DISS. ETH NO. 25475

FOLLOWING FINANCIAL STOCKS AND FLOWS:

GLOBAL IMBALANCES, FINANCIAL CRISES AND CRYPTO CURRENCIES

A thesis submitted to attain the degree of

DOCTOR OF SCIENCES of ETH ZURICH

(Dr. sc. ETH Zurich)

presented by

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2018

Abstract

This dissertation is a compilation of three self-contained research papers that contribute to the literature of financial macroeconomics. All three papers are co-authored by Professor Didier Sornette and have been submitted to peer-reviewed journals, where they are awaiting review. The papers as presented in this thesis include additional material that goes beyond the versions that have been submitted to the journals.

The first research paper analyses crypto currencies from the perspective of monetary theory. The rise of crypto currencies, notably bitcoin, has fueled new and old debates about money. We discuss attempts to complement or replace fiat money by 'stablecoins'. In a first step, we review today's endogenous and debt-backed money. Second, we analyse attempts to use stablecoins in order to overcome the inherent speculative and deflationary design of fixed supply coins like bitcoin. Building on theories stating that economic and liquidity expansion go hand in hand we find that stablecoins have flexible supply designs. However, we also find that the algorithmically planned allocation of new coins, that is characteristic of stablecoins, is inferior to contemporary ways of money creation for two reasons: (i) it is not market-based and (ii) it is not backed by a 'We Owe You'. Moreover, it builds on outdated monetarist theories in an attempt to control prices. We predict that crypto-monetarism in its present formulations will fail because quantity adjustments are not a sufficient condition for stable prices. Finally, regarding price stability, we suggest the importance of overcoming the illusionary dichotomy between the real and the financial circuit in (crypto) monetary policy. We show that, in the real world, firms set prices according to cost-based pricing rules, so that changes in unit labour costs correlate well with inflation. As a consequence, and in line with a path-dependent and institutional perspective on the labour market, coordinated wage bargaining appears vital to achieve price stability.

The second research paper goes beyond monetary analysis of closed economies and looks at countries' foreign financial flows and stocks. Concretely, the paper analyses the Swiss National Bank's accumulation of foreign reserves after 2008. The latter amount to the size of Swiss GDP and, yet, the Swiss franc is still considered to be significantly over-valued. Against this backdrop, the paper discusses challenges and opportunities for Swiss policy making, drawing on comparisons with other surplus countries. Our findings are fourfold. First, the upward pressure on the Swiss franc cannot be explained by safe haven effects alone, but has been driven by a pronounced decline in Swiss residents' foreign investments. Second, other surplus countries typically purchase and manage significant amounts of foreign assets via central banks and sovereign wealth funds. Third, from a global perspective, such public intervention is subject to a mercantilist critique. Fourth, given the need to invest in the real economy to foster growth and avoid the present excess flushing of the financial system that boost asset prices in an insufficient productive way, we conclude that Switzerland should assess room for re-balancing and highlight the opportunity

of building a Swiss sovereign wealth fund. Our analysis suggests that this would be beneficial both for Swiss residents and for the world at large.

The third research paper exploits accounting identities to build a Stock-Flow-Consistent (SFC) model. The research is motivated by the slow growth in the US and the eurozone after 2008. We argue that, in order to escape further sluggish growth, the present ailments must be seen as rooted in the characteristics of growth regimes prior to the crisis. We use key stylized facts to develop a stylized SFC model that incorporates a financial and a real economic circuit, household credit and distributive dynamics. As such, it is able to trace stylized growth patterns over the last decades, taking non-linear dynamics into account. The model generates three main findings. First, positive feedback between financialization and rising income inequality leads, over time, to credit-burdened growth (the Perpetual Money Machine regime). Second, households either consume or speculate with the newly created money giving rise to a bubble, which endogenously bursts in a financial crisis. The GDP collapses, asset prices fall, and the private sector deleverages. Third, in the after-crisis period, the government has room to stabilize GDP temporarily by acting as a borrower of last resort. Our analysis suggests that establishing solid growth requires observation of the golden wage rule, namely re-coupling of wages and output.

Zusammenfassung

Diese Doktorarbeit besteht aus drei in sich geschlossenen Forschungsarbeiten aus dem Bereich der finanziellen Makroökonomie. Alle drei Arbeiten wurden gemeinsam mit Professor Didier Sornette verfasst und bei Peer-Review-Zeitschriften eingereicht, wo sie auf Prüfung warten. Im Vergleich zu den eingereichten Arbeiten, enthalten die in dieser Dissertation vorliegenden Versionen zusätzliches Material.

