Guerrero et al. (2016) gives an in-depth comparison of the characteristic and good overview of the literature comparing system dynamics and agent-based modelling.

different levels. In contrast, ABM models the interaction of agents in discrete-time events with logical specifications that often cannot be reduced to an equation. This has three significant consequences:

1. Only an ABM specification is able to integrate a stochastic element (Bonabeau 2002).
2. SD was not designed to allow for a spacial dimension (Guerrero et al. 2016).
3. Compared to SD, ABM entails a time-consuming simulation and interpretation processes (Osgood 2007).

Nevertheless, many systems can equivalently be modelled by either approach (Macal 2010).[49] Moreover, for some research questions one paradigm alone is not enough to provide an insightful analysis (Lättilä et al. 2010, Shafiei et al. 2013). This is especially the case when the research question investigates the link between two parts of the system (Martin & Schlüter 2015).[50]

There are three possibilities to combine those two modelling techniques: (1) heterogeneous agents (AB micro level) in interaction with their environment (SD) (cf. Haase et al. 2012), (2) heterogeneous agents (AB) with complex internal logics (SD) (cf. Bradhurst et al. 2015), or (3) two parallel, same level interacting systems (one AB, one SD) with different logics (cf. Martin & Schlüter 2015, Ding et al. 2018). Linking the different parts of the system requires to specify the variables of interaction, the aggregation level and the time syncing mechanism.[51] The choice of model design is determined by the research question. Figure 17 summarizes the epistemological characteristics of the separate models and their hybrid combination. In addition to the possibilities offered by the characteristics of its modelling parts, the hybrid model is able to investigate the interactions between the different levels and their mutual influence on each other.The very few papers that implement such hybrid models are dominated by ecological questions (cf. Hudjetz et al. 2014, Bradhurst et al. 2015, Vincenot et al. 2015, Martin & Schlüter 2015) and operational research (cf. Brailsford et al. 2019).

For the research question in this paper, the seemingly natural combination of both approaches is the preferred choice: heterogeneous households described by an agent-based submodel interact within their economic and social environment modelled by system dynamics. The hybrid SD-ABM facilitates the definition of appropriate levels of aggregation for each component of the system. Moreover, the dynamics of a fully agent-based can be extremely difficult to understand. The combination with system dynamics reduces complexity where it might not be needed (Ding et al. 2018). Another advantage of a hybrid approach that should not be underestimated is that the combination reduces the tremendous computation time that a fully agent-based model would require.

4.3 Country-specific modelling

While post-Keynesian economics has been mostly analysing macroeconomic dynamics, institutional economics has been picturing the intersectoral relationships and structural change (Forstater 2001*b*). In spite of these different emphases or perhaps because of them, institutional economics has been widely acknowledged to have a fruitful influence on post-Keynesian theory and many authors argue that a synthesis would create a more comprehensive approach than either can offer by itself.[52] One could argue that system dynamics is the link between institutionalism and macro-modelling. Moreover, it is capable to model interaction between different spheres or subsystems (Jackson et al. 2014) such as the social

[49] This is only possible if no randomness is introduced (Brock 1986). Examples of the same problem studied with both approaches can be found in Parunak et al. (1998), Marin et al. (2006) or Norling (2007).

[50] The models do not necessarily have to be connected the way their aggregation level suggests it (Swinerd & McNaught 2012).

[51] In a hybrid model, some parts can be modelled discretely and others in continuous time, based on the characteristics of the subsystems (Osgood 2007).

[52] The list of contributions to this discussion is interminable. Eichner (1979, 1985) has been especially formative for it. Furthermore, see for example Wilber & Kenneth (1983), Hodgson (1989), Kregel (1990), Milberg (1992), Lawson (1994), Harvey (1994), Forstater (2001*a*,*b*, 2003), and Radzicki (2003, 2004, 2008).

Figure 17: Characteristics of ABM, SD and the hybrid model.

