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A Stock-Flow Consistent Model of Income Inequality: The destabilizing Effects of the German Labor Market on the EMU

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A Stock-Flow Consistent Model of Income Inequality: The destabilizing Effects of the German Labor Market on the EMU

THESIS SUBMITTED TO LEVY ECONOMICS INSTITUTE OF BARD COLLEGE

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Abstract

This thesis presents a stock-flow consistent model (SFC) that analyzes the effects of Germany's wage moderation on other Eurozone economies. It shows that excessive German saving comes at a cost: the decoupling of productivity growth and real wage growth for the largest share of the German workforce relies on internal and external debt. The SFC model presented in this paper is inspired by the recent Eurozone model by Gräbner et al. (2021) that is published as a working paper. Germany's wage moderation will be discussed as an example for how income inequality reduces domestic aggregate demand but gets compensated through an increase in net exports. This allows to derive some general conclusions about the nexus between income inequality, secular stagnation and financial instability. If the institutional structure of the EMU is not changed, Germany will continue to free-ride on the aggregate demand created by debt-led growth in peripheral EMU economies.

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1. INTRODUCTION

Economic inequality is often criticized on normative grounds such as fairness or its distortionary effect on democratic decision making (Wade 2005, Pickett and Wilkinson 2015, Scanton 2018). The aim of this paper, however, is to examine its macroeconomic implications.

Economies with increasing income inequality face a growth problem. The reason for this is straightforward: high income groups have a higher propensity to save than low income groups which is why income inequality depresses aggregate demand and output (Kaldor 1955, Dynan et al. 2004, Saez and Zucman 2016).
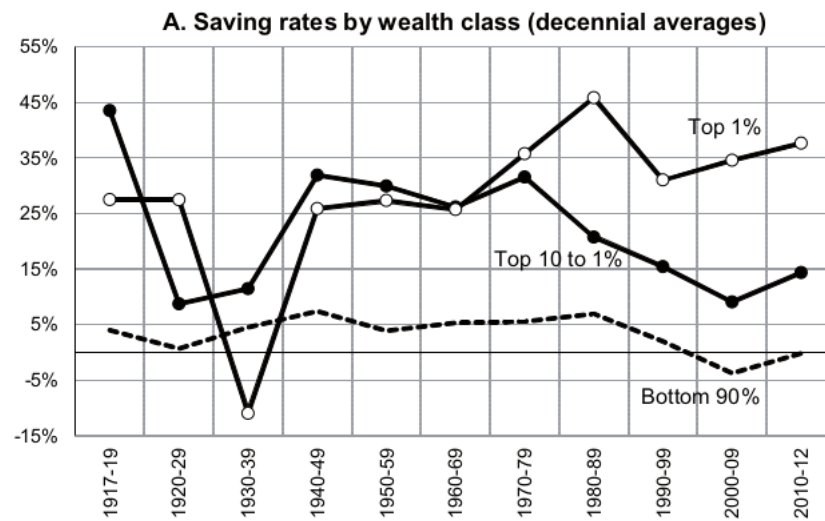
Figure 1: Saez and Zucman 2016, p.564

The nexus between income inequality and financial instability is well established in the Post-Keynesian literature (Keynes GT Ch. 8, Kalecki 1938, Kaldor 1955, Pasinetti 1962, 1974, Robinson 1962, Kalecki 1971, Hein 2014, van Treeck 2013, Belabed et al. 2018) but also gaining prominence in mainstream macroeconomic research (Mian et al. 2021/forthcoming, Mian and Sufi 2010/2011/2018, Mian et al. 2017).[1] Increasing income inequality (both functional and personal)

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[1]Recent empirical finance papers published in the top-5 economics journals have made striking observations which run contrary to the economic orthodoxy. Mian, Straub and Sufi (2020), for example, find a simultaneous increase in the debt to GDP ratio and a decrease in interest rates for the US between 1970 and 2020. Their finding is counter intuitive because one might expect the interest rate, as the price of debt, to increase with an increasing amount of debt. In a

attaches a larger part of GDP to higher saving rates. However, saving is a two step-decision (Keynes 1936, chapter 6) and not ex ante identical to investment as in a corn economy. [2] Therefore, an increase in the aggregate saving rate can drag aggregate demand and growth. Therefore, the cost of saving is high in a monetary economy. [3] The income inequality of the decades prior to the global financial crisis (GFC) in 2007/8 was accompanied by increasing household leverage, thereby even reducing the overall saving rate and pumping up demand (Zezza 2008, Fazzari 2022, already discussed by Marx 1894(1992) Chapter 25 and expanded by Luxemburg 1913(2003) chapter 30).

Growth can only be achieved if the income inequality induced loss in aggregate demand is compensated by either an increase in investment (a), an increase in the government deficit (b), an increase in domestic leverage (c), an increase in net exports (d), or by a combination. As investment has slowed down in all advanced capitalist countries (Koo 2015, ECB 2016) [4] and government deficits are limited due to austerity ideology and fiscal rules (Herndon et al. 2014 on Reinhart and Rogoff's Growth in a time of debt, Sawyer 2018), growth in the past decades has mainly been driven by (c) and (d), or a combination of both (Barba and Pivetti 2009, Gu and Huang 2014, Kapeller and Schütz 2014). Why are some

second paper, the same authors argue that increasing income inequality created a savings glut among the rich, which financed the consumption of the bottom 90% of the income distribution instead of investment (2021). The expansion of household credit is seen as the main driver for the global financial crisis (GFC) of 2007/8 (Schularick and Taylor 2012). Kumhof, Rancière and Winant (2015) observe a co-movement of income inequality and household leverage prior to the GFC and the Great Depression of the 1930s. However, authors that study the general relationship between economic inequality and financial crises in larger samples find mixed and often insignificant results (Bordo and Meissner 2012

[2] "The theory which I desiderate would deal (...) with an economy in which money plays a part of its own and affects motives and decisions and is, in short, one of the operative factors (...), so that the course of events cannot be predicted, either on the long period or in the short, without a knowledge of the behavior of money (...). And it is this which we ought to mean when we speak of a monetary economy." (Keynes, Festschrift, 1933)

[3] "Every such attempt to save more by reducing consumption will so affect incomes that the attempt necessarily defeats itself. It is, of course, just as impossible for the community as a whole to save less than the amount of current investment, since the attempt to do so will necessarily raise incomes to a level at which the sums which individuals choose to save add up to a figure exactly equal to the amount of investment." (GT, Chapter 7)

[4] This phenomenon is explained differently by different schools of thought. New-Keynesian scholars would emphasize the decreasing marginal productivity of capital while Post-Keynesians might focus on uncertainty, high liquidity premia and income inequality leading to a low level of effective demand. Marxists see the decline in investment as capitalism's "disease of old age" (Sweezy 1942, p. 189) based on the relations of production and the decline in the rate of profit as a secular consequence of competition.

countries able to fix their demand problem abroad while others fix it domestically? Behringer and van Treeck (2021) argue that countries which experience a shift in their functional income distribution tend to develop export-led growth regimes while countries that face a shift in their personal income distribution tend to develop consumer debt led growth due to Veblenian dynamics (see also Belabed et al. 2018).

A lot of scholarship has been devoted to study the latter dynamic, for example the importance of US consumer debt in the upswing before the global financial crisis in 2007/2008 (see van Treeck 2013 for a survey). It is argued that the decline in aggregate demand due to a shift in the personal income distribution was masked by an increase in household loans that were underpinned by an asset bubble. This is why the aggregate saving rate in the U.S. actually declined prior to the GFC despite the surge in income inequality (Zezza 2008, Nikiforos 2016, Fazzari 2022). This nexus is formalized in a Kaldorian model by Nikiforos as a "non-behavioral theory of saving": in an environment of current account deficits, restricted fiscal policy and income inequality, full employment can be maintained through increasing leverage of the bottom 90% of the income distribution (2016).

In this paper, I will take Germany's wage moderation of the 2000s as an example for how a shift in the functinal income distribution reduces domestic aggregate demand but gets compensated by an increase in net exports. The flipside of Germany's current account surpluses are current account deficits in the peripheral economies of the Emropean Monetary Union (EMU, abstracting from the current account surplus of the EMU with the rest of the world). Hence, Germany's export-led growth is partly driven by debt-led growth in peripheral Europe.

2. THEORETICAL BACKGROUND

2.1 Why Monetary Economies are Demand-led

Orthodoxy is agnostic towards economic inequality as long as factor returns represent marginal productivity, and marginal productivity of CEOs can be very high in neoclassical theory. Orthodox economists that think outside the representative agent framework agree with the notion that higher income earners have a higher savings rate and talk about a "Saving Glut of the Rich" (Mian

et al. 2020). In a non-monetary economy, increasing savings provide increasing supply in the market for loanable funds and thereby investment which is seen as the long run determinant of economic growth.[5] Therefore, one has to explain the bold claim that income inequality is a hindrance for growth and stability. From the following discussion it will become clear that money is the issue. Money makes the model of the economy more complex and introduces a range of paradoxes Keynes and his followers discovered as soon as it is introduced into macroeconomic analysis.

Keynes' proposition was that monetary economies are fundamentally different from the barter abstraction with a loanable funds market.[6] In the *Festschrift for Arthur Spiethoff* (1933) Keynes explicitly states that he developed his theory in opposition to Marshall's Principles which dealt with "relative exchange values" and money as a veil:

> "The theory which I desiderate would deal, in contradistinction to this [Marshall], with an economy in which money plays a part of its own and affects motives and decisions and is, in short, one of the operative factors in the situation, so that the course of events cannot be predicted, either on the long period or in the short, without a knowledge of the behavior of money between the first state and the last. And it is this which we ought to mean when we speak of a monetary economy." (Festschrift, 1933)[7]

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[5]A nice critique can be found in Robinson's Essay on Marxian Economics: "But in the orthodox scheme the theory of employment scarcely existed, and in its original setting the chief use to which the argument was put was to justify the unequal distribution of income. Unequal distribution is favourable to saving, since it concentrates large incomes in the hands of a few individuals who can saturate their demands for consumption and accumulate wealth without any uncomfortable tightening of the belt. Thus any assault upon inequality, for instance by heavily progressive taxation, is held to be dangerous to society, since it dries up the source of capital accumulation and so prevents economic progress (...) Moreover, if society is conceived to tolerate inequality in order to promote saving, it is obvious that a large part of the higher incomes runs to waste in providing the rich with a luxurious standard of life. Unequal distribution of income is an excessively uneconomic method of getting the necessary saving done. The argument that inequality is justified because it promotes saving turnes inside out, and becomes an argument in favour of corporate saving by the state combined with an egalitarian distribution of consuming power." (1942, p. 64-65)

[6]I'm actually not sure if the loanable funds market necessarily implies barter. The idea of a neutral rate is a non-inflationary rate, hence a rate, which leads to an equalization of savings and investment. Investment can be independent of savings, but when too high because interest rates too low, it simply is inflationary (see Hayek 1933). Therefore, the distinction between Keynes and neoclassical economics is again on the persistence of full employment.

[7]Keynes continues: "Nevertheless it is my belief that the far reaching and in some respects

As capitalism is characterized by expensive and debt financed capital equipment, money does not lubricate any barter exchange but marks the start and end of any cycle of production (see also the contributions by Hawtrey, Robertson or Hahn).[8] The differential between the two sums, monetary profit, is the main motive of production. Money is understood as an asset whose main return is subjective: liquidity. Saving then means spending less than one's (monetary) income in order to hold a liquid position. This has led to the famous paradox of thrift: If individual agents try to save more, the aggregate saving rate might actually decline because the attempt to save foremost reduces aggregate demand and thereby income of which individuals can save.[9]

In the General Theory, investment is determined independent from savings.[10] Liquidity preference, the aim of storing savings in a liquid position, determines asset prices which determines investment. The necessary aggregate equality of investment and savings is achieved through an adjustment of income by the multiplier. In opposition to the New-Keynesian view which is dominating economics today, Keynes was very explicit on this:

> "The novelty in my treatment of savings and investment consists,
> not in my maintaining of their necessary aggregate equality, but
> in the proposition that it is, not the rate of interest, but the level of
> incomes which (in conjunction with certain other factors) ensures
> this equality." (1937, p.249)

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fundamental differences between the conclusions of a monetary economy and those of the more simplified real-exchange economy have been greatly underestimated by the exponents of traditional economics; with the result that the machinery of thought with which real-exchange economics has equipped the minds of practitioners in the world of affairs, and also of economists themselves, has led in practice to many erroneous conclusions and policies."

[8]Fazzari and Minsky write: "The Wall Street vision of business people and bankers negotiating liability structures to finance asset holdings and activity, and these liability structures being validated or repudiated by events that happen later in calendar time, is the essential theoretical and institutional structure upon which Keynesian theory is based" (1984, p.106).

[9]"Every such attempt to save more by reducing consumption will so affect incomes that the attempt necessarily defeats itself. It is, of course, just as impossible for the community as a whole to save less than the amount of current investment, since the attempt to do so will necessarily raise incomes to a level at which the sums which individuals choose to save add up to a figure exactly equal to the amount of investment." (GT, Chapter 7).

[10]"The introduction of an independent investment demand function together with the rate of capacity utilization as an endogenous variable breaks the identity between saving and investment, and generates a class of Keynesian models in which Say's Law does not hold." (FMT textbook, p.240)

Output is determined by effective demand, and fluctuations in effective demand are mainly driven by investment which is constrained by liquidity preference, hence by the existence of money (Kregel 1985).[11] This is why monetary economies usually equilibrate below full capacity (Lavoie 2014, Stockhammer 2021). There is a gap between potential output (if all factors of production were employed efficiently) and real output.