Die erste Forschungsarbeit untersucht Kryptowährungen aus geldtheoretischer Sicht. Der rasante Aufstieg von Kryptowährungen, allen voran Bitcoin, lässt alt bekannte sowie neue Diskussion rund um das Thema Geld aufkommen. Wir untersuchen Bestrebungen von sogenannten Stablecoins das heutige Fiatgeld zu ergänzen oder abzulösen. Im ersten Schritt geben wir einen Überblick über unser heutiges endogenes Schuldgeldsystem. Im zweiten Schritt analysieren wir den Versuch mit Stablecoins das inhärent spekulative und deflationäre Design von Kryptowährungen mit begrenzter Menge, wie beispielsweise Bitcoin, zu umgehen. Wir beobachten, dass die Menge der Stablecoins variabel ist. Letzteres ist im Einklang mit Theorien, die Liquididäts- und Wirtschaftswachstum Hand in Hand gehen sehen. Gleichzeitig finden wir, dass die für Stablecoins charakteristische algorithmisch gesteuerte Allokation von neuen Coins aus zwei Gründen nicht so gut ist wie die heutige Geldschöpfung:(i) die Allokation ist nicht markt-basiert und (ii) sie ist nicht durch ein kollektives Schuldversprechen, ein 'We Owe You', gedeckt. Um Preisstabilität zu erreichen, basiert das Design von Stablecoins darüber hinaus auf überholten monetaristischen Theorien. Wir sagen vorher, dass Krypto-Monetarismus scheitern wird, weil Geldmengensteuerungen keine hinreichende Bedingung für stabile Preise sind. Schlussendlich weisen wir im Hinblick auf Preisstabilität darauf hin, dass die Geldpolitik (von Kryptowährungen) die illusorische Dichotomie zwischen dem finanziellen und realwirtschaftlichen Kreislauf überwinden muss. Wir zeigen, dass die Preise von Firmen gemäss kostenbasierten Regeln gesetzt werden, und daher Veränderungen von Lohnstückkosten gut mit Preisänderungen korrelieren. Als Konsequenz, und in Übereinstimmung mit einer institutionellen und pfadabhängigen Sicht auf den Arbeitsmarkt, erscheinen koordinierte Lohnverhandlungen wichtig um Preisstabilität zu gewährleisten.

Die zweite Forschungsarbeit geht über monetäre Analysen von geschlossenen Volkswirtschaften hinaus, indem sie finanzielle Strom- und Bestandsgrössen über Grenzen hinweg betrachtet. Konkret analysieren wir die Anhäufung von ausländischen Währungsreserven der Schweizer Nationalbank nach 2008. Obwohl letztere die Grösse des Schweizer BIP erreichen, wird der Schweizer Franke als deutlich überbewertet eingeschätzt. Vor diesem Hintergrund, und mit Hilfe einer komparativen Studie von anderen Überschussländern, analysiert die Forschungsarbeit Möglichkeiten und Herausforderungen für die Schweizer Politikgestaltung. Unsere Ergebnisse lassen sich in vier Punkten zusammen fassen: Erstens kann der Aufwärtsdruck auf den

Schweizer Franken nicht allein durch sichere-Hafen-Zuflüsse von nicht-Schweizern erklärt werden, denn Inländer haben ihre Auslandsinvestitionen deutlich reduziert. Zweitens kaufen und managen andere Überschussländer erhebliche Mengen Auslandsvermögen über Zentralbanken oder Staatsfonds. Drittens ist solch eine Intervention durch die öffentliche Hand global gesehen merkantilistisch. Viertens, da Finanzmärkte bereits mit Liquidität überhäuft sind, und Investitionen in die reale Wirtschaft dringend benötigt werden, folgern wir, dass die Schweiz überlegen sollte, ihre Leistungsbilanz etwas ins Gleichgewicht zu bringen, und weisen auf die Chance hin, einen Schweizer Staatsfond zu gründen. Dies wäre nicht nur für die Schweiz, sondern auch für die Welt von Vorteil.