	Agent-based model	System dynamics model	Hybrid model
Characteristic question	emergent system-level patterns	evolution of stocks dominant processes	+ interaction between structure/ parameters and dynamics
Purposes	identify mechanisms (specific interactions) responsible for emerging patterns	aggregate dynamics stability properties evolutionary dynamics, prognosis	+ different micro- or system level mechanisms that drive certain dynamics
Focus	micro-level interactions network structure heterogeneity transient dynamics	processes driving accumulation stable-states feedbacks (balancing, amplifying) non-linearities	+ (two-way) restructuring in a system
Tests for model calibration	statistical pattern matching	stability analysis	separate subsystem tests qualitative check for full model
Analysis tools and typical experiments	plotting group/system level characteristics over time (average) evaluating a limited parameter range describing transient dynamics	state space plots from simulations evaluating stable-states, equilibria	+ interaction of submodels
Type of outcome	emerging patterns scenario comparison system properties (averages)	aggregated system properties in terms of stability loop dominance	+ time series of emerging state-transitions

Source: Own representation based on Martin & Schlüter 2015.

environment, the real economy, the financial economy and the lateral distribution. Non-linearities and emergent behaviour are in particular important in an institutional context. They contribute significantly to a system's evolutionary behaviour. In addition, system dynamics models are not only evolutionary in their behaviour but also in the modelling process itself. They are pattern models and try to identify regularities, so-called 'generic structures' (or real typologies) (Radzicki 1988) which can be used to guide the creation of new system dynamics models (Radzicki 2011). This pattern modelling is also a common mode of explanation in different institutional approaches (Wilber & Harrison 1978, Radzicki 1988), even if the analysis is far from the level of formalization of system dynamics. Holism is another concept that institutional economics and complexity economics have in common. On these grounds, Radzicki (1988) and Radzicki & Sterman (1994) argue for a synthesis between those two approaches. In addition, agent-based modelling enriches the complexity strand with its real micro foundation, which reflects the heterogeneous behaviour shaped by nationally distinct institutions.

This results in specific epistemological consequence, which can be derived from reversing the general argument made at the beginning of this chapter : the existence of diverse real economic systems calls for the necessity of different or at least nationally adjusted economic approaches. The institutional framework and the behaviour of the agents inside it will always be historically-contingent for a country or a region, depending on the normative and cultural imprint of its inhabitants and the over centuries grown and developed legal, political, economic and social institutions (Schefold 1994). Path dependence will shape future outcomes. This makes it indispensable to study the specific systems more thoroughly and look at their evolution to get a better understanding which development one might expect (Rodrik 2003, Colander & Kupers 2014). General laws of capitalism hardly can be derived from the diversity of its forms. This argument for country-specific modelling is very much in line with the idea of visual theory and various institutional approaches. Moreover, it is inevitable to take a more detailed look at the specific institutions involved in inequality dynamics.

In combination with economic theory and the chosen methodology, several arguments were put forward as to why the research question cannot be answered by an abstract universal model with standard assumptions. Instead, it should be tackled by a model allowing for complexity, path dependence and institutional structures.

5 Submodel of lateral distribution

The general idea behind the purposed model can be best described by reverting to Garegnani's visualization of the modelling concept of classical theory (Garegnani 1984). The surplus theories can be broken down into a so-called "core" problem which is isolated from the rest of the analysis and takes certain variables, such as the social product, the technical conditions, the subsistence part of the wage and one of the distribution variables, as given. The theory in the core then determines distribution and prices. The idea is not one of the Marshallian partial equilibrium (cf. Marshall 1890) but rather a step by step approach. The concept rather entails that different economic questions might have to be answered by different parts of the framework which follow different logics and might be separated by time.

Consolidating and expanding this idea and introducing modern terminology, the model at hand can be split up into a main model of the economy and a submodel of lateral distribution. This paper will solely focus on the specifics of the latter. This submodel describes the connection between households' income and wealth distribution by splitting income into its sources, determining the allocation of savings and introducing differentiated rates of return. The interrelations can be best described by the lateral distribution matrix already presented above (figure 15). The following paragraphs shall give a formalized representation of the dynamics. In many aspects this model follows the general behavioural assumptions presented in benchmark SFC models (Godley & Lavoie 2007, Caiani et al. 2016, Nikiforos & Zezza 2017). Its distinguishing feature lies in the disaggregation of these behavioural assumption and thus in the introduction of differently behaving household agents.