Keynes frames saving as a "two-sided affair" in the General Theory (Chapter 7). First, individuals decide to not consume all of their income. Second, individuals decide how to allocate their savings. In a barter economy, the savings necessarily consist of real assets (investment). In a monetary economy, individuals can decide from a variety of financial instruments. The higher the liquidity preference, the stronger the wedge between actual investment and investment necessary for full employment, the stronger the depressionary effect of saving and, therefore, of income inequality. In the short run, income inequality increases the output gap. In the long run, income inequality furthermore decreases potential output through a decline in investment and therefore productive capacity.[12]

If the economy is below full employment, increasing spending, e.g. through redistribution, government spending, investment, consumer leverage, or export demand, can boost growth without causing inflation or crowding out other investment.[13] Changes in demand can have permanent effects through their effect on investment (hysteresis). This is because an increase in investment increases

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[11]"It is in this sense that money is a 'real' phenomenon: changes in the price of money, the rate of interest, will bring about changes in the rates of return on capital goods and thus cause investment and income to adjust. At the same time, this argument shows clearly that Keynes's theory of interest is simply the other side of the multiplier medal." (1988 p.237)

[12]Keynes: "That the world after several millennia of steady individual saving, is so poor as it is in accumulated capital-assets, is to be explained, in my opinion, neither by the improvident propensities of mankind, nor even by the destruction of war, but by the high liquidity- premiums formerly attaching to the ownership of land and now attaching to money. I differ in this from the older view as expressed by Marshall with an unusual dogmatic force in his Principles of Economics, p. 581: Everyone is aware that the accumulation of wealth is held in check, and the rate of interest so far sustained, by the preference which the great mass of humanity have for present over deferred gratifications, or, in other words, by their unwillingness to 'wait'." (General Theory, p. 121)

[13]Part of this are two further paradoxes. First, an increase in the wage share can increase capacity utilization and thereby investment if the economy is wage led (Paradox of Cost), see FMT textbook, Chapter 12). Second, a tax on capital income can increase profits when redistributed to workers through the increase in aggregate demand (Paradox of Profit). This is because an increase in the tax on capital income increases aggregate demand as potential savings (leakages) are taxed and added as a quasi autonomous component to aggregate demand which increases the equilibrium amount of profits (Kalecki 1937).

profits. The open economy profit equation, formalized by Kalecki, is given by the following identity: Aggregate profits are equal to the sum of capitalist consumption, investment, the government deficit and net exports, minus saving out of wages.[14] Therefore, current investment validates past investment by adding to aggregate demand which is the Widow's cruse Keynes described in the *Treatise on Money* (1930, p. 125).

2.2 Varieties of Capitalism and demand-led growth models

Acknowledging that monetary economies are demand-led in conjunction with the decomposition of aggregate demand has led to the immense literature on demand-led growth regimes. A lot of this literature goes back to a paper by Bhaduri and Marglin from 1990 in which the authors show that depending on the specification of the investment function, economies can be wage-led, or profit-led (see also Kurz 1990). If an increase in the wage share leads to an increase in investment through the increase in demand and thereby capacity utilization, the economy tends to be wage-led. If an increase in the profit share increases investment through the increase in the profit rate, the economy tends to be profit-led (for an empirical analysis of profit-led and wage-led regimes, see Lavoie and Stockhammer 2013, Onaran and Galanis 2014).

But why are some economies wage-led and others profit-led? Over the past decade, demand-led growth regimes are increasingly acknowledged in the comparative political economy (CPE) literature and thereby causing a shift from the more supply side oriented Varieties of Capitalism (VoC) based on different labor market institutions and price competitiveness (Johnston and Regan 2016)[15] to Post-Keynesian growth theory (Baccaro and Pontussion 2016, 2018, Behringer and van Treeck 2021).

The wage-led profit-led framework has been expanded recently to take the depressing effect of income inequality into account. Hein et al. (2021) argue that what they frame as finance-dominated capitalism has depressed the wage share and thereby led to the evolution of debt-led private demand (DLPD) and export-led mercantilist (ELM) regimes in formerly wage-led economies. Both regimes

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[14]"Workers spend what they get, capitalists get what they spend."

[15]The argument goes that coordinated market economies (CMEs) were able to supress wages and increase competitiveness while mixed market economies (MMEs) had stronger organization of labor which led to inflationary pressures (for a critique, see Kohler and Stockhammer 2020, p.5).

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were interconnected before the global financial crisis (GFC) as for every net exporter there is a net importer which is likely to lead to persistent indebtedness of the same countries (Dodig et al. 2016, Hein 2012, 2019). In a panel of 18 countries Behringer and van Treeck (2021) find that countries which experienced a shift in their functional income distribution tend to develop export-led growth regimes through the reduction in demand for imports while countries with a shift in their personal income distribution tend to be DLPD due to Veblenian, upward looking consumption patterns (Duesenberry 1949, Frank et al. 2014, Bertrand and Morse 2016)[16]

Household deleveraging after the GFC turned DLPD regimes either into ELM regimes when the fiscal space was restricted such as in Spain due to the Maastricht rules, or into domestic demand led (DDL) regimes such as in the U.S. or the UK where government deficits compensated for household deleveraging (Hein 2019, Hein and Martschin 2020, Hein et al. 2021).

Kohler and Stockhammer (2020) articulate a subtle critique of the framework used by Hein and his co-authors. They emphasize to look at drivers of growth instead of contributors to growth. The growth contributor framework (DLPD vs ELM) is silent about the actual growth drivers: export sophistication (non-price competition), fiscal space (government spending), and consumer finance (Minskyan debt cycles). Kohler and Stockhammer argue that the shift from current account deficit to current account surplus countries after the GFC only occurred through a decrease in income which depressed import demand. Hence, what appears to be a weakly export-led regime in fact has nothing to do with a country whose growth is based on high tech exports and non-price competition. Instead, the reaction of the government to household deleveraging, either austerity, or fiscal expansion, fundamentally affected the growth path of the economies which is similar to Hein's conclusion though slightly different than their focus. The change in growth drivers then explains a change in the growth model.

An example for this is the structural break in the relationship between a country's economic complexity index (used as a proxy for non-price competition) and its growth performance. Before the GFC, the relationship was actually neg-

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[16]Further reasons are that coordinated market economies tend to have more regulated financial markets, more public goods provided by the government and unions that not only accept wage repression but also somewhat constrain CEO pay (Belabed et al. 2018 p.48-50, Behringer and van Treeck 2021, p.5).

ative due to household leverage in DLPD regimes leading to growth despite low economic complexity. After household deleveraging and fiscal austerity, the relationship between ECI and GDP growth turned positive (Kohler and Stockhammer 2020 p.30). From a growth model perspective, the interconnectedness of DLPD and ELM regimes broke down after the GFC (Kohler and Stockhammer 2020, p.35). Due to household deleveraging, demand for exports from ELM countries has decreased leading to stronger domestic growth drivers despite ongoing and structural surpluses (Kohler and Stockhammer 2020, p.17). Kohler and Stockhammer conclude:

> "Macroeconomic Regimes are stable for a while, but then endogenously undermine themselves through unintended outcomes like high inflation or financial instability that trigger political pressures towards regime change." (Kohler and Stockhammer 2020, p.35)

The proposed focus on growth drivers (consumer finance or economic complexity) instead of growth contributors (consumption or net exports) allows to incorporate a stronger emphasis on financial relations and cyclical growth patterns (Borio 2014, Kohler and Stockhammer 2020). Minsky's financial instability hypothesis was initially developed to explain the endogenous fragility of investment[17] , but can be applied to debt financed consumption, for imported or domestic goods, as well (Ryoo 2016, Fazzari 2022).

Taking consumer finance as an example and looking back to the Kalecki equation: negative saving out of wages increases profits and thereby stimulates the economy (Iacoviello 2008). If real wages are stagnant, household mortgages can be validated through increasing leverage of other households leading to an increase in house prices, which resembles a version of Minsky's increasing margin of safety through the increase in net worth through increasing the equity share on household balance sheets (Tymoigne and Wray 2014). Validation, however, increases fragility through adaptive expectations under uncertainty (Fazzari 2022, p.9).

Risk, as measured by the standard deviation of returns, decreases in periods of validation. This leads to less collateral demanded even in a situation where

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[17]It adds a financial theory of investment to Keynes's investment theory of the cycle as "monetary and financial institutions will affect the path of the economy through time" (Minsky 1993 p.17).

the actual distribution of returns remains unchanged or even gets more dispersed (Kregel 2008)[18] If cash flows are sufficient to service debt commitments, the lender interprets this as having been excessively conservative in the past, and therefore loosens its lending standards over the financial cycle.[19] At the same time, the increase in the stock of debt leads to an increase in the flows of debt servicing which tends to depress demand assuming saving out of profits is higher than saving out of wages and household borrowing becomes less elastic with increasing leverage. Palley notes: "the crux of the argument is that borrowing initially serves to increase aggregate demand and output, but that debt service payments subsequently serve to reduce them" (1996 p.213, see also Dutt 2006, Stockhammer 2015, Stockhammer and Kohler 2019).[20]

With an increasingly vulnerable financial structure, the reduction of aggregate demand through debt servicing ultimately leads to asset sales and a debt deflation, where agents have to sell position in order to make position (Minsky 2008(1975) p.139).[21] However, as there is no liquidity in the aggregate (Keynes 1936 p. 155), the fall of asset prices can be very strong. Minsky's financial instability hypothesis can be seen as an application of Kalecki to time:[22]

> "The financial instability hypothesis relates finance and aggregate
> demand through the impact of financial market events upon invest-
> ment and the impact of investment upon income and on the flows
> that are capitalized into the price level of capital and financial assets

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[18]"[S]uccessful functioning of a capitalist economy means that there is an increases acceptance of liability structures that pledge ever greater proportions of the expected cash flow from operations or assets to servicing liabilities." (Minsky 1988b, p.2).

[19]leading to Minsky's famous notion that stability is destabilizing (Minsky 2008(1975) Chapter 6). The increase of borrower's and lender's risk over the business cycle was already discussed by Keynes in the General Theory (1936, p. 145)

[20]Leverage and short term growth already discussed by Marx (Capital Vol. 3, Chapter 25) and expanded by Luxemburg (Accumulation of Capital, Chapter 30)

[21]"the burden of debt increases in a deflation. Under these circumstances we can expect the willingness to go into debt to finance investment to decrease. (…) Furthermore, as prices and wages fall, the realization spreads that speculative gains can be earned by holding money: velocity will tend to decline. Instead of levering retained quasi-rents to finance investment, firms will use retained quasi-rents to decrease debts. A wage deflation can be expected to lead to a fall in real investment below the level at which the initial excess supply of labor existed. Downward wage flexibility, in a situation with unemployment, will make things worse" (Minsky 2008(1975) p.139). The last sentence attacks the New-Keynesian interpretation of Keynes. Minsky's FIH endogenizes the build up of debt in Fisher's theory of debt deflation (1933).

[22]The capital stock of today depends on expectations of the past but its profitability depends on investment today which depends on expectations about the future (Minsky 1978, 1992a).

> and that are used to fulfill payment commitments." (Minsky 1978, p.6)

The FIH was originally developed as a financial theory of investment: "a decision to invest – to acquire capital assets – is always a decision about a liability structure (...) [i]nvestment is therefore a financial phenomenon" (Minsky 1986, p.192 and 209). We can restate and apply Minsky to stagnant incomes: a decision to increase consumption nowadays is also often a decision about a liability structure: consumption is therefore a financial phenomenon.[23]

The Minskyan consumer finance cycles which erupted in 2007/8 are closely linked to asset price inflation. Especially real estate served as collateral for household loans. Through the appreciation of their real estate, households felt wealthier and increased borrowing (Boyer 2000, Crouch 2009, Hay 2009, Ansell 2012 p.533, Hay and Smith 2013, Stockhammer and Wildauer 2016b, Chwieroth and Walter 2019, Adkins et al. 2020, Christophers 2020). This period is described by Crouch as "privatized Keynesianism" (2009) or by Cynamon and Fazzari as the "Consumer Age" (2008). Loans were no longer made in expectation of repayment but to "originate and distribute" (Minsky 1987, Whalen 2017).[24] In 1987, Minsky describes a "symbiotic relation between the globalization of the world's financial structure and the securitization of financial instruments" and that "[t]hat which can be securitized will be securitized" (p.1-2).[25] Through securitization mortgage rates were very low which is why the causality runs in both directions: The supply of mortgages increased the demand for houses which increased house prices which increased the value of collateral for consumer loans in a pro-cyclical manner (Adelino et al. 2012, Tymoigne and Wray 2014, Favra and Imbs 2015, Di Maggio and Kermai 2017, Mian and Sufi 2019).

Even subprime borrowers saw their house prices increasing which increased their equity share in their homes which made them qualifying for prime refinancing (Kregel 2008, Mian and Sufi 2019). Mortgages were bundled and sold

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[23]In a 1990 manuscript, Minsky indicated: "The modern credit card economy carries the household indebtedness phenomena to new heights" (p.11), unfortunately, without elaborating this thought further.

[24]Securitization is an example for the paradox of risk: The individual attempt to reduce risk leads to an increase in systemic risk that has to be ex-post validated by the central bank (Wojnilower 1980)

[25]Minsky also links the emergence of securitization as an innovative response by mortgage lenders to Volcker's interest rate policies (ibid. p.3).

in tranches of which some were rated triple A allowing institutional investors such as pension funds to participate. In summary, asset based lending replaced income based lending in the 2000s (Tymoigne 2014). In their empirical analysis, Kohler and Stockhammer find a strong positive link between house prices and growth for 30 OECD countries (2020, p.3). Piling up consumer debt led to an increase in debt service which erupted in an asset fire sale starting in 2007 (Kumhof et al. 2012, 2015). The nexus between income inequality, stagnation and financial fragility is summarized by Fazzari:

> "[N]ow that unsustainable household borrowing no longer props up household demand, the chickens of inequality-induced demand drag have come home to roost. High and rising economic inequality explains secular stagnation of household demand, stagnation that was hidden during a nearly three-decade Minsky cycle" (2022 p.24)

In this section, I have argued that monetary economies usually operate below capacity which is why a variety of growth regimes emerge that have dialectical relationships with each other. In the next section, I will discuss various channels that reduced wages in Germany and how they have affected growth models in the EMU.

3. LABOR MARKET ROFORMS IN GERMANY

3.1 Schröder and the Agenda 2010

The end of the Soviet Union influenced the German economy mainly via two channels. First, the German reunification increased the public deficit and the unemployment as noncompetitive former state owned companies got privatized by the Treuhand and 16 million citizens of the former German Democratic Republic (GDR) were integrated into the social security system of Western Germany (Bofinger 2017). Second, some German manufacturing got outsourced to the newly independent countries, which is why the economic complexity index has increased for eastern European countries (Kohler and Stockhammer 2020, p.30), and some companies would threat to relocate production. Overall unemployment was cyclical but with an upward trend. Germany was framed as the "sick man of Europe" (Dustmann et al. 2014).