Die dritte Forschungsarbeit nutzt buchhalterische Identitäten aus um ein Stock-Flow-Consistent (SFC) Modell zu bauen. Die Forschung ist durch das langsame Wachstum in den USA und der Eurozone nach 2008 motiviert. Wir argumentieren, dass man die heutigen Wirtschaftsprobleme als charakteristische Folgen der Wachstumsregime vor der Krise sehen muss. Wir benutzen stilisierte Fakten um ein SFC Modell zu entwickeln welches einen finanziellen und einen realen Kreislauf, sowie Kredite an private Haushalte und Verteilungseffekte beinhaltet. Als solches berücksichtigt das Modell nichtlineare Dynamiken und ist in der Lage stilisierte Wachstumsmuster der letzten Dekaden nachzuzeichnen. Das Modell lässt drei Schlussfolgerungen zu. Erstens führt positive Wechselwirkung zwischen Finanzialisierung und wachsender Ungleichheit, über die Zeit, zu Kredit-belastetem Wachstum(credit-burdened growth). Zweitens konsumieren oder spekulieren Haushalte mit dem neu kreierten Geld, was zu einer Blase führt die endogen in einer Finanzkrise platzt. Das BIP kollabiert, Vermögenspreise fallen, und der Privatsektor senkt seine Verschuldung. Drittens hat die öffentliche Hand nach der Krise das BIP temporär zu stabilisieren, in dem sie als Schuldner in letzter Instanz auftritt. Unser Analyse deutet darauf hin, dass man der goldenen Lohnregel, sprich einer Kopplung von Löhnen und Produktion, folgen sollte, um einen soliden Wachstumspfad zu erreichen.

Acknowledgments

This dissertation has benefited from input from many people and institutions who have accompanied me over the last years. Without their comments and advice, academic inspiration, material support and infrastructure, the current research could not have been conducted.[1]

First and foremost, I wish to express my profound gratitude and sincere respect to Professor Didier Sornette for being an endless source of energy, ideas, support and knowledge. His open-mindedness, dedication, endurance and critical thinking never ceases to inspire me and he has become a role model in many ways. Professor Sornette's Chair for Entrepreneurial Risks is a unique community of enthusiastic, talented and interdisciplinary people. I am fortunate and grateful for the opportunity to have been part of this chair.

Second, I would like to thank Peter Wuffli. Without his initiative, encouragement and intellectual support, a significant part of this thesis would not have been possible. I am overly grateful to have had the opportunity to build upon his extensive experience in the financial sector, his knowledge of Swiss economics and politics, as well as his network. Peter Wuffli, whose guidance has reached well beyond the domain of economics and finance, has become a source of inspiration for career building and ethical as well as entrepreneurial action.

Third, I am deeply indebted to Professor Andrea Terzi and Professor Alexander Lipton for being co-examiners of my work, and Professor Michael Ambühl for presiding over the examination committee. Andrea Terzi is one of the very few economists in Switzerland working on monetary economics, and I am very grateful for his detailed feedback and comments on early versions of the SFC model. Alexander Lipton, with his unique background as a scientist, mathematician and financial expert, has added tremendous value to my academic development. I have learned a lot from his recent academic and practical work on crypto currencies and the (history of) monetary theory.

Going back to the roots, I would to thank Professor Heiner Flassbeck for having inspired the decision to leave physics and turn my passion, economics, into a profession. He taught me a coherent macroeconomic framework that has guided me throughout my studies. His impact on this thesis cannot be underestimated.

[1] Note that the persons mentioned below are not necessarily familiar with the whole thesis, and might not necessarily endorse all material covered.

Many thanks also go to Alexandro Izurieta and Elissa Braunstein for having introduced me to the key literature used in this thesis. Alexandro Izurieta, in particular, has taught me SFC modeling, which is an integral component of this thesis.

Turning to the younger generation, I would like to thank Anne-Sophie Senner for her emotional and intellectual support. She has taught me that good drafting and communication skills are not inferior to quantitative methods but constitute a skill-set of at least equal importance that requires training and practice. Anne-Sophie has shown me that the process of verbal and written communication is very helpful to clarify thinking.

I am also incredibly thankful for the support and input from Silvan Fischer, Florian Böser, Vincent Giorgis and Sascha Bützer. They have provided feedback and ideas that have shaped this thesis in a critical way. Many thanks to Viktor Winschel for the exchange of ideas, and for his courage to turn them into a business.