5.1 Setting up the initial starting point of the model

In the tradition of an agent-based model this section begins with the description of the starting point. All households are endowed with a certain wage and a certain wealth in the beginning. They are sorted by income and, therefore, assigned to a certain percentile. To reduce dimensions in the beginning it is assumed that the households in the income distribution percentiles correspond to those in the wealth distribution. From the data we derive the households' income from wealth, which shall be called capital income and their portfolio choices. Capital income is the aggregated of income from three categories of wealth: (1) bonds or deposits, (2) stocks or enterprises and (3) real estate. From this we can calculate the rate of return for each category of investment for each percentile of the distribution.

5.2 Model equations

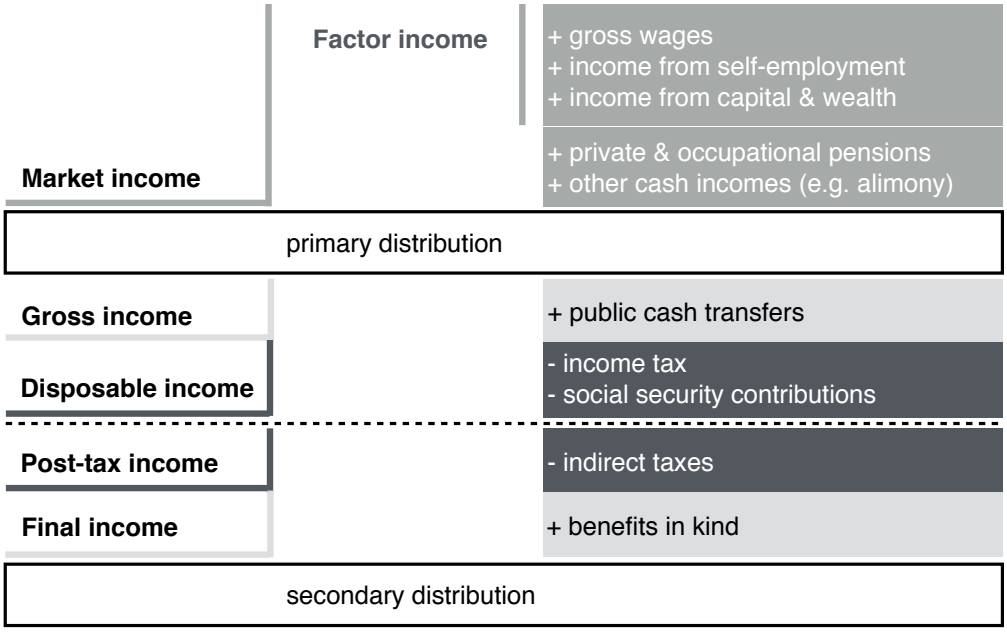
The economy consists of n households denoted by the suffix which belong to a certain percentile i of the income distribution and a particular percentile j of the wealth distribution, both determined in the previous period. Each period the following sequence of events takes place.

Each household receives an income, which can be split into two parts(cf. figure 18): market income and redistributed income. All following abstracting assumptions are made in order to isolate the main dynamics and keep the model as simple as possible. In our model we confine market income to factor income which can be split up into two main components:

$$Y^F_{i,t} = W_{i,t} + RPI_{j,t} \tag{1}$$

where $Y^F_{i,t}$ is the individual household's factor income, $W_{i,t}$ represents the household wage, subsuming

Figure 18: Overview of primary and secondary stages of income distribution



Source: Own representation.

income from employment and income from self-employment[53], and $RPI_{j,t}$ denotes the return private on investment. The wage depends on its position in the income distribution up until now. The household's return on investment depends on the wealth percentile the household is in. Its wealth position determines the rate of return itself as well as the allocation of wealth. Wealth can be held as bonds or deposits (labelled B), in stocks or enterprises (labelled S) or as real estate (labelled R):

$$RPI_{i,t} = \alpha_j^F V_{j,t-1} r_j^F + \alpha_j^E V_{j,t-1} r_i^E + \alpha_j^R V_{j,t-1} r_j^R \tag{2}$$