Only 15 years later, Germany rose to a global export power. There are different narratives of the apparent German success story. Some emphasize the extraordinary productivity growth while others argue that German exports are merely the result of beggar-thy-neighbour wage moderation and thereby questioning if German exports should be considered a success story at all (Lapavitsas et al. 2011, Stockhammer 2011, Bibow 2012, Flassbeck and Lapavitsas 2013, Bofinger 2015, Wren-Lewis 2015).

The latter narrative starts in the end of the 1990s with the election of Gerhard Schröder. His coalition of the SPD (center-left) and the Green Party initiated the pact for work, education and competitiveness (Bündnis für Arbeit, Ausbildung und Wettbewerbsfähigkeit) as a joint project with unions and employer organizations. The agreement contained implicit agreements on wage moderation in exchange for job security as well as an increase in the flexibility of part-time work contracts (Wolf 2000, Bündnis 2000, Bofinger 2017). In a similar vein, the 2004 Pforzheim agreement of metal and electrical unions institutionalized wage moderation (Bofinger 2017).

Another major change was introduced by the Hartz reforms that were part of the so called Agenda 2010 and introduced between 2003 and 2005. The Hartz I-III reforms created new types of employment ("Minjobs") [26] , deregulation of short term work agencies, increase in Ich-Ags/Me.Inc's), wage subsidies (Bedarfsgemeinschaften), financial sanctions for declining job offers and the of the restructuring Federal Employment Agency (Launov and Wälde 2016). Employees of the new Bundesagentur für Arbeit (Agency for Work) received premia for putting unemployed into any type of employment independent of the workers satisfaction or the duration of the subsequent employment type (Hannemann 2015, p. 33). The Hartz IV package is the most prominent one of the reforms. It became effective in 2005 and introduced a cut of the duration of unemployment benefits of 60-67% [27] of the previous wage from 32 to 12 months, as well as making the follow up benefits purely means tested and even taking income of relatives for this into account (Hochmuth et al. 2021).

3.2 Germany's Labor Market after the Reforms

German unemployment declined from 5 to 3 million between 2005 and 2008,

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[26] A work contract which allowed for a 400€ per month salary being free of tax.
[27] 67% for unemployed labor force participants with children.

exports rose to 1.7trn Euro (½ of GDP) in 2011 (Dustmann et al. 2014). Krebs and Scheffel (2013) find that the Hartz reforms reduced the non-cyclical component of unemployment in Germany by 2.8 percentage points. Launov and Wälde find that the Hartz reform explain 20% of the post-reform unemployment decline (2016). The reforms created winners and losers: High income earners paid lower social security contributions while short and long term unemployed experienced an increase in the precariousness of their living conditions (Hochmuth et al. 2021). The reduction in benefits for early retirement increased the employment rate the elderly population (Odendahl 2017). Overall, the reforms have contributed to the rising trend in short term work contracts and the low wage sector [28] from 16% of all work contracts in 1997 to 25% in 2008 and has stagnated since (Grabka and Schröder 2019). At the Davos Forum of 2005, Schröder gave a proud speech about Germany's low wage sector: "We have created one of the best low wage sectors in Europe (..) for years the unit wage costs have been stagnating. A good development for investments in this country. [29]

Unemployment and net exports in Germany after the Euro introduction and the Hartz reforms
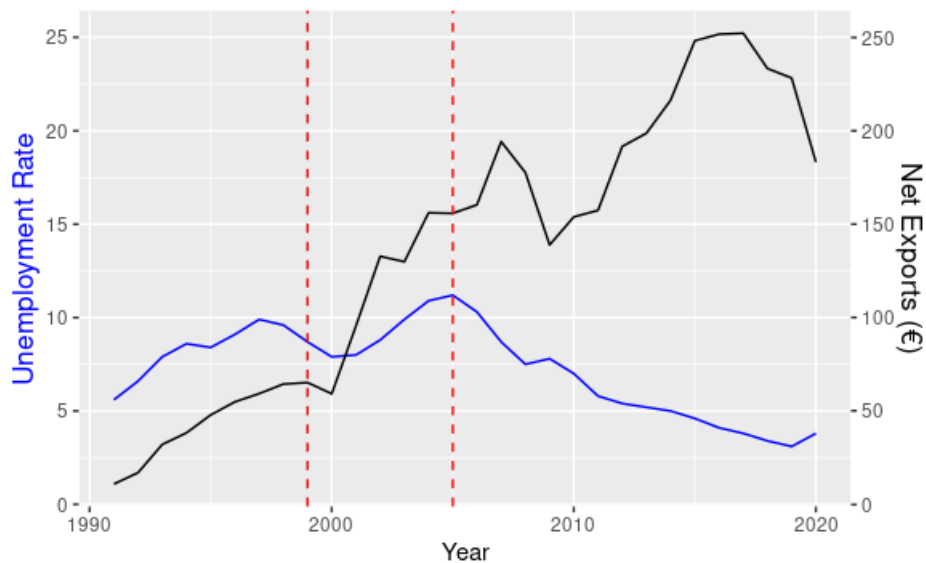
Figure 2: Data: AMECO, current prices

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[28] defined as 2/3 of median income.

[29] "Wir haben einen der besten Niedriglohnsektoren aufgebaut, den es in Europa gibt (…) Wir haben seit Jahren in Deutschland eine stagnierende Lohnstückkosten-Entwicklung. Gut für Investitionen in diesem Land."

But how important were the Hartz reforms for this? Commentators have mixed opinions. Bofinger argues that the employment effect of the Hartz Reforms is overestimated and that the increase in the German low wage sector and part time employment actually slowed during the early 2000s (2017, similar Weinkopf 2013). Bofinger further stresses the secular effects of the phasing out of the German reunification (2017). Between 1989 and 2006 2.8M citizens of the former Soviet Union received German citizenship and had initially high unemployment rates that declined subsequently (2017, Brück-Klingberg et al. 2007). A further important contributor to the decline in wage growth are the implicit, and sometimes explicit, agreements between employer associations, work councils, and trade unions, or "codetermination" (Palladino 2019) mentioned above (Dustmann et al. 2014).

3.3 Does Germany's Wage Moderation explain its Export Success?

Overall, a lot of studies see a link between Germany's wage moderation and EMU trade imbalances (Lapavitsas et al. 2011, Stockhammer 2011, Bibow 2012, Flassbeck and Lapavitsas 2013, Bofinger 2015, Wren-Lewis 2015). It is argued, that low wages in Germany's manufacturing sector outcompeted industry in the periphery which has led to a de-industrialization in several regions. However, if all EMU countries have had wage moderation at the same time, demand for Germany's export goods would have declined too. Therefore, Bofinger argues that the success of the German wage moderation depends on rising wages in the peripheral economies: "[A]ny attempt to improve a country's competitiveness via wage moderation has the character of a zero-sum game" (2017).

Wage growth in peripheral EMU countries was different as their labor markets were characterized by strong unions that allowed real wages to move in line with productivity gains, and sometimes even more then that (Johnston and Regan 2016). Different inflation rates under the same currency in core and peripheral countries had accumulated to a decline in export competitiveness throughout the early 2000s, while the ECB only targeted average inflation (Strom and Naastepad 2015c, Gräbner et al. 2020). Diaz Sanchez and Varoudakis (2014) and Storm and Naastepad (2015c) argue that the low interest rates by the ECB in the early 2000s were appropriate for stagnant Germany but not for peripheral Europe leading to a debt-led boom and that the ECB rates clearly track the Taylor rule determined rate for the core.

Different inflation rates in the EMU prior to the GFC
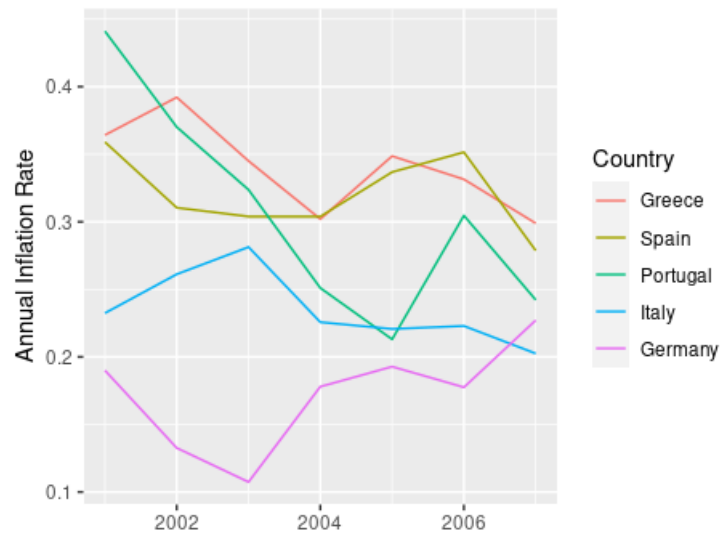
Figure 3: Data: IMF

In sum, it is argued, trade imbalances rely on changes in unit labor costs: while wage growth moved in line with productivity growth in the periphery they decoupled in the core. The story then goes like this: the low interest rates by the ECB led to very low real interest rates in the periphery. Combined with the disappearance of exchange rate risk after the introduction of the Euro, this has led to capital inflows into the peripheral economies, tightening labor markets and huge investments in real estate development.

Evolution of real wages and labor productivity
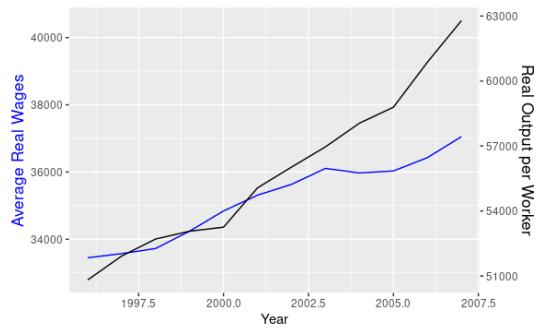
(a) Germany
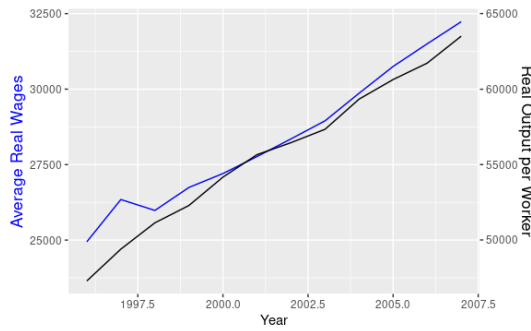
(b) Italy
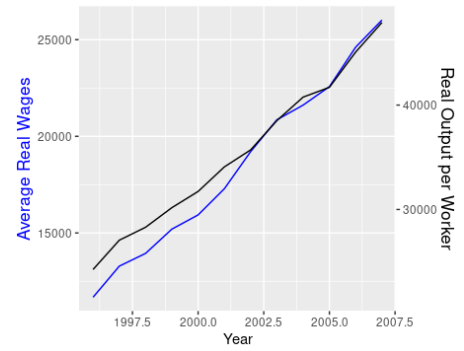
(c) Greece
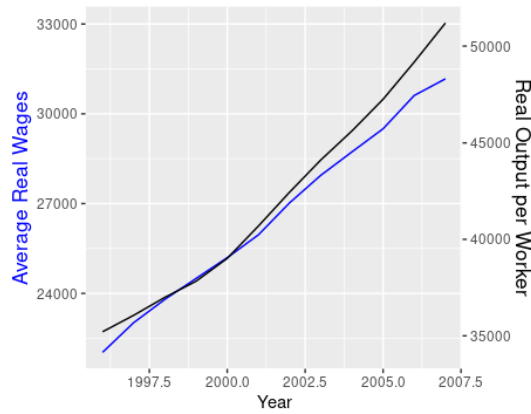
(d) Spain
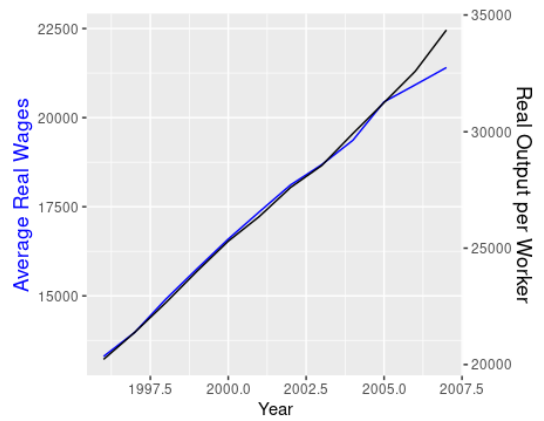
(e) Portugal

Figure 4: Data: EPWT 7_0, current prices

Despite numerous attempts of conservative politicians and liberal economists to deregulate the labor markets in the peripheral economies and to slash social spending, it took a coordinated attack via the Troika institutions to break resistance after the socialization of private bank losses has led to surging public debt to GDP ratios (Jaumotte 2011 [30] , Storm and Naastepad 2015c, Tsoulfidis et al. 2016, Perez and Matsaganis 2018). The recommendations of the Troika turned out to be toxic and led to even more divergence as they solely focused on wage restraint and employer friendly labor market reregulation. [31]

The core-periphery patterns persists until today (Simonazzi et al. 2013, Baldwin et al. 2015, Storm and Naastepad 2015c, Iversen et al. 2016, Johnston and Regan 2016, Regan 2017, Celi er al. 2018, Gräbner et al. 2019, Gräbner et al. 2020). This is why, later in the model, I will use the term "core" to refer to Northern EMU economies Austria, Belgium, Finland, Luxembourg, Germany and the Netherlands, and the term "periphery" in order to refer to Greece, Ireland, Italy, Portugal and Spain. France is hard to locate in this distinction (Gräbner et al. 2019).

There are two potential policy proposals based on the labor cost competitiveness perspective on EMU trade imbalances. A more left-wing, Keynesian, perspective would aim for increasing wages in the core countries, while a conservative, neoliberal lens would propose a reduction in wages in the periphery (Sinn 2005, Stöllinger 2016). After the GFC, the dominant view within Brussel's policy circles has been close to the neoliberal perspective, hence to put the adjustment burden on the deficit countries. An attempt of a consensual interpretation of the Eurozone crisis was published in 2015 by leading economists on Vox according to which the crisis was ultimately caused by a sudden stop of capital flows, excessive public and private leverage, doom-loops between banks and states, absence of lender of last resort opportunities and no external devaluation opportunities but mainly underpinned by the "rigidity of factor and product markets"

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[30] The author of this IMF working paper argues that the Spanish labor market is "ill-suited to membership of a currency union".