Moreover, this thesis has benefited from comments and discussions with (in alphabetic order): Marcel Bräutigam, Beniamino Callegari, Hendrik Clausdeinken, Cristiano Duarte, Philipp Epstein, Daniela Gabor, Niklas Garnadt, Jeremy Henrichs, Willy Hautle, Simona Helmsmüller, Patrick Kaczmarczyk, Vahe Krrikyan, Tim Lappe, Marc Lavoie, Mario Meier, Michael Pircher, Maximilian Seyrich, Robert Smith, Lea Steininger, Engelbert Stockhammer, Jochen Streb, Eugene Trubowitz and Thomas Vass.

Current and former members of the Chair have contributed to my everyday working experience and helped me clarify my research in endless discussions. Among them are Michael Schatz, Spencer Wheatley, Lucas Fivet, Herman Hellenes, Tobias Huber, Diego Ardila, Guilherme Demos, Ralf Kohrt, Dorsa Sanadgol, Sumit Ram, Florian Ulmann, Rebecca Westphal, Dmitry Chernov and Ke Wu. Special thanks go to my office mate Tatyana Kovalenko. Isabella Bieri and Judith Holzheimer have ensured a smooth, efficient and cheerful administrative support.

I would like to thank the Institute for New Economic Thinking (INET) and its Young Scholar Initiative for enriching conferences and webinars and for building a community of next generation economists. Similarly, I would like to thank the Deutsche Studienstiftung for providing me with an intellectual network along my career. Further, I am thankful for technical expertise provided by members of the Swiss National Bank, the Financial Stability Board, the OECD and the Peterson Institute.

This work was financially supported by Peter Wuffli as well as by the Swiss National Foundation, under grant 100018 160305/1, for the project on “Real Estate Bubbles: Emergence, Deflation, Propagation, and Systemic Risk”.

Last but not least I would like to thank my family, without whose unconditional love and financial support I could not have started my career with a long-run, high risk perspective. Samuel, our son, has given me endless joy and reminds me every day that any power comes along with great responsibilities. Dedicated to Samuel, Anne-Sophie, Petra, Johann, Simon and Sonja.

Zurich, August 2018 *Richard Senner*

To my parents, Petra and Johann.

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1 Introduction and Motivation

Mainstream economic theory has been fundamentally challenged by the global financial crisis in 2008. This thesis seeks to contribute to the ongoing rethinking of economic science by proposing a set of novel conceptual frameworks to analyze macro financial issues.

Economists are typically classified as social scientists because they seek to develop theories about the behavior of individuals, groups and institutions. Over the past decades, and in particular since the 1980s, economic science has become more mathematical. Standard models use representative agents who maximize a utility function and are endowed with rational expectations. The financial sector is usually neglected because money is presumed to be neutral. As a consequence, economic modeling tends to focus on real as opposed to nominal variables.

Recently, however, the assumptions underlying the prevailing modeling approach sketched above have come under increasing criticism. A growing body of evidence challenges conceptions of rational behavior and foresight. Moreover, and most relevant for this thesis, financial variables slowly make their appearance in modeling and understanding of monetary economies.

The methodology underlying this thesis is rooted in the simple fact that every spending goes along with an income, and vice versa. One person‘s income is another person‘s expenditure. One agent‘s financial asset is another agent‘s financial liability. And so forth. This basic logic, also known as stock and flow consistency, might appear trivial, but has crucial implications for economic analysis: The variables of interest, i.e. income, financial wealth and debt, follow certain accounting rules. What is more, they are typically documented on every agent‘s balance sheet and can easily be collected for economic analysis, making economics fundamentally different from most other social sciences. This thesis advocates that economics should harvest and exploit the low hanging fruits of financial accounting as a solid starting point for further analysis.

This thesis comprises three self-contained research papers. The first paper focuses on the most basic and, at the same time, most important financial asset and its corresponding liability: money and debt. Starting with a historical perspective, the paper shows that money reflects debits and credits between people, different legal groups and nations. Over time, individual ‘I Owe You’ (IOUs) are replaced with more universal ‘We Owe You’ (WOUs). It is the recording and trading of these debts that allows economists to empirically test theories, and to think within a coherent accounting framework. This paper contrasts the insights of this approach with various theories underlying crypto currencies in light of the recent popularity of crypto currencies and

the associated interest in money theory. Ultimately, it answers the question of whether crypto currencies can eventually replace fiat money.

The analysis conducted in the second paper goes beyond a purely money-focused discussion, looking at a variety of financial stocks and flows. The objective is to evaluate and categorize the rapid growth of the Swiss National Bank's balance sheet after 2008. A careful analysis of currency denominations, ownership structures and accounting standards allows to better understand the drivers behind the Swiss current and capital accounts. Putting the Swiss situation in international context, the analysis reveals the increasingly important role played by sovereign wealth funds, in addition to central banks, in the management of publicly controlled foreign assets.