The household invests a certain percentage into each category of assets, which is denoted by α. Thus $\alpha_j^F + \alpha_j^S + \alpha_j^R = 1$ for each j. r gives the corresponding rate of return, dependent on the amount household's of total wealth accumulated in the previous period. Relevant to the households consumption decision is however the disposable income, which it receives after redistribution part of the secondary distribution took place. Thus, we describe the income group dependent taxes T_i^H as:

$$T_i^H = \theta_{i,W} W_{i,t} + \theta_{RPI} RPI_{j,t} \tag{3}$$

The differentiation between wages and return on investment is necessary as taxation practices may differ here.

$$YD_{i,t} = Y_{i,t}^F - T_i^H + R_i \tag{4}$$

where $Y_{i,t}^F$ is the previously defined income, T_i^H are the direct taxes and R_i represents the aggregated redistributional payments from the welfare state.[54] Once every household's disposable income is determined, the new income distribution can be computed and every household gets new information on its position (i.e

[53] Where data does not differentiate between the wage part of self-employment and the return on investment this can approach can cause a significant bias. In this case, following Kravis (1959), the adjust labour compensation and the percentage of self-employed in each income percentile should be used to adjust the measures. However, this is not an insignificant complication of the modelling process.

[54] At this point we ignore the financing decisions for the reason of simplicity. Obviously, especially from a post-Keynesian, leaving out this aspect could result in a significant bias. Thus it most definitely should be integrated later on.

i is updated). This recalculation is especially important to capture changes in the shape of the distribution over time.

Now the household decides what to do with his income. Consumption and savings are two sides of the same coin. From the perspective on distribution savings is the variable that plays the crucial role in the creation of wealth. Since, whatever is not saved is assumed to be consumed, consumption on the other hand, although relevant for the aggregated economic dynamics, plays a secondary role in this submodel. The household's savings decision depends on a heterogeneous savings rate, which in turn is determined by its new percentile in the income distribution.

$$S_i = (1 - c_i)YD_{i,t} = s_i YD_{i,t} \tag{5}$$

Through savings wealth will increase:

$$V_{j,t} = V_{j,t-1} + S_i \tag{6}$$

After calculating the individual wealth, the overall shape of the wealth distribution can be recalculated (i.e. new j for every household). When households receive their income in the next period, it will depend on a given wage distribution and newly achieved wealth.

The lateral distribution submodel is the agent-based component to a larger model and not a standalone simulation. It is the microeconomic disaggregated behavioural household part which needs to interact with the macroeconomy. Consumption is the variable that translates the macroeconomic dynamics and at the same time the income created in the macroeconomy in the next period will will be distributed among the households. This submodel is closed in its logic and can be flexibly integrated into any type of model. The personal preference of the author have been stated in the previous chapter.

6 Conclusions

The purpose of this paper was to find a multidimensional bridge between functional and personal distribution as well as to show a possibility of integration the heterogeneity of the microeconomic distribution into dynamics of the macroeconomy.

The suggested tool is the *lateral distribution matrix*, which is estimated for a specific country and can be used directly in models and simulations. Therefore, it reflects at the same time also inter-country heterogeneity by incorporating behavioural factors such as risk-aversion, financial market participation, and investment behaviour of households, which are the result of an amalgamation of characteristic behaviour for a specific variety of capitalism, the influence of financialization and for some countries (such as Germany) a national peculiarity. This refers to the undeniable relationship between the shape and intensity of distribution, as described by (Chauvel 2016), and the distinct lines of research in comparative capitalism studies following the works of Esping-Andersen (1990, 1999), Hall & Soskice (2001), Boyer (2005) and Amable (2003). Not only formal institutions such as the welfare state or regulation (Acemoglu & Robinson 2015) but also informal institutions such as norms and habits (Williamson 2000) play an essential role in shaping country-specific distributional dynamics.

While systems dynamics are suggested to define the relationships between the entities, describe the system's structure and the dynamics arising from it, the peresented agent-based submodel adds the country-specific heterogeneous behaviour. On both levels the basis for determining the variable is an extensive analysis of the national institutions involved in the distributional analysis, the insights from which have to be implemented into the systemic model. Institutions of the welfare state play here a special central role in restructuring the economy, determining the disposable income and thus consumption and aggregate demand.

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