[31] The IMF recommendations for Greece read for example: "the economy needs to be more competitive. This means pro-growth policies and reforms to modernize the economy (...) It also means that inflation be reduced below the euro average, including by keeping wages and wage costs flat, so that Greece can regain price competitiveness" (IMF 2010) while Jaumotte (2011) argued that a reduction of employment production would bring down Spanish unemployment from 25% to 7-10%. Similarly the exclusively labor market focus of the OECD proposals for growth (2011).

in the periphery as a hindrance to restore competitiveness quickly (Baldwin et al. 2015). Similar results can be found in Lane (2012) and Gabrisch and Staehr (2014). In 2012, the European Commission introduced the Macroeconomic Imbalance Procedure (MIP) in order to assess relative changes in competitiveness of the periphery vis-á-vis the core (Storm and Naastepad 2015c).

Both, the Keynesian as well as the neoliberal perspective on wage competitiveness, however, are criticized by a strand of literature which disaggregates German exports and thereby argues that EMU trade imbalances are largely driven by non-price competition for which unit labor cost does not really matter.

This strand of literature emphasizes the increase in German labor productivity especially for high valued added goods relative to low productivity growth in service sector dominated economies of the periphery. Varieties of capitalism within the EMU is not so much characterized by different labor market institutions but rather by different industrial structures. In a series of articles, Storm and Naastepad argue that export performance is hardly driven by unit labor costs (Storm and Naastepad 2015a, 2015c, Storm 2016). Unit labor costs only explain 25% of output prices for goods since firms passed costs only partly to consumers (Storm 2016). Storm calls the view presented in the previous paragraph the "labor cost competitiveness myth" (reflecting the Kaldor-Paradox 1978). Actually, Storm argues, the change in unit labor cost was driven by changes in productivity as German nominal wages only decreased slightly relative to all other EMU members between 1999 and 2007 while relative labor productivity increased by 8%-points (Storm and Naastepad 2015a).

Storm concludes with a bold statement: "It was German engineering ingenuity, not nominal wage restraint or the Hartz "reforms", which reduced its unit labor costs. Any talk of Germany deliberately undercutting its Eurozone neighbors is therefore beside the point" (2016). Similarly, Wyplosz (2013) and Gabrisch and Staehr (2014) find that relative unit labor costs only explain a tiny amount of Germany's export surpluses and Danninger and Joutz (2007) find in their study ranging from 1993 to 2005 that relative cost improvements only explain 2% of Germany's export growth. Therefore, it is no surprise that Kohler and Stockhammer do not find any increase in growth rates despite real depreciation by more than -15% measured by the real effective exchange rate in manufacturing (2020, p.26-27)

Storm and Naastepad (2015a) emphasize income effects and non-price com-

Economic Complexity Index Ranking
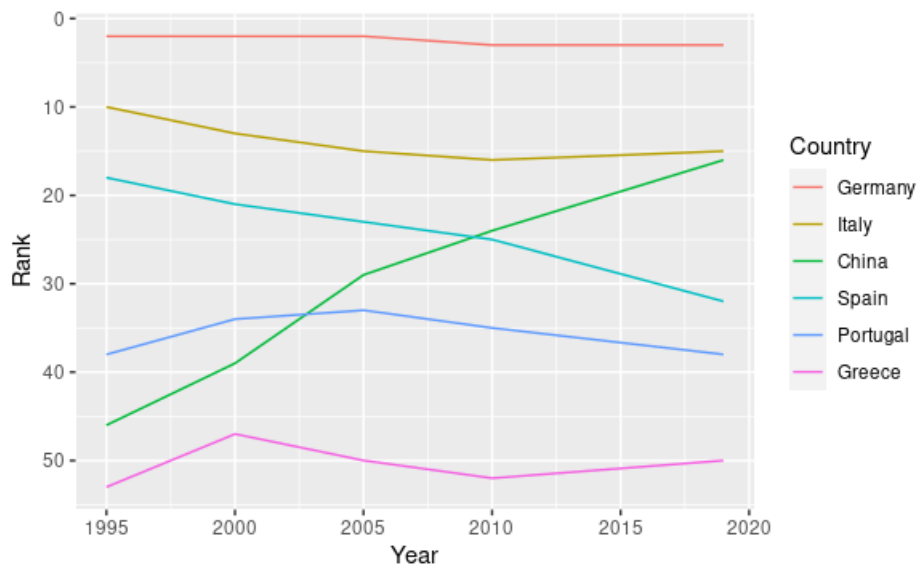
Figure 5: Data: ATLAS of Economic Complexity

petition due to technology and exports to emerging markets which is in line with another range of studies (Gabrisch and Staehr 2014, Diaz Sanchez and Varoudakis 2013, Storm and Naastepad 2015a, Schröder 2015) [32]. Differences in technological capabilities lead to divergence and path dependency within the EMU (Gräbner et al. 2020). Value added in high tech industries has increased in the core but decreased in the periphery (Strom and Naastepad 2015c). This is why growth in the periphery transmits to growth in the core but not vice versa (Janger et al. 2012, Simonazzi, Ginzburg and Nocella 2013, Botta 2014, O'Connell 2015).

Gabrisch and Staehr show with Granger causality tests and vector autoregressive models that capital flows, especially after the introduction of the Euro removed exchange rate risk and harmonized financial sector regulation (Chen et al. 2012), precede unit labor cost between 1995 and 2012 for 27 EU countries

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[32] Schumpeter: "Economists are at long last emerging from the stage in which price competition was all they saw. [...] in capitalist reality, as distinguished from its textbook picture, it is not that kind of competition which counts, but the competition from the new commodity, the new technology, the new source of supply, the new type of organization [...] – competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives." (1943 p.84)

(2014) [33]. For every decrease in the annual current account balance by 1% they find an increase in unit labor costs on average by 0.3 percentage points for the subsequent years (similarly Strom and Naastepad 2015c). Lane (2013) finds that the inflow of foreign capital led to an increase in local credit financed domestic demand. Atoyan et al. (2012) discuss the eagerness of German banks to expand their foreign market shares throughout the early 2000s.

Furthermore, China's emergence on the international trade scene after joining the WTO in 2001 disrupted trade flows among nearly all advanced capitalist countries. Regarding the EMU, China initiated a severe price competition vis-à-vis peripheral economies while German exports fitted well into the Chinese supply chain and even outcompeted Chinese competitors when entering a market (Benkovskis et al. 2013, Strom and Naastepad 2015c, Gräbner et al. 2020, Kohler and Stockhammer 2020, p.9). This pattern reflects a general trend that low-tech industries often face stronger price competition from emerging economies than high-tech industries (Carlin et al. 2001, Dosi et al. 2015). Additionally, the common currency harmed the peripheral exports as the Euro has appreciated via-á-vis the US Dollar, the Japanese Yen and the RMB compared to their previous currencies. Most authors agree that the Euro is overvalued for the core and undervalued for the periphery (Carton and Hervè 2012, Storm and Naastepad 2015c, Mazier p.143). Wierts et al. (2013) show that the negative effect of overvalued real exchange rates on exports is stronger for low-tech industries as they are more price elastic (Bottega and Romero 2021).

Germany's specialization in high-tech goods made its export demand inelastic and often enabled price setting behavior (Simonazzi et al. 2013, Gräbner et al. 2020)[34]. There is path dependency in this, resembling the Kaldor-Verdoorn relation: Lower wages can lead to higher profit margins in Germany which leads to higher investment and productivity growth by employing the latest equipment but also by raising aggregate demand, employment and thereby the division of labor (Botta 2014, Storm and Naastepad 2015a, 2015b, 2015)[35]. However, the increase in business saving in the core has not led to increasing investment (Belabed et al. 2018).

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[33] This idea goes back to Böhm-Bawerk (1924) who argued that current account follows the capital account. See also Minsky (1988): Money Manager Capitalism, Fiscal Independence and International Monetary Reconstruction. H. P. Minsky Archive Paper No 431)

[34] However, Baccaro and Benassi (2017) argue that that this power has declined after the GFC

[35] for a discussion of the Kaldor-Verdoorn law, see Basu and Budhiraja 2021 CJE)

Additionally, the German reunification and the cheap purchases of firms with value chains and existing contracts in eastern Europe led to a jump in productivity growth over the 2000s (Simonazzi et al. 2013, Storm and Naastepad 2015b, Stöllinger 2016, Odendahl 2017).

The related policy proposals are different compared to the wage competitiveness perspective on EMU trade imbalances. More important than changes in wage levels is active fiscal policy to induce a technological catching-up process by reconsidering the state market dichotomy (Mazzucato 2013, Strom and Naastepad 2015c, Gräbner et al. 2020) as there is a general trend of increasing economic complexity and increasing income (Hidalgo and Hausmann 2009). Productivity is not exogenous but a policy decision and depending on the "social overhead structure of the productive system and technology" (Storm and Naastepad 2015c, p.866). However, austerity measures such as the Maastricht criteria [36] or the Euro Plus Pact [37] make this virtually impossible. Sectoral balances determine that structural current account deficits lead to public and or private deficits that accumulate over time. Austerity policies restrict public deficits and thereby create a permanent private sector crisis in peripheral countries.

I conclude that Germany's wage moderation matters for EMU trade imbalances but in a specific way. Putting it bluntly, an increase in German real wages would not lead to an decrease in periphery's demand for German machinery. Having said that, German wages do have a depressionary effect on peripheral Europe due to the relative high income elasticities of demand for export goods of the periphery. Both channels lead to a structural trade deficit of the periphery vis-à-vis Germany. Most importantly, a significant share of the surplus of Germany is sustained by indebtedness of the periphery (Kohler and Stockhammer 2019). The combination of export-led and debt-led growth has decoupled productivity and real wage growth in Germany in the 2000s.

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[36] The 60% limit of the public debt to GDP ratio and a maximum of 3% primary deficit are institutionalized in the Stability and Growth pact (Storm and Naastepad 2015c)

[37] The Euro Plus Pact was proposed by Germany and France and signed by 23 EU countries in March of 2011. It contained measures to enhance competitiveness with the aim to reduce "unsustainable" external debt. "The Euro Plus Pact (...) will further strengthen the economic pillar of EMU and achieve a new quality of policy coordination, with the objective of improving competitiveness and thereby leading to a higher degree of convergence." (European Council 2011, p.5) However, Gabrisch and Staehr (2014) argue that the Euro Plus Pact is based on a flawed analysis of the causal link between capital flows and unit labor costs (simialry, Gros and Alcidi 2011). From a Keynesian perspective, increasing competitiveness by reducing unit labor costs reduces domestic demand and is likely to conversely increase external debt.

In the following, I propose a comprehensive stock-flow consistent model (SFC) that summarizes the channels sketched above and thereby allows to assess potential institutional change. A monetary policy that is biased towards inflation in the core and the removal of exchange rate risk after the Euro introduction lead to an investment boom in the periphery resulting in tighter labor markets, real wage growth and moderately higher inflation (Kohler 2022). A simultaneous appearance of China on the world trade stage has led to price competition with the periphery and a decline in manufacturing that was masked by a debt-led real estate boom. The trade imbalances have further widened through wage moderation in Germany that depressed demand for periphery's export goods. Overall, the drag in Germany's aggregate demand through the increase in income inequality has been replaced by debt-led demand from the periphery.

4. METHODOLOGY

4.1 Stock-Flow Consistent Modeling

SFC models are gaining prominence due to their comprehensive understanding of the mechanisms that led to the global financial crisis of 2007/8 (Godley and Zezza 2006, Bezemer 2010, Bank of England 2016) but also due to their methodological consistency regarding the analysis of the real and the financial side of the economy (Godley and Cripps 1983, Dos Santos and Macedo 2010, Godley and Lavoie 2012, Pasarella 2019). This is very relevant for ongoing policy discussions around the role of fiscal and monetary policy in an environment of secular stagnation (DeLong and Summers 2012). The SFC aproach is appealing for the inequality financial crises nexus, as well as for interconnected demand-led growth regimes, as it takes the interdependencies of all sectors into account.[38] While some research groups developed empirical SFC models for certain countries (Papadimitriou et al. 2013, Byrialsen and Raza 2020, Nalin and Yajima 2020) other's devoted their energy to theoretical contributions regarding debt cycles (Dafermos 2018), an increase in dividend payouts (Duwicquet 2021) or share buybacks (Van Treeck 2009), securitization (Nikolaidi 2015), quantitative easing

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[38]New-Keynesian scholars have come up with their own heterogeneous-agent models which rely on neoclassical microfoundations but include a range of rigidities (Kumhof et al 2015, Gabaix 2020, Caverzasi and Russo 2018 for a critical discussion)

(Haas and Young Taft 2017), or climate change (Dafermos et al. 2017). Increasingly, distributional issues are incorporated into the SFC framework (Dos Santos and Zezza 2008, Carvalho and Di Guilmi 2014, Belabed et al. 2018, Zezza 2019). Distributional SFCs link the theoretical and empirical Post-Keynesian studies of growth and distribution with the methodological SFC framework and its analysis of financial fragility and interdependencies.

Modeling the Eurozone in an SFC framework has a long tradition in the economic thinking of the its main founder, Wynne Godley. A model that was published in 2007 with his co-author Marc Lavoie rather prophetically predicts the crisis of sovereign debt which evolved between 2010 and 2012 with its effects being still visible a decade after. Godley and Lavoie mainly argue that countries with a trade deficit will issue more and more bills that will be purchased by the common central bank. Assuming limited purchases by the CB, however, the interest rate on sovereign debt will increase. As devaluation is impossible due to the common currency and fiscal policy restricted, trade deficits require austerity with strong negative effects on domestic output and employment (p.2).

In the following, I will present an SFC model which is inspired by the three regions model developed by Gräbner et al. (2021) [39]. The authors use the terms "South" and "North" for both regions of the monetary union, however, in light of economic theory on international dependencies, I prefer the terms "core" and "periphery" but have used both terminologies interchangeably for now.

4.2. A Replication of Gräbner et al. (2021)

Gräbner et al. (2021) analyze the emergence of debtor-creditor dynamics in a monetary union. Their basic argument is that initial differences in technological capabilities translate in different export propensies of which debtor-creditor dynamics emerge. The monetary union of their model consists of two regions (North and South), whereas the trade flows of each region with the RoW resembles their trade relations with China. The size of the southern region is 2/3 of the northern region. Both regions of the monetary union are specified in terms of aggregate households, firms and banks, as well as a government. Both regions share a central bank. The rest of the world is modeled as an aggregate sector that exports and imports from both regions.