In both the first and second paper monetary analysis is used to critically assess existing theories, as well as to propose new conceptual frameworks. In the first paper, for example, such analysis allows to reject (crypto-)monetarism and, at the same time, to provide a new coherent framework to assess and classify stablecoins. Along similar lines, the second paper shows that export-led growth is subject to the mercantilist critique, and proposes to quantify public interventions by looking not only at central bank interventions, but also at sovereign wealth funds.

The third paper seeks to move beyond descriptive statistics and qualitative conceptual frameworks by building a Stock-Flow-Consistent (SFC) model. The objective of the model is to understand long-term growth patterns in developed economies. Underlying the model's key ingredients is an interdisciplinary approach. On the one hand, financial assets and liabilities, both of which constitute conventional elements in SFC literature, are key components. On the other hand, the model draws on insights from the literature on complex systems. The premise is that developed capitalist economies are complex systems. This means that linear dynamics, one-way causality as well as a state of equilibrium, are the exception rather than the norm. Instead, more complex and potentially highly non-linear processes occur. In line with the literature on complex systems, the model suggests that these processes eventually give rise to regime changes.

In the following the three self-contained research papers are presented, each preceded by a short general introduction. [1] Subsequent to the third paper a concluding chapter discusses the findings, challenges and shortcomings of this thesis from a broader perspective than adopted in each paper.

[1] All articles in this thesis have been co-authored by Prof. Didier Sornette and Richard Senner. The research question was formulated jointly. The articles were also written jointly. Richard Senner provided data analysis, simulation studies and literature reviews.

2 Monetary Theory and Crypto Currencies

The research presented in this chapter is motivated by the rise of crypto currencies, notably bitcoin, and the associated growing interest in monetary theories outside of economic faculties. The main objective is to contrast state-of-the-art monetary theories with theories that back different cryptocurrencies.

As mentioned in the introduction of this thesis, conventional economic theory has not devoted much attention to monetary theory over the last decades. The result is an intellectual and institutional vacuum regarding knowledge about monetary economies. This, in turn, has fueled a gold-rush atmosphere in today's crypto community, where a variety of seemingly disruptive and well-funded designs for crypto currencies are proposed. Not surprisingly, many of the underlying theories are theoretically and empirically flawed.

For example, some proponents of bitcoin view money as a 'special good', comparative to the seashells, nails or silver that had been used to exchange goods and services in the past. In their judgement, gold is the 'soundest' type of money because it is difficult to reproduce and because the new gold flow is relatively small compared with the existing gold stock. Taking this line of argumentation further, bitcoin is portrayed as having the potential to eventually become the new gold standard that could bring along a new area of prosperous growth and stability, in which 'government imposed' money is no longer necessary.

This view on money is deeply flawed and bears little resemblance with the reality of monetary economies. The first section of our paper shows that money is generally a double-entry accounting element. Money and debt cannot be separated; they reflect two sides of the same coin. The paper describes the debt side of money as a historical evolution from IOUs (I Owe You) to WOUs (We Owe You). Hence, money is not a 'positive' thing in the sense that it has no counterpart.

Along similar lines the paper identifies and criticizes monetarist ideas behind the design of crypto currencies' pricing theories. In so doing it seeks to speed up the learning process in the crypto community regarding money theory, while, at the same time, pointing towards challenges inherent in today's monetary architecture, particularly regarding price stability.

From a methodological point of view, it is the objective of this paper to encourage interdisciplinary research about crypto currencies in the context of the ongoing rethinking of today's financial architecture. Anthropologists and historians, for example, are needed to understand

the evolution of money and debt, while computer scientists and economists can build upon these insights and propose next steps to render the financial system more resilient and efficient. This paper,(**Senner, R. and Sornette, D.**, 2018a) **(1)** advocates to rethink presumably price stable crypto currencies, and suggests to scrutinize the design of monetary policy more generally.

Research Paper

(1) Senner, R. and Sornette, D. The holy grail of crypto currencies: read to replace fiat? *reprint submitted to the Journal of Economic Issues*, 2018a

The Holy Grail of Crypto Currencies: Ready to replace fiat money?

Richard Senner and Didier Sornette*

Abstract

The rise of crypto currencies, notably bitcoin, has fueled new and old debates about money. We discuss attempts to complement or replace fiat money by 'stablecoins'. In a first step, we review today's endogenous and debt-backed money. Second, we analyse attempts to use stablecoins in order to overcome the inherent speculative and deflationary design of fixed supply coins like bitcoin. Building on theories stating that economic and liquidity expansion go hand in hand we find that stablecoins have flexible supply designs. However, we also find that the algorithmically planned allocation of new coins, that is characteristic of stablecoins, is inferior to contemporary ways of money creation for two reasons: (i) it is not market-based and (ii) it is not backed by a 'We Owe You'. Moreover, it builds on outdated monetarist theories in an attempt to control prices. We predict that crypto-monetarism in its present formulations will fail because quantity adjustments are not a sufficient condition for stable prices. Finally, regarding price stability, we suggest the importance of overcoming the illusionary dichotomy between the real and the financial circuit in (crypto) monetary policy. We show that, in the real world, firms set prices according to cost-based pricing rules, so that changes in unit labour costs correlate well with inflation. As a consequence, and in line with a path-dependent and institutional perspective on the labour market, coordinated wage bargaining appears vital to achieve price stability. Against this backdrop, we propose that wages have to grow in line with productivity plus the inflation target. Such an approach, if properly complemented with fiscal, interest rate and fx policies, would not only benefit price stability, but also financial resilience and economic development at large.

JEL: E32, E51, E64, G21
Keywords: crypto currencies, endogenous money, monetarism, blockchain, post-fiat world, unit labour costs, coordinated bargaining

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1 Introduction

"The problem of money cannot be separated from the problems of economics generally just as the problems of economics cannot be separated from the larger problems of human prosperity, peace, and survival" (Lerner (1947), p. 317)

In 2008, a paper was posted online by an anonymous programmer under the pseudonym 'Satoshi Nakamoto', entitled "Bitcoin: A Peer-to-Peer Electronic Cash System"[1]. This paper laid the foundation for the now well-known crypto currency Bitcoin[2].

Bitcoin is based on blockchain, a technology that is expected to disrupt a number of industries, including the financial one. Since then, dozens of other crypto currencies have been created, with the top 100 having a market capitalization of over$ 350 billion, of which $152 billion can be attributed to Bitcoin, and $67 billion to Ethereum, as of March 2018[3].

The rapid rise of crypto currencies has been fueled by the 2008 financial crisis and, more particularly, by public authorities' responses to the latter, that have given rise to a significant distrust in both private and public sector entities. Against this backdrop, crypto currencies appear to provide the foundation for a novel economic system that requires neither a private nor a public sector.

The increasing interest in crypto currencies has also been driven by the failure of conventional economic theories to deal with monetary issues. Indeed, contemporary economic theory struggles to understand the dynamics of monetary economies, which is largely due to the fact that mainstream models focus on 'real' variables and disparage money as being a 'veil' on economic activity. For the crypto community, this means that there is currently no coherent and easily accessible body of economic knowledge available that allows to effectively identify and address potential use cases of blockchain within the existing financial architecture. Not surprisingly, therefore, several proponents of crypto currencies have started to build their own theories about money, often relying on outdated economic theories. As a matter of fact, not only computer scientists, but also sociologists, physicists, and philosophers, etc. have joined emerging new and old debates about money theory, central banking and the organization of monetary economies more broadly.

We contribute to this debate by analyzing crypto currencies' attempts to replace fiat money. To the knowledge of the authors, this paper is the first to use a holistic macro-financial approach to discuss different crypto currencies' attempts to be price-stable and to eventually replace fiat money[4]. We review key features, both of our current monetary system and of blockchain technology, in order to then assess the (implicit) monetary theories underlying crypto currencies. In so doing, we place a particular focus on theories that are used to achieve price stability - an analysis that matters as conventional monetary policy is struggling to achieve inflation targets.

This paper is structures as follows: Section 2 reviews basics of our monetary system, displaying where fiat money comes from, both technically and historically. Section 3 contrasts fiat currencies

[1] see here https://bitcoin.org/bitcoin.pdf

[2] In this paper we will adopt terminology used in the crypto community that might not coincide with terminology in the (historical) economics literature. As we will see, the term cypto currencies, for example, should be regarded with caution because it does not in general refer to a currency in the economic sense.