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[39] Gräbner et al. (2021) is based on the model presented in Kapeller and Schütz (2014)
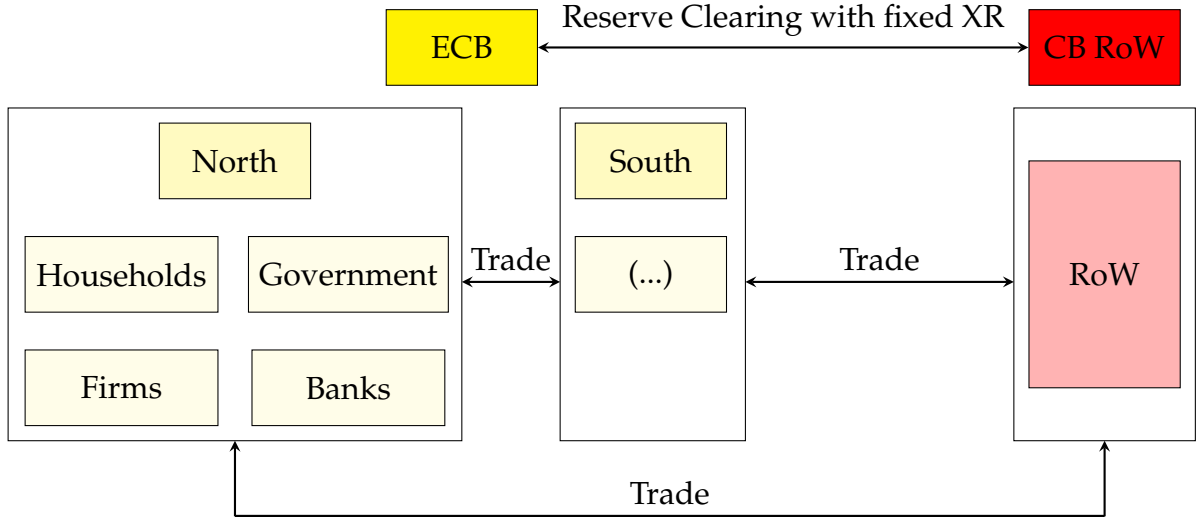
The model presented in this paper adapted some ideas of the model by Gräbner et al. (2021). I will first comment on the most important features of the model before explaining the modifications I undertook.

The GDP expenditure equation for region i is given by

$GDP_i = C_i + I_i + G_i + X_i - IM_i$

An equal proportion of Consumption C_i, investment I_i and government spending G_i is imported from the other region j and from the RoW. [40] As imports require cross-border financing, which can be constrained in this model, the determination of consumption, investment and government spending follows a three step procedure. Since investment demand entails further complication, I will take its determination as an example.

Firms

Investment demand in region i depends on an autonomous component $i0_i$, past period's capacity utilization z_i, profit rate $\pi_{F,i}$, and debt ratio $DR_{F,i}$. All end of period profits are shifted to the domestic household sector, hence, investment is financed entirely through bank loans. This lending follows Minskyan dynamics with a margin of safety $\theta_{F,i}$ that declines in every period in which no firm loans are canceled, but also depends on the firm's debt ratio and the bank's leverage ratio. Firms become credit constrained when the margin of safety exceeds its profit rate and, hence, can only partially finance their investment demand.

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[40] $GDP_i = m_i * (C_i + I_i + G_i) + (1 - m_i) * (C_i + I_i + G_i) + X_i \smile m_i * (C_i + I_i + G_i) = (1 - m_i) * (C_i + I_i + G_i) + X_i$

```
┌─────────────────────────────────────┐
│  1. Determine demand for investment  │
└─────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐
│  2. Are firms in region i credit constrained?  │
└─────────────────────────────────────────┘
        Yes                    No
```

$$Id_i = i0_i + i1_i * z_i + i2_i * \pi_{F,i} + i3_i * DR_{F,i}$$

$$Id_i = rcr * (i0_i + i1_i * z_i + i2_i * \pi_{F,i} + i3_i * rDR_{F,i})$$

```
┌──────────────────────────────────────────────┐
│ 3.Does the national banking system have suffi- │
│ cient reserves to import a fraction of investment │
│ demand?                                        │
└──────────────────────────────────────────────┘
        Yes                    No
```

$$Idf_i = Id_i$$

$$Idf_i = RCC_i * Id_i$$

$$IMd_{j,i} = m_{j,i} * (Cdf_i + Idf_i + Gdf_i)$$

```
┌──────────────────────────────────────────┐
│ 4.Can the other region supply that demand? │
└──────────────────────────────────────────┘
        Yes                    No
```

$$I_i = Idf_i$$

$$I_i = crr_i * Idf_i$$

$$IM_{j,i} = IMd_{j,i}$$

$$IM_{j,i} = crr_j * IMd_{j,i} \ [20]$$

[20] The same mechanism applies to exports to the RoW: $Xd_{row,i} = m_{i,row} * Y_{row} \rightarrow X_{row,i} = crr_i * Xd_{row,i}$

Id_i is the demand for investment in region i, rcr is the rate of credit restriction, Idf_i is the demand for investment goods in region i that can be financed given reserves, and I_i is the actual investment in region i. RCC_i is a factor that distributes the reserves available proportional to demand for importing consumption goods, investment goods, (rcr is the rate of credit restriction). or government spending. As this channel can lead to strong contractions, the central bank of the monetary union steps in as a lender of last resort when the finance available is less then 75% of import demand. This is prior to quantitative easing and unlimited Target II clearing. This institutional constraint, that is special in the Eurozone, will be lifted in a policy scenario. ccr is a capacity restriction rate that works as a control mechanism to ensure that financed investment demand can actually be produced by the exporting country given the stock of capital and capital productivity.

The domestic banking system can obtain reserves either through the interbank market when the other banking system has excess reserves, or directly from the ECB. However, when the bank's rate of profit falls below a Minskyan margin of safety, the banking system becomes credit constrained and imports can only partially be financed. The procedure is structured as follows:

| 1. Reserve demand for clearing trade in region i is determined |

| 2. Is the banking system in region i credit constrained? |

Yes / No

| Import demand is only partially fulfilled (see flow chart above) |

| Can the excess demand for reserves from region i be fulfilled by excess supply from region j? |

Yes / No

| No ECB loans needed. |

| The gap can be closed through ECB loans to region i. |
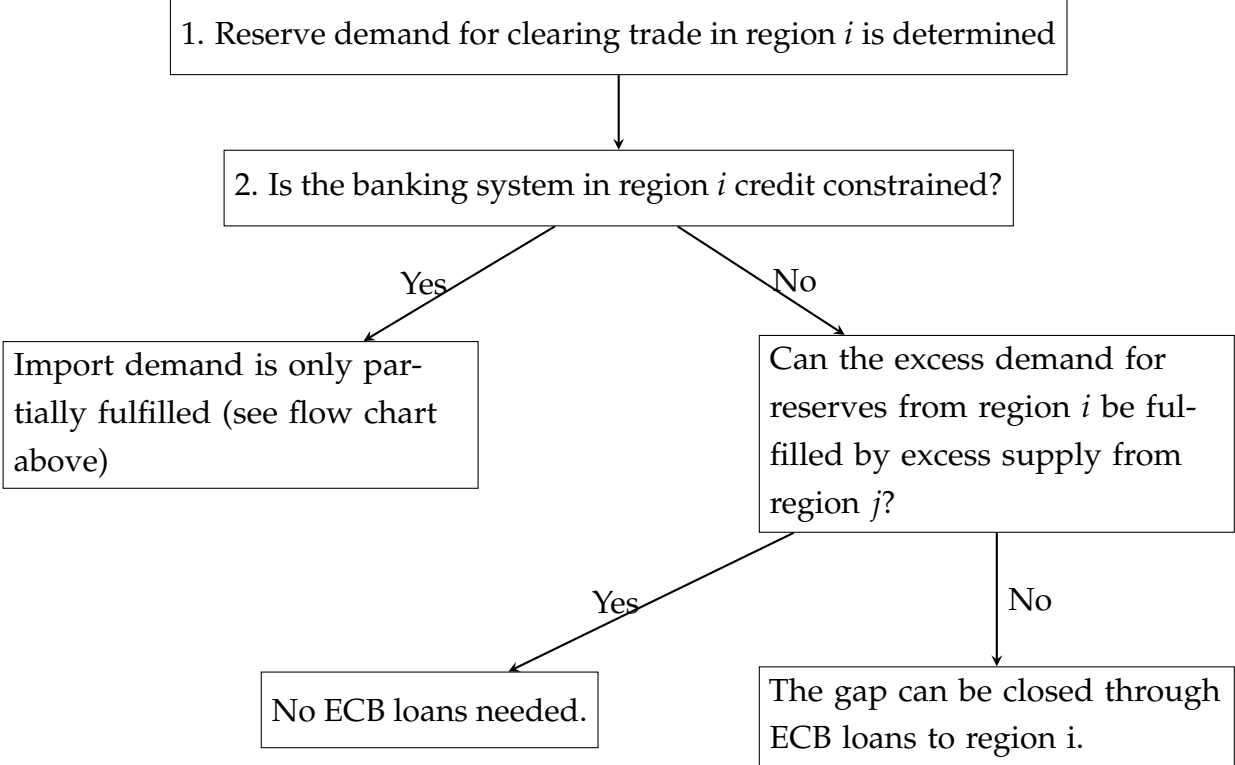
The bank's margin of safety $\theta_{B,i}$ changes over the business cycle. It is reduced in every period in which no loans are canceled and also depends on both banking sector's leverage ratios.

Government

Government spending is equal to government income, consisting of taxes, paid by the household sector, and the region's share in ECB profits. In the baseline scenario, the government budget is therefore balanced. An initial stock of government loans is held by domestic banks. In (rare) times of surpluses, governments accumulate claims against their domestic banking sector. [41]

Banks

In the model of Gräbner et al. (2021), banks generally distribute their profits to the domestic households but retain some earnings when their leverage ratio is above a threshold and distribute retained earnings when their leverage ratio is below that threshold. However, it is not clear in which forms those "retained earnings" are held. Therefore, I exclude this mechanism for now and distribute all bank profits to the domestic rentiers that hold an initial stock of domestic bank equities (see Godley and Lavoie 2012, Chapter 11)

A typical bank balance sheet looks like this:

Assets	Liabilities
Household Loans	Household Deposits
Government Loans	Government Deposits
ECB Reserves	ECB Loans
IB Loans	IB Liabilities
Firm Loans	
	Equity

---

[41] The deposit account of governments at their domestic banks is only included in the model to absorb surpluses when the banking system is credit constrained and demand for government spending, given by its income, can only partially be fulfilled. This channel does not play a significant role in the current model though.

4.3 Preliminary Results based on the Replication

The baseline scenario starts with the steady state solutions of a simulation based on the parameter choices in Gräbner et al. (2021). The public and the external sector are in balance, the profit rate of firms stabilizes at the equilibrium value and the margin of safety for firms decreases over the simulation period. The results for the North looks the same, only GDP is 1.5 times larges than GDP in the South.

Baseline Scenario South
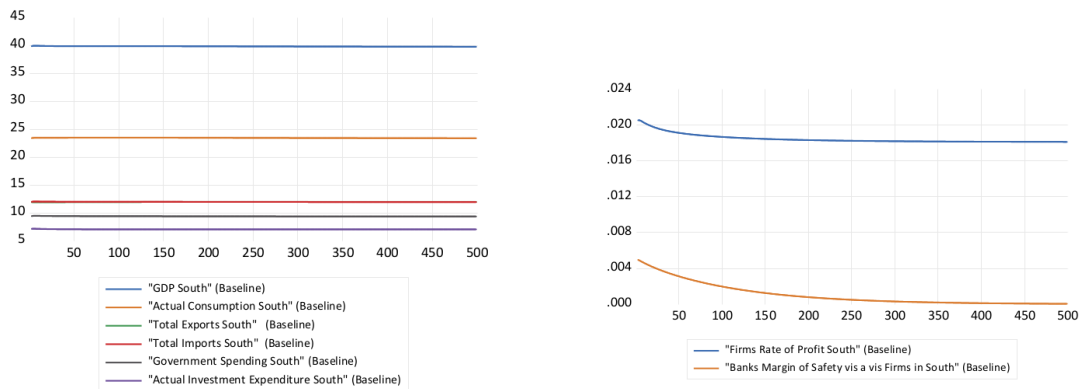
I then introduce the same shock as Gräbner et al. (2021) to the autonomous component of the investment function in the South in order to resemble the investment boom in the early 2000s after the introduction of the Euro. Initially, the increase in investment increases aggregate demand and output and propagates through the increase in the capacity utilization rate which further increases investment. The real side of the economy looks stable for a while but crashes in period 150. The boom bust cycles is persistent in the model.

However, in order to understand the fluctuation in the real side of the economy, we can to look at the financial side. As investment is debt financed, the shock to the autonomous component of investment leads to an increase in the firm's stock of debt. Therefore, debt servicing reduces the profit rate over the financial cycle until it falls below the margin of safety. In period 150, firms become credit constrained which leads to a collapse in investment and, therefore, a recession.