[3] Prices fluctuations by more than 10% per day are not unusual. Source: https://coinmarketcap.com/

[4] Hong et al (2017) also contrast crypto and fiat currencies, but use a non-systemic micro approach. The authors assume some individual costs or benefits for using either crypto or fiat money. As such, their approach differs from ours.

with crypto currencies, focusing on 'stablecoins'. Section 4 analyses the drivers behind inflation in developed economies theoretically and empirically. Section 5 concludes.

2 Today's money as a we owe you (WOU)

2.1 Technical and historical origins

One common misconception motivating crypto designs is that a central institution, the central bank, determines the money supply, and that banks simply act as intermediaries, channeling predetermined amounts of money to firms and households. As we will see in section 3, based on such misconceptions, early proponents of crypto currencies thought that Bitcoin would eventually replace fiat currencies like the USD or the Euro.

However, in modern economies, money is created by banks in the process of lending[5]. As a consequence, the amount of money is determined endogenously, by individual banks.

More precisely, there are three types of money today, namely notes and coins, bank deposits and central bank money[6]. Bank deposits make up most money in modern economies and are created by banks. Whenever a bank provides a loan to a non-bank, deposits are created on the liability side, and a new loan occurs on the asset side of the bank (Bank of England (2014)).

Consequently, money is mirrored by debt, and there is no such thing as a positive pool of money as suggested by some forms of the loanable funds theory. In accounting terms, money is a financial asset, which, by definition, goes hand in hand with a corresponding financial liability (Terzi, 2016). All financial assets and liabilities sum up to zero[7].

This process of money creation appears very intuitive once a historical perspective is taken. [8] The history of money is closely connected to the history of debt, where the latter typically predates the former (see Graeber (2011) for a detailed analysis). Debt has ever since been at the heart of human society. Patterns of demand vary, i.e. some people want to borrow (a farmer needs help on the field), while others want to save (a father helps on the field expecting that the farmer will marry his daughter). This heterogeneity in demand and the associated debts and claims are inherent to human society. As a consequence, humans have continuously searched for new tools, rules and techniques to manage and, later on, record debt.

Put differently, social relations and economic activity have always been inherently linked to debt. Initially, different WOUs (We Owe You) or IOUs have been issued by small groups or even individuals. Along these lines, Hayek (1976) proposed that each bank should issue its own currency in order to have competition amongst banks. Customers would read news about each bank and decide where to allocate their funds. However, given high monitoring costs due to moral hazard, it is clearly not feasible to turn every conventional customer into a currency trader. Put differently, once ontological uncertainty *à* la Keynes is assumed, where we assume that "no apparent regularity

[5] Note that while many scholars might agree that banks create money, they would wrongly argue that the extend of money creation is limited by the monetary base, as suggested by the money multiplier theory.

[6] This contestable definition of money forms leaves out higher hierarchies of the money pyramid like shadow banking. For the objectives of this paper, it is sufficient to consider conventional forms of money. See von der Becke and Sornette (2017) for a more detailed analysis of the hierarchy of money.

[7] Note that non-financial assets such as houses or machines do not incur any liability. As a consequence, the world can have positive non-financial wealth (depending on valuation standards) but all financial assets and liabilities always sum up to zero. Clearly, one person's financial asset is another person's financial liability.

[8] See Lipton (2017b) for a brief, critical assessment of prevailing views on the history of money.

can be considered a permanently acquired basis for a statistical anticipation of the future" (Terzi, 2010), it becomes evident that the "consolidation" of scattered IOUs into more universal WOUs is one of the greatest financial innovations for ordinary market participants.

Hayek later adapted his original writings, correctly arguing that multiple currencies are not feasible, and that eventually only one, or a limited number of currencies, will survive[9]. The reason This consolidation of IOUs went hand in hand with new regulation and law enforcement that try to avoid moral hazard between creditors and debtors, i.e. to ensure that the debtor will pay whenever he can, and the lender will only lend whenever it is reasonable to do so (more on this below).

In the same spirit, central banks should be seen as an emergent institution that helped creating widespread trust. The FED, for example, was not created out of a bureaucratic top-down approach, but in order to solve liquidity problems in the banking sector, and to restore trust in it, following a number of high profile defaults, bankruptcies and financial crises. Regional differences in demand for currency and bank loans (think of loan, not deposit, volumes correlating strongly with agricultural production) called for a central institution that could clear regional differences (see Carlson and Wheelock (2016)). From this evolutionary perspective, today's money can be seen as a "social institution" (King, 2006).