Boom Bust Cycles after the Investment Boom
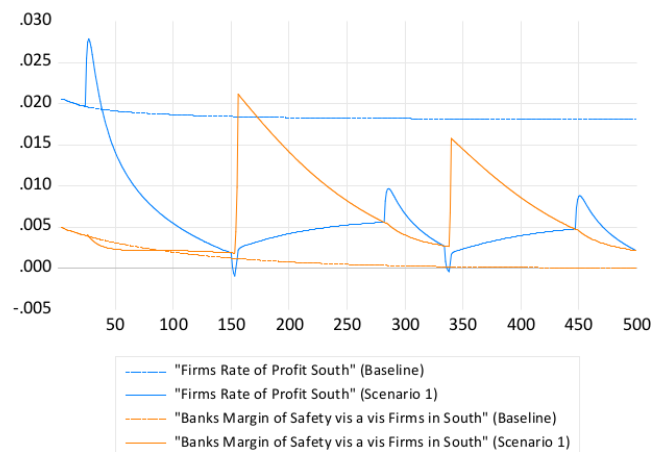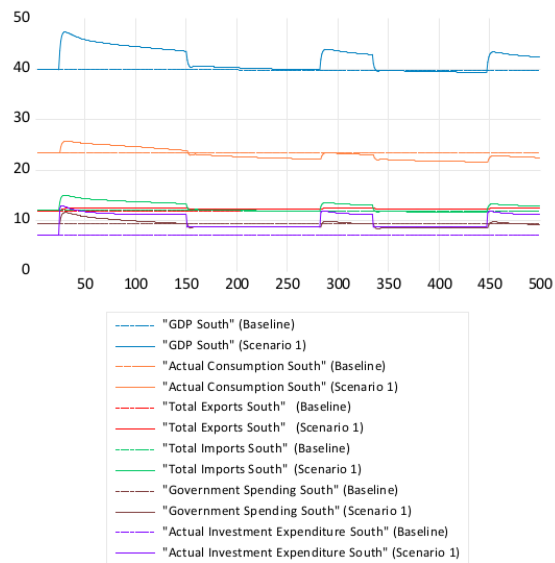
The trade balance resembles this dynamic. Since a constant proportion of investment goods are imported, the shock to autonomous investment increases imports from the North. In the recession, income declines that strong, that the South becomes a net exporter which echoes the critique of the export-led framework by Kohler and Stockhammer (2020).

Trade Imbalances
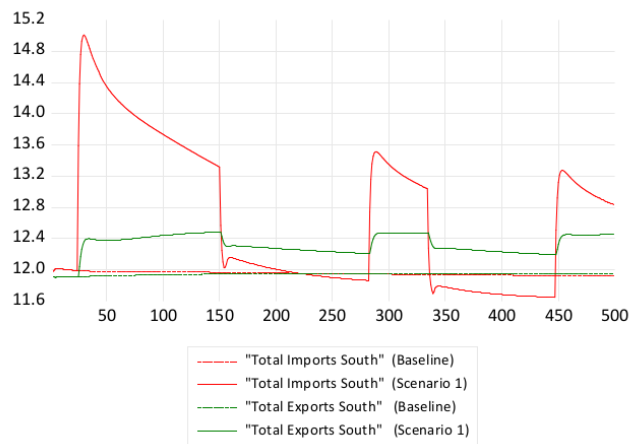
The development of GDP in the North reveals the interdependency of export-led and debt-led growth regimes in both regions. The boom bust cycles in the South spill over to the North through the increase in imports.

Boom Bust Cyles after the Investment Boom
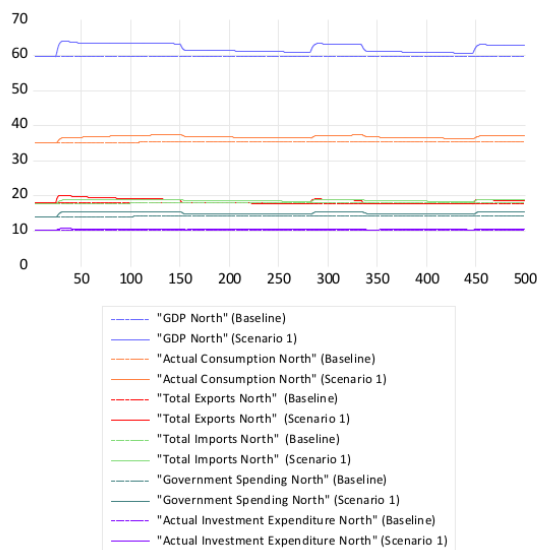
However, since firms in the North do not pile up debt, their rat of profit follows the boom bust pattern but never falls below the margin of safety.

Boom Bust Cycles after the Investment Boom

"Firms Rate of Profit North" (Baseline)
"Firms Rate of Profit North" (Scenario 1)
"Banks Margin of Safety vis a vis Firms in North" (Baseline)
"Banks Margin of Safety vis a vis Firms in North" (Scenario 1)
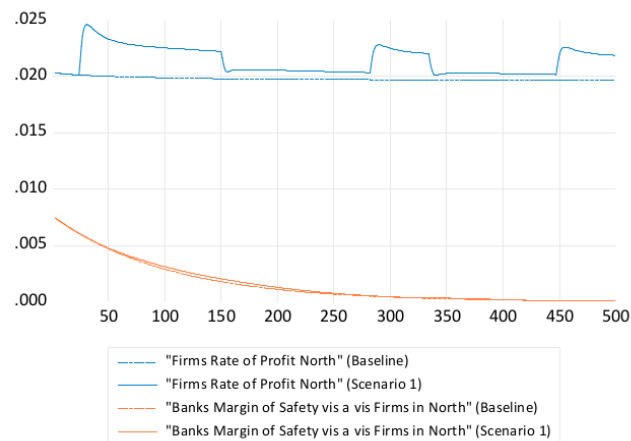
4.4 Modifications to Gräbner et al.2021

(a) Disaggregating the household sectors

In Gräbner et al. (2021) trade is determined by fixed propensities. This is changed in this model. I have argued that varieties of capitalism with different labor market institutions and industrial structures affect trade patterns. To take this into account, I disaggregated the household sectors in both regions into "rentiers" and "workers". The rentiers receive all domestic bank's and firm's profits, interest on their money deposits, pay interest on loans and a repay a fraction of their debt every period. The workers receive mainly wage income, given by the region specific wage rate multiplied with the level of employment, plus interest on money deposits, pay interest on loans and a repay a fraction of their debt every period. Both classes have the same consumption function as in Gräbner et al. (2021), though with different parameters. In the Kaleckian tradition, the propensity to consume out of income is higher for the workers than for the rentiers. Therefore, a shift in the functional income distribution depresses aggregate demand. I also assume a quite high autonomous component of consumption leading to increasing household leverage when the economy is in a downturn. Increasing inequality in the core then translates into less demand for import goods produced in the periphery. The following discussion will show that disaggregating the household sector allows to replace some of the ad hoc assumptions made by Gräbner et al. (2021) regarding shocks of the propensities to import with endogenous labor market determinations of export prices.

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(b) Endogenous price levels and wage determination

Godley and Lavoie (2007) have a flexible exchange rate between the USA and the Eurozone which is endogenous to the cross border demand and supply for bills, while Lequain (2003) has a fixed exchange rate. Imports in Godley and Lavoie (2007) therefore depend on the real exchange rate as well (p.6). For now, I will assume a fixed exchange rate between the currency of the monetary Union (Euro) and the RoW (RMB) and a constant labor productivity as in Gräbner et al. (2021, p.5).

While Godley and Lavoie (2007) model two different currencies for the monetary union and the U.S. neither them nor Belabed et al. (2018) or Gräbner et al. (2021) model price levels and a labor market determination of export goods prices. In this model, the price levels for the South and the North are determined by cost plus mark-up equations (as in Dos Santos and Zezza 2008, p.449-450, or in the Eurozone model by Duwicquet and Mazier 2012 p.203, see also see also Taylor 1991 ch.2) whose parameters resemble the varieties of capitalism literature (see Behringer and van Treeck 2021) and insights from structuralist Post-Keynesian theory (Kohler and Stockhammer 2020).

The wage rate in region i is given by:
$$wi_i = \sigma_{i0} + \sigma_{i1} * \Delta p_i^e + \sigma_{i2} * \Delta \lambda^e - \sigma_{i3} * u_i(-1)$$

$$w_i = w_i(-1) * (1 + wi_i)$$

Hence, wage inflation depends on an autonomous component, expected inflation, expected growth in labor productivity and past periods unemployment rate. For now, the model is stationary. Therefore, the labor productivity term does not matter.

The price level in region i is given by unit labor cost and a region specific mark-up:
$$p_i = w_i * \frac{1}{\lambda_i} * (1 + \phi_i)$$

(c) Imports and price competition

In order to capture the price competition between South and RoW, imports are not given as a constant proportion of consumption, investment and government spending as in Gräbner et al. (2021) but depend on relative price levels. As dis-

cussed in the previous section, the imports of the North depend on price competition between the South and the RoW. Therefore, the imports of the South from the RoW also depend on relative prices as domestic demand in the South will be substituted to cheaper products. The demand for exports by the North are price inelastic.

$$m_{s,n} = \psi_0 - \psi_1 * (p_s - p_{row})$$

$$m_{n,s} = \psi_2 \text{ and } m_{n,row} = \psi_3$$

4.5 Shocks and Dynamics

The dynamics are introduced as two shocks. First, the price competition components between the South and the RoW of the import propensities are introduced as a shock resembling China's membership in the WTO in 2001. Second, the parameters in the wage equation of the north are shocked a few periods later to resemble the labor market reforms in Germany in 2004/5. The South faces an investment boom and inflation after the introduction of the Euro. The model will show an endogenous divergence through loss in competitiveness, and spillover growth in North through boom bust cycles in the south.

Table 1: Transactions-Flow Matrix

		North										South											ECB		RoW		
		Production C/A	Rentiers C/A	Cap.	Workers C/A	Cap.	Firms C/A	Cap.	Government C/A	Cap.	Banks C/A	Cap.	Production C/A	Rentiers C/A	Cap.	Workers C/A	Cap.	Firms C/A	Cap.	Government C/A	Cap.	Banks C/A	Cap.	C/A	Cap.	C/A	Cap.	Σ
[1]	Consumption	+C_n	−C_Rn		−C_Wn								+C_s	−C_Rs		−C_Ws												0
[2]	Government Spending	+G_n							−G_n				+G_s							−G_s								0
[3]	North Imports	−IM_n											+X_n,s													−X_row,n		0
[4]	South Imports	+X_s,n											−IM_s													−X_row,s		0
[5]	RoW Imports	+X_row,n											+X_row,s													−IM_row		0
[6]	[Total Production]	[Y_n]											[Y_s]													[Y_w]		Y
[7]	Wage Income	−WB_n			+WB_n								−WB_s			+WB_s												0
[8]	Gross operating surplus	−GOS_n					+GOS_n						−GOS_s					+GOS_s										0
[9]	Taxes		−T_Rn		−T_Wn				+T_n					−T_Rs		−T_Ws				+T_s								0
[10]	Interest on Deposits		+id*M_Rn(-1)		+id*M_Wn(-1)				+id*M_Gn(-1)		−id*M_Rn(-1)			+id*M_Rs(-1)		+id*M_Ws(-1)				+id*M_Gs(-1)		−id*M_Rs(-1)						0
[11]	Interest on Loans		−il*L_Rn(-1)		−il*L_Wn(-1)		−il*L_Fn(-1)		−il*L_Gn(-1)		+il*L_Rn(-1)			−il*L_Rs(-1)		−il*L_Ws(-1)		−il*L_Fs(-1)		−il*L_Gs(-1)		+il*L_Rs(-1)						0
[12]	Interbank Interest Payment North										−il*L_IBn(-1)												+il*L_IBn(-1)						0
[13]	Interbank Interest Payment South										+il*L_IBn(-1)												−il*L_IBs(-1)						0
[14]	Interest Payments to CB										−il*L_CBn(-1)												−il*L_CBs(-1)		+il*L_CBn(-1)				0
[15]	Interest on Reserve Requirements										+id*Res_n(-1)												+id*Res_s(-1)		−id*Res(-1)				0
[16]	Distributed Firm Profits		+DIV_Fn				−DIV_Fn							+DIV_Fs				−DIV_Fs										0
[17]	Distributed Bank Profits		+DIV_Bn								−DIV_Bn			+DIV_Bs								−DIV_Bs						0
[18]	Profit Central Bank								+DIV_CBn											+DIV_CBs				−DIV_CB				0
[19]	Surpluses		−S_Rn	+S_Rn	−S_Wn	+S_Wn	−S_Fn	+S_Fn	−S_Gn	+S_Gn	0	0		−S_Rs	+S_Rs	−S_Ws	+S_Ws	−S_Fs	+S_Fs	−S_Gs	+S_Gs	0	0					0
	FLOW OF FUNDS																											
[20]	Δ Capital	+I_n						−Δ K_n					+I_s						−Δ K_s									0
[21]	Δ Deposits			−Δ M_Rn		−Δ M_Wn						+Δ M_Hn			−Δ M_Rs		−Δ M_Ws						+Δ M_Hs					0
[22]	Δ Loans Core Banks			+Δ L_Rn		+Δ L_Wn		+Δ L_Fn		+Δ L_Gn		−Δ L_n			+Δ L_Rs		+Δ L_Ws		+Δ L_Fs		+Δ L_Gs		−Δ L_s					0
[23]	Δ Central Bank Loans											+Δ L_CBn											+Δ L_CBs		−Δ L_CB			0
[24]	Δ Inter Bank Loans to North											−Δ L_IBn											+Δ L_IBn					0
[25]	Δ Inter Bank Loans to South											+Δ L_IBs											−Δ L_IBs					0
[26]	Foreign Reserve Transactions																								−Δ Res_f	+Δ Res_f		0
[27]	Δ Reserves											+Δ Res_n											+Δ Res_s		+Δ Res	−Δ Res_row		0
	OTHER CHANGES IN STOCKS																											
[28]	Firm Debt Cancellation							+CANC_Fn				−CANC_Fn							+CANC_Fs				−CANC_Fs					0
[29]	Interbank Debt Cancellation											+CANC_Bn											−CANC_Bn					0
[30]	Σ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+CANC_Bs / −CANC_Bs		0	0	0	0

Table 2: Stock Matrix

	North					South					ECB	RoW	Σ
	Rentiers	Workers	Firms	Government	Banks	Rentiers	Workers	Firms	Government	Banks			
Money Deposits	+M_Rn	+M_Wn		+M_Gn	-M_n	+M_Rs	+M_Ws		+M_Gs	-M_Hs			0
Bank Loans	-L_Rn	-L_Wn	-L_Fn	-L_Gn	+L_n	-L_Rs	-L_Ws	-L_Fs	-L_Gs	+L_s			0
Real Capital			+K_n					+K_s					+K
Reserve Deposits					+Res_n					+Res_s	-Res	+Res_row	0
CB Loans					-L_CBn					-L_CBs	+L_CB		0
Interbank Loans North					-L_IBn					+L_IBn			0
Interbank Loans South					+L_IBs					-L_IBs			0
Foreign Reserves											+Res_f	-Res_f	0
Equities	+e_Bn*p^e_n				-e_Bn*p^e_n	+e_Bs*p^e_s				-e_Bs*p^e_s			0
Balance (net-worth)	-V_Rn	-V_Wn	0	-V_Gn	0	-V_Rs	-V_Ws	0	-V_Gs	0	0	-V_row	-K
Σ	0	0	0	0	0	0	0	0	0	0	0	0	0

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5. FURTHER EXTENSIONS OF THE MODEL

In following research projects, I would like to expand the model with the following mechanism.

(i) Introduce a Taylor rule ECB that is biased towards inflation in the North. Making the investment function also depending on interest rates, leading to an endogenous boom in the South in the early 2000s with inflation and loss in competitiveness vis a vis China.

ii) Introduce internationalization of North's banks by increasing lending to the South after the Euro introduction. Borio and Disyatat (2011) have shown that capital inflows mainly occur via bank credit and not via excessive savings from abroad (similarly Kohler 2022).

iii) Introduce labor productivity growth that is endogenous to investment resembling Hicks (1932) and Kaldor (1957).

iv) Disaggregate production into investment and consumption goods, with capital goods of the North having a higher mark-up due to high price setting power.

v) Start the model with different exchange rates and model the introduction of the Euro as a shock that depresses the exports of the periphery, while treating the exchange rate between the monetary union and RoW fixed as the exchange rate management by the People's Bank of China allows for fluctuations within a corridor.

vi) It should not be the private banks who face the haircut when their borrowers default, but the respective government in turn is bailing out its banks after a threshold and the debt is transferred from the banks balance sheet to the balance sheet of the government as happened in the Eurozone after the global financial crisis of 2007/8.

vii) Expand the financial sector. Explicitly model bonds and stocks, and Tobinesque portfolio choice (see Belabed et al. 2018 for deposits + equity). In Gräb-

ner et al. (2021) bank deposits are the only financial assets households accumulate. Respective interest rates on loans and deposits are the same across all sectors, i.e. the same interest rate is applied for loans to households, firms and governments. Belabed et al. (2018) assume equality of lending and deposit rates to rule out banks profits (p.59). I believe this needs to be adjusted to take the different default probabilities into account. For example, in Godley and Lavoie (2007) households hold domestic currency but bills from either of the three governments based on Tobinesque principles (see their coding on p.7, or Duwicquet and Mazier 2012 p.203). The Euro central bank holds bills in both currencies while the FED only holds dollar bills because the USD is the international reserve currency (p.9). The ECB is prohibited from directly purchasing bills from their governments due to Article 21.1 of the Statute of the European System of Central Banks and of the European Central Bank (ECB 2004, see Godley and Lavoie 2007 p.12).

viii) Gräbner et al. (2021) analyze two policy responses: counter-cyclical fiscal policy and an extensive lender of last resort function by the central bank. Counter-cyclical fiscal policy stabilizes the Southern economy and its demand for North's exports, however, after a few cycles, bank's profits erode sufficiently to trigger a credit constraint for reserve lending from the North and a strong contraction only alleviated by the central bank stepping in to sustain interest flows from South to North. However, when the central bank steps in quicker as an unconditional lender of last resort, long depressions can be prevented (p. 25). The counter-cyclical fiscal policy is constrained by some arbitrary parameter choices. In the future, I will apply a punishment whenever governments violate the Maastricht criteria.

ix) Incorporate business saving in the core and consumer finance.

x) introduce a housing asset as in Zezza (2008)

6. CONCLUSION

In this thesis I have argued that economies with income inequality face a growth problem. This has led to the emergence of export-led and debt-led growth regimes which are in a dialectical relationship with one another. An example for this is the EMU in which several dynamics lead to persistent divergence. First, the institutionalized shift in the functional income distribution in Germany has decreased demand for imports from the peripheral EMU. Second, differences in economic complexity lead to different export demand elasticities. While exports from Germany face mostly non-price competition, the peripheral EMU got into a price competition with China. Third, the introduction of the Euro removed exchange rate risk within the EMU and has thereby led to capital flows and a real estate bubble in the periphery. This heated up labor markets and led to a further deterioration of its competitiveness vis a vis China. After the GFC, the adjustment burden was taken upon the deficit countries through bailouts and conditional lending. This has further depressed demand and thereby imports, turning some economies into net exporters, however, only by causing a long recession.

This thesis calls for various policy responses and institutional changes. First, increasing wages and fiscal expansion in the core can create demand for imports from the periphery. Second, a removal of the debt limits within the EMU should allow for a more active industrial policy in order to initialize a technological catching up process. Third, and more generally, the adjustment burden ought to be put on the surplus countries, as enforced austerity will only make the problem worse. Storm and Naastepad (2016, p.63) argue that labor market deregulation can actually have negative effect on technological catching up as it leads to less investment in human capital by firms and labor saving technical change (Kohler and Stockhammer 2020, p.32).

Finally, I argue that income inequality can be seen as an initial sin of capitalism. An economy that does not produce sufficient drawing rights on its produce faces a realization problem which can only be solved temporarily through domestic or foreign debt. Debt-led and export-led growth regimes can temporarily mask stagnation, at some point, however, debt service takes over and thereby leading to a financial crisis. On an international scale, income inequality exports stagnation to countries with elastic demand for their exports. ´

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Appendix

Here is a full list of the equations of the model.

The GDP expenditure equation for region i is given by

$$GDP_i = C_i + I_i + G_i + X_i - IM_i \tag{1}$$

Income for the rentiers in region i consists of net interest and firm and bank profits minus repayment of loans. Income for the workers in region i consists of wage income plus net interest minus repayment of loans. Both pay a uniform tax rate on their income, hence, disposable income is given by

$$Y_{R,i} = (1 - th) * (i_d * M_{R,i} - i_l * L_{R,i} - REP_{R,i} + DIV_{B,i} + DIV_{F,i}) \tag{2}$$

$$Y_{W,i} = (1 - th) * (w_i * N_i + i_d * M_{W,i} - i_l * L_{W,i} - REP_{W,i}) \tag{3}$$

where i_d and i_l are the uniform interest rates on deposits and loans respectively. Tax revenue is then given by multiplying the uniform tax rate with the income flows:

$$T_i = th * (Y_{R,i} + Y_{W,i}) \tag{4}$$

Workers and rentiers have the same consumption demand function, though with different propensities, resembling Kaleckian ideas. The code ensures that the autonomous component of demand provides a floor to consumption demand:

$$Cd_{R,i} = Max[c0_{R,i} + c1_{R,i} * Y_{R,i}(-1) + c2_{R,i} * V_{R,i}(-1), c0_{R,i}] \tag{5}$$

$$Cd_{W,i} = Max[c0_{W,i} + c1_{W,i} * Y_{W,i}(-1) + c2_{W,i} * V_{W,i}(-1), c0_{W,i}] \tag{6}$$

with $c1_{R,i} + c2_{R,i} < c1_{W,i} + c2_{W,i}$

A region's consumption demand is given by the sum of rentier's and worker's consumption demand:

$$Cd_i = Cd_{R,i} + Cd_{W,i} \tag{7}$$

However, this is not the final consumption as part of it is imported and the domestic banking system can be credit constrained. Therefore, we will first determine the investment demand and government spending demand.

Firms distribute all profits to the domestic rentiers. Therefore, investment is entirely financed by bank loans. This lending relationship can be constrained when the past period's rate of profit $\pi_{f,i}$ falls short of the past period's margin of safety $\theta_{F,i}$. The firm's profit rate is given by dividing gross profits through the stock of capital:

$$\pi_{f,i} = \frac{\Pi_{F,i}}{K_i} \tag{8}$$

The margin of safety vis-á-vis firms decreases slowly in periods of stability and spikes in periods of financial distress.

$$\theta_{F,i} = Max[(\theta_{F,i}(-1) + \mu_{F,i} * |\theta_{F,i}(-1)| + \zeta_1 * \Delta DR_{F,i} +$$
$$\begin{cases} LR_{B,i}(-1) > 0 \wedge LR_{B,i}(-2) > 0: & \zeta_2 * \Delta LR_{B,i} \\ \text{otherwise}: & 0 \end{cases})$$
$$, 0] \tag{9}$$

where $\mu_{F,i}$ adds to the margin of safety when firm loans are canceled.

$$\mu_{F,i} = \begin{cases} Canc_{F,i}(-1) = 0: & -\gamma_f \\ \text{otherwise}: & \tau_f \end{cases} \tag{10}$$

A proportion χ of firm loans are canceled when their profit rate falls short of their margin of safety and their profits are negative, conditioned of having a positive amount of outstanding loans.

$$Canc_{F,i} = \begin{cases} \pi_{F,i} - \theta_{F,i} < 0 \wedge \Pi_{F,i} < 0 \wedge L_{F,i} > 0: & \chi * L_{F,i} \\ \text{otherwise}: & 0 \end{cases} \tag{11}$$

The debt ratio of the firms is given by:

$$DR_{F,i} = \frac{L_{F,i}}{K_i} \qquad (12)$$

The leverage ratio of the banks is given by:

$$LR_{B,i} = \frac{Assets_{B,i}}{e_i * p_i^e} \qquad (13)$$

where the amount of equities in each banking system e_i as well as their price level p_i^e remain constant in this version of the model. In line with Godley and Lavoie (2012, Chapter 11), I assume that rentiers have initially invested some capital which leads to flows of dividend payments in every period. Investment demand then is given by an autonomous component plus an amount that depends on the capacity utilization z_i, the rate of profit $\pi_{F,i}$ and the debt ratio $DR_{F,i}$ of the past period. However, when the firm's are credit constrained, a fixed rate of credit restriction rcr applies. The autonomous component sets a floor to investment demand in periods of distress.

$$Id_i = Max\big[$$
$$\begin{cases} \pi_{F,i}(-1) \geq \theta_{F,i}(-1): & i0_i + i1_i * z_i(-1) + i2_i * \pi_{F,i}(-1) + i3_i * DR_{F,i}(-1) \\ \text{otherwise:} & rcr(i0_i + i1_i * z_i(-1) + i2_i * \pi_{F,i}(-1) + i3_i * DR_{F,i}(-1)) \end{cases}$$
$$, i0_i\big]$$
$$(14)$$

where capacity utilization is given by dividing GDP by potential output:

$$z_i = \frac{Y_i}{Yp_i} \qquad (15)$$

and potential output by multiplying the stock of capital with capital productivity κ_i

$$Yp_i = K_i * \kappa_i \qquad (16)$$

The government's demand for spending is given by its income: taxes, the region's share of central bank profits plus net interest income.

$$Gd_i = T_i(-1) + \rho_i * \Pi_{ECB}(-1) - i_l * L_{G,i} + i_d * M_{G,i} \tag{17}$$

As indicated above, fulfilling demand for consumption, investment and government spending depends on the ability of the domestic banking system to finance a fraction which is imported.
Reserve demand for the bank sector in region i is given by:

$$Res_{d,i} = M_i - X_i - \rho_i * \Pi_{ECB} - i_d * Res_i(-1) + (i_{IB} + a) * (L_{IB,i}(-1) + \\ L_{ECB,i}(-1) - L_{IB,j}(-1)) + rrr * M_{P,i}(-1) - Res_i(-1) \tag{18}$$

where
i_{IB} is the interbank interest rate for reserve lending
a is the installment rate at which interbank and central bank loans are paid back annually
$L_{IB,i}$ are the interbank loans from region j to region i
$L_{ECB,i}$ are the central bank loans to region i
rrr is the fixed minimum reserve requirement
$M_{P,i}$ are the private sector money deposits in region i, hence $M_{P,i} = M_{R,i} + M_{H,i}$
Res_i is the stock of ECB reserves hold by banks in region i.
Banks can borrow reserves through the interbank market as long as they are not credit constrained, hence $\pi_{B,i} \geq \theta_{B,i}$. The bank's margin of safety declines in periods in which no interbank loans are canceled but spikes in periods of financial distress. It also depends on both banking system's changes in their leverage ratios:

$$\theta_{B,i} = Max[\theta_{B,i}(-1) + \mu_{B,i} * |theta_{B,i}(-1)| + \\ \begin{cases} LR_{B,i}(-1) > 0 \wedge LR_{B,i}(-2) > 0: & \eta_1 * \Delta LR_{B,i} \\ \text{otherwise:} & 0 \end{cases} \tag{19}$$

$$+ \begin{cases} LR_{B,j}(-1) > 0 \wedge LR_{B,j}(-2) > 0 : \eta_2 * \Delta LR_{B,j} \\ \text{otherwise:} \hspace{4em} 0 \end{cases}$$

$$, 0]$$

where $\mu_{B,i}$ adds to the margin of safety when bank loans are canceled.

$$\mu_{B,i} = \begin{cases} Canc_{B,i}(-1) = 0 & -\gamma_b \\ \text{otherwise:} & \tau_b \end{cases} \tag{20}$$

A proportion χ of firm loans are canceled when their profit rate falls short of their margin of safety and their profits are negative, conditioned of having a positive amount of outstanding loans. *CancBmin* indicates a minimum amount of loans canceled to speed up the adjustment process in recessions.

$$Canc_{B,i} = \begin{cases} L_{IB,i}(-1) > 0 \wedge \pi_{B,i} - \theta_{B,i} < 0 \wedge \Pi_{B,i} < 0 : & Max[\chi * L_{IB,i}(-1), \\ Min[CancBmin, \text{\pounds}_{IB,i}(-1) - a * L_{IB,i}(-1)]] \\ \text{otherwise:} & 0 \end{cases}$$

$$\tag{21}$$

If bank's are not credit constrained, demand for interbank loans is limited by the other banking system's excess reserves:

$$Ld_{IB,i} = \begin{cases} \pi_{B,i}(-1) - \theta_{B,i}(-1) \geq 0 \ \wedge \ Resd_i(-1) > 0 \ \wedge \ Resd_j(-1) < 0 : \\ Min[Resd_i(-1), -Resd_j(-1)] \\ \text{otherwise:} \hspace{14em} 0 \end{cases}$$

$$\tag{22}$$

The rest can be borrowed directly from the ECB:

$$Ld_{ECB,i} = \begin{cases} Resd_i > Ld_{IB,i} : & Resd_i - Ld_{IB,i} \\ \text{otherwise:} & 0 \end{cases} \tag{23}$$

If one region's banking sector is credit constrained import demand is reduced to the amount of reserves available for international clearing. As this mechanism can lead to strong contractions, a fixed emergency lending rate *elr* provides a floor for consumption demand that is financed.

$$
Cdf_i = \begin{cases} \pi_{B,i}(-1) < \theta_{B,i}(-1): & [Max[Min[Cd_i, RCC_i * \frac{Cd_i}{Cd_i+Id_i+Gd_i}], elr * Cd_i] \\ \text{otherwise:} & Cd_i \end{cases}
$$

(24)

$$
Idf_i = \begin{cases} \pi_{B,i}(-1) < \theta_{B,i}(-1) & [Max[Min[Id_i, RCC_i * \frac{Id_i}{Cd_i+Id_i+Gd_i}], elr * Id_i] \\ \text{otherwise:} & Id_i \end{cases}
$$

(25)

$$
Gdf_i = \begin{cases} \pi_{B,i}(-1) < \theta_{B,i}(-1) & [Max[Min[Gd_i, RCC_i * \frac{Gd_i}{Cd_i+Id_i+Gd_i}], elr * Gd_i] \\ \text{otherwise:} & Gd_i \end{cases}
$$

(26)

where the rate of credit restriction is computed as

$$
RCC_i = (X_i(-1) + \rho_i * \Pi_{ECB}(-1) + i_d * Res_i(-1) + i_{IB} * (L_{IB,j}(-1) \\ - L_{IB,i} - L_{ECB,i}(-1)) + Res_i(-1) - rrr * M_{h,i})/m_n
$$

(27)

The rate of credit restriction is based on the net inflow of reserves in the current period. Since X_i is not determined yet, $X_i(-1)$ serves as a proxy. $Res_i * \frac{Cd_i}{Cd_i+Id_i+Gd_i}$ is the amount of reserves allocated to consumption and $m_i * Cd_i$ is the share of consumption demand that is imported. Both have to be equal in order for the imports to be financed. If the banking sector is credit constrained, only a fraction can be financed: $C_i = \frac{Res_i}{m_i} * \frac{Cd_i}{Cd_i+Id_iGd_i}$ where $\frac{Res_i}{m_i}$ is the factor with which import demand of consumption, investment and government spending is multiplied.