Trust in WOUs is often supported by the fact that a particular currency is needed to pay taxes. In other words, money becomes legal tender and is "universally" accepted because the government demands it constantly (see Goodhart (1998) for the role governments played in the history of money). However, our definition of money goes beyond simple forms of chartalist theories because government's demand is not a sufficient condition for anything to become money. Without a comprehensive macroeconomic environment, tax burdens cannot generate trust in a currency. History witnesses many periods where trust in a currency vanished despite having a government that continuously demanded the currency. Against this backdrop we can generalize that, given a supportive economic and regulatory environment, money has always been backed by an (implicit) debt. This debt typically consists of a collection of individual and/or collective debts towards private and/or public institutions.

Modern fiat currencies like the USD or the Euro are backed by a We Owe You of the whole monetary area. Put differently, these currencies represent a universal claim on the economy, not on specific firms or individuals. If the monetary area is set-up properly, risk-sharing and economies of scale will lower individual monitoring (and thus transaction) costs. The whole society is eventually backing the currency. Today's money can thus be described as a "special kind of IOU that is universally trusted" (Bank of England, 2014). As such, the evolution of money is a volatile process that tends to increase trust, enhance risk-sharing capabilities and exploit economies of scale. Today's result is a complex hierarchy of money (von der Becke and Sornette, 2017).

2.2 Double-entry bookkeeping at the heart of finance

Once debts have been recorded on ledgers such as wooden sticks, stone tablets, bark or hard drives, they could be traded and managed more easily (Lipton, 2017). A key invention in this regard

[9] Note that hundreds of regional currencies exist around the globe, with specific local trust mechanisms, typically supported by a regional government. However, they are almost exclusively pegged to the domestic fiat currency, and thus not really independent.

was double-entry bookkeeping, which deserves a closer look given its importance to understand blockchain's potential impact on finance, which is analysed in section 3.

The accounting technique of double-entry bookkeeping might appear trivial from today's perspective[10]. Every debit has a corresponding credit and vice versa. Yet, historically seen, it is, as Johann Wolfgang Goethe puts it, "one of the human spirit's most beautiful inventions" (Goethe (1796)[11]. It is thus no coincidence that commerce and investment banking flourished at the same time when bookkeeping spread across the world (Higgins, 2009). During the eleventh and twelfth century, Italian city-states such as Genoa, Florence, and Venice were the leading trade centers and accounting pioneers in Europe. It is likely that the Italians picked up their double entry accounting in Alexandria or another eastern city. One of the oldest double-entry system are the Massari accounts of the Republic of Genoa from 1340 (Lauwers and Willekens, 1994)).

In 1494, the "Summa de arithmetica, geometrica, proportioni et proportionata" (Review of arithmetic, geometry, and proportions) was published in Venice by Luca Pacioli, documenting in detail the Venecian accounting rules. The use of debit and credit is described to secure a double entry. Accounting knowledge then spread to London, Amsterdam and Germany. The main challenge has been to maintain trust in the ledgers by avoiding crime and fraud.

Today, money bookkeeping is very centralized relative to the number of users, with around 30 bank branches per 100'000 adults in the US. While banks hold those ledgers that record payments of individuals and firms, the central bank manages the central ledger that records payments between banks. Users have to trust the centralized ledger system to properly record and protect all entries. It is helpful to keep these facts in mind because (de-)centralization plays an important role in understanding crypto currencies (see section 3).

2.3 Money's role within a dynamic theory of capitalism

In order to understand the role of money and analyse crypto currencies, the foregoing static perspective - money being backed by debt, and recorded on ledgers - has to be complemented by a dynamic perspective. Such a dynamic perspective is one of the key elements of Schumpeter's theory of economic development where the creation of money "out of nothing" enables innovative entrepreneurship and thus economic development (Schumpeter, 1934)[12]. Schumpeter finds that existing financial savings are not sufficient to increase an economy's capacity utilization. [13]

Money creation by commercial banks via balance sheet extension is thus at the heart of capitalist economies. If (and only if) properly regulated, money is created for new investments in the real economy (rather than for boosting financial or real estate bubbles). In conventional neoclassical

[10] However, note that many macroeconomic models still introduce financial asset like money as if it was a single-entry bookkeeping operation.

[11] In the original novel Wilhelm Meisters Lehrjahre, Johann Wolfgang Goethe wrote: "Welche Vorteile gewaehrt die doppelte Buchhaltung dem Kaufmanne! Es ist eine der schoensten Erfindungen des menschlichen Geistes, und ein jeder