Import demand of region i for goods of region j is given by:

$$IMd_{j,i} = m_{j,i} * (Cdf_i + Idf_i + Gdf_i) \tag{28}$$

As a last step, the model checks whether the import demand can be fulfilled given the productive capacity of the exporting economy. This capacity restriction rate (crr_i) is given by:

$$crr_i = \begin{cases} (((1 - m_{j,i} - m_{row,i}) * (Cdf_i + Idf_i + Gdf_i) + IMd_{i,j} + Xd_{row,i})/Yp_i) \leq 1 : & 1 \\ \text{otherwise:} & \\ Yp_i / ((1 - m_{j,i} - m_{row,i}) * (Cdf_i + Idf_i + Gdf_i) + IMd_{i,j} + Xd_{row,i})) \end{cases} \tag{29}$$

Finally, actual imports of region i are given by:

$$IM_i = crr_j * IMd_{j,i} + IM_{row,i} \tag{30}$$

$$C_i = crr_i * Cdf_i \tag{31}$$

$$I_i = crr_i * Idf_i \tag{32}$$

$$G_i = crr_i * Gdf_i \tag{33}$$

Capital accumulates through investment and minus depreciation.

$$K_i = K_i(-1) - \delta * K_i(-1) + I_i \tag{34}$$

The price level in region i is given by:

$$p_i = w_i * \frac{1}{\lambda_i} * (1 + \phi_i) \tag{35}$$

where w_i is the money wage per unit of labor in region i, α_i is the output-labor

ratio in region i, and ϕ_i is the constant mark-up in region i.
Inflation is then

$$pi_i = p_i/p_i(-1) - 1 \tag{36}$$

The wage rate in region i is given by:

$$wi_i = \sigma_{i0} + \sigma_{i1} * \Delta p_i^e + \sigma_{i2} * \Delta \lambda^e - \sigma_{i3} * u_i(-1) \tag{37}$$

$$w_i = w_i(-1) * (1 + wi_i) \tag{38}$$

As both regions in the monetary union differ by their labor market institutions, the parameters in the respective wage equations reflect the Varieties of Capitalism literature.

$\sigma_{s1} > \sigma_{n1}$, as workers in the periphery are assumed to be more successful in bargaining for nominal wage increases when inflation is expected

$\sigma_{n2} > \sigma_{s2}$, as workers in the periphery are assumed to resist stronger to wage cuts when unemployment rises compared to the core.

Expected inflation follows simple backward looking expectations:

$$p_i^e = p_i(-1) \tag{39}$$

Unemployment in period in region i is given by:

$$u_i = \frac{N_i - E_i}{N_i} \tag{40}$$

Populations are assumed to be constant,

$$N_i = \overline{N_i} \tag{41}$$

Employment in region i is determined by output divided by labor productivity:

$$E_i = \frac{Y_{t,i}}{\lambda_i} \tag{42}$$

Labor productivity is constant in the stationary version of the model: $\lambda_i = 1$.

The total wage bill is given by:

$$WB_i = w_i * E_i \tag{43}$$

The price level in the RoW is assumed to be constant: $P_{RoW} = 1$

The propensity to import of the north from the south is given by:

$$m_{s,n} = \psi_0 - \psi_1 * (p_s - p_{row}) \tag{44}$$

Imports of the south and of the RoW from the north do not depend on the price levels but are inelastic. So $m_{n,s} = \psi_2$ and $m_{n,row} = \psi_3$.

Imports of the south from the RoW also depend on relative prices since domestic households and firms also take relative prices of the price competing produce into account.

$$m_{s,row} = \psi_4 - \psi_5 * (p_{row} - p_s) \tag{45}$$

In every period, a constant proportion of the outstanding loans is repaid:

$$Rep_{R,i} = a * L_{R,i}(-1) \tag{46}$$

$$Rep_{W,i} = a * L_{W,i}(-1) \tag{47}$$

$$Rep_{F,i} = a * L_{F,i}(-1) \tag{48}$$

$$Rep_{G,i} = a * L_{G,i}(-1) \tag{49}$$

$$Rep_{IB,i} = a * L_{IB,i}(-1) \tag{50}$$

$$Rep_{ECB,i} = a * L_{ECB,i}(-1) \tag{51}$$

The change in the stock of loans by firms is given by:

$$\Delta L_{F,i} = -Rep_{F,i} - Canc_{F,i} + I_i \tag{52}$$

$$L_{F,i} = L_{F,i}(-1) + \Delta L_{F,i} \tag{53}$$

Firm's profits and net wealth are given by:

$$\Pi_{F,i} = Y_i - WB_i - i_l * L_{F,i}(-1) - Rep_{F,i} \tag{54}$$

$$DIV_{F,i} = \Pi_{F,i} \tag{55}$$

$$V_{F,i} = K_i - L_{F,i} \tag{56}$$

The flow of savings of rentiers and workers are given by:

$$S_{R,i} = Y_{R,i} - C_{R,i} \tag{57}$$

$$S_{W,i} = Y_{W,i} - C_{W,i} \tag{58}$$

In this model, the only financial asset is bank deposits. Therefore, positive savings led to an increase in bank deposits and negative savings are partly deducted from the stock of deposits and partly financed through new bank loans:

$$\Delta M_{R,i} = \begin{cases} S_{R,i} \geq 0: & S_{R,i} \\ \text{otherwise:} & Min[S_{R,i}/2, M_{R,i}] \end{cases} \tag{59}$$

$$\Delta M_{W,i} = \begin{cases} S_{W,i} \geq 0: & S_{W,i} \\ \text{otherwise:} & Min[S_{W,i}/2, M_{W,i}] \end{cases} \tag{60}$$

$$M_{R,i} = M_{R,i}(-1) + \Delta M_{R,i} \tag{61}$$

$$M_{W,i} = M_{W,i}(-1) + \Delta M_{W,i} \tag{62}$$

$$\Delta L_{R,i} = \begin{cases} S_{R,i} < 0: & -Rep_{R,i} - (S_{R,i} - \Delta M_{R,i}) \\ \text{otherwise:} & -Rep_{R,i} \end{cases} \tag{63}$$

$$\Delta L_{W,i} = \begin{cases} S_{W,i} < 0: & -Rep_{W,i} - (S_{W,i} - \Delta M_{W,i}) \\ \text{otherwise:} & -Rep_{W,i} \end{cases} \tag{64}$$

$$L_{R,i} = L_{R,i}(-1) + \Delta L_{R,i} \tag{65}$$

$$L_{W,i} = L_{W,i}(-1) + \Delta L_{W,i} \tag{66}$$

The net wealth of rentiers and workers is then given by:

$$V_{R,i} = M_{R,i} - L_{R,i} + p_i^e * e_i \tag{67}$$

$$V_{W,i} = M_{W,i} - L_{W,i} \tag{68}$$

Government saving is given by:

$$S_{G,i} = T_i - \rho_i * \Pi_{ECB} - G_i - i_l * L_{G,i} - Rep_{G,i} + i_d * M_{G,i} \tag{69}$$

which leads to a change in the stock of government debt:

$$\Delta L_{G,i} = -Rep_{G,i} - S_{G,i} \tag{70}$$

$$L_{G,i} = L_{G,i}(-1) + \Delta L_{G,i} \tag{71}$$

$$\Delta M_{G,i} = \begin{cases} S_{G,i} \leq (L_{G,i}(-1) - Rep_{G,i}) \land S_{G,i} < 0 \land M_{G,i}(-1) > 0 : & Min[S_{G,i}, M_{G,i}] \\ \text{otherwise:} & S_{G,i} - (L_{G,i} - Rep_{G,i}) \end{cases} \tag{72}$$

$$M_{G,i} = M_{G,i}(-1) + \Delta M_{G,i} \tag{73}$$

Government net wealth is given by:

$$V_{G,i} = M_{G,i} - L_{G,i} \tag{74}$$

The changes in firm debt and their net wealth are given by:

$$\Delta L_{F,i} = -Rep_{F,i} - Canc_{F,i} + I_i \tag{75}$$

$$L_{F,i} = L_{F,i}(-1) + \Delta L_{F,i} \tag{76}$$

$$V_{F,i} = K_i - L_{F,i} \tag{77}$$

Bank profits are given by:

$$\begin{aligned} \Pi_{B,i} = i_l * (L_{R,i}(-1) + L_{W,i}(-1) + L_{F,i}(-1) + L_{G,i}(-1)) - \\ (i_{IB} + a) * (L_{ECB,i}(-1) + L_{IB,i}(-1) - L_{IB,j}(-1)) - i_d * (M_{R,i}(-1) + \\ M_{W,i}(-1) + M_{G,i}(-1) - Res_i(-1)) \end{aligned} \tag{78}$$

$$DIV_{B,i} = \Pi_{B,i} \tag{79}$$

ECB's profits are given by:

$$\Pi_{ECB} = i_{IB} * (LECB, i(-1) + L_{ECB,j}(-1)) - i_d * (Res_i(-1) + Res_j(-1)) \quad (80)$$

Some equations which follow from trade finance have been excluded above to make the flow of the argument more comprehensive. Those are listed here:

$$\Delta Res_i = -IM_i + X_i + \rho_i * \Pi_{ECB} + i_d * Res_i(-1) + (i_{IB} + a) * (L_{IB,j}(-1) \\ - L_{IB,i}(-1) - L_{ECB,i}(-1)) + Ld_{IB,i} - Ld_{IB,j} + Ld_{ECB,i} \quad (81)$$

$$Res_i = Res_i(-1) + \Delta Res_i \quad (82)$$

$$\Delta L_{IB,i} = Ld_{IB,i} - a * L_{IB,i}(-1) - Canc_{B,i} \quad (83)$$

$$L_{IB,i} = L_{IB,i}(-1) + \Delta L_{IB,i} \quad (84)$$

$$\Delta L_{ECB,i} = Ld_{ECB,i} - a * Ld_{ECB,i}(-1) \quad (85)$$

$$L_{ECB,i} = L_{ECB,i}(-1) + \Delta L_{ECB,i} \quad (86)$$

$$V_{ECB} = -Res_i - Res_j + L_{ECB,i} + L_{ECB,j} + Resf_{ECB} - Res_{row} \quad (87)$$

$$Assets_{B,i} = L_{F,i} + L_{G,i} + L_{H,i} + L_{IB,j} + Res_i \quad (88)$$

$$V_{B,i} = -M_{R,i} - M_{W,i} + L_{R,i} + L_{W,i} + L_{F,i} + L_{G,i} - M_{G,i} + \\ Res_i - L_{ECB,i} + L_{IB,j} - L_{IB,i} \quad (89)$$

Rest of the world:

$$Xd_{row,i} = m_{i,row} * Y_{row} \quad (90)$$

where GDP of the RoW is fixed and endogenously given.

If region j is capacity constrained, goods are instead imported from RoW:
change how I explained this in the code.

$$IM_{row,i} = m_{row,i} * (C_i + I_i + G_i) + IMd_{j,i} * (1 - crr_j) \qquad (91)$$

$$X_i = (IM_j - IM_{row,j} + X_{row,i}) \qquad (92)$$

Actual exports from region i to *RoW*:

$$X_{RoW,i} = crr_i * Xd_{row,i} \qquad (93)$$

The RoW obtains reserves to settle trade by exchanging domestic currency reserves for monetary union currency reserves at the fixed and exogenous exchange rate.

$$FRT_{row} = \begin{cases} (Res_{row}(-1) + IM_{row,i} + IM_{row,j} - X_{row,i} - X_{row,j}) \geq 0: \\ (-(IM_{row,i} + IM_{row,j} - X_{row,i} - X_{row,j}) - Res_{row}) \\ \text{otherwise:} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad 0 \end{cases} \qquad (94)$$

$$\Delta Res_{row} = IM_{row,i} + IM_{row,j} - X_{row,i} - X_{row,j} + FRT_{row} \qquad (95)$$

$$Res_{row} = Res_{row}(-1) + \Delta Res_{row} \qquad (96)$$

RoW's foreign reserve transactions equal the change in ECB's foreign reserves:

$$\Delta Resf_{ECB} = FRT_{row}(-1) \qquad (97)$$

$$Resf_{ECB} = Resf_{ECB}(-1) + \Delta Resf_{ECB} \qquad (98)$$

$$V_{row} = Res_{row} - Resf_{ECB} \qquad (99)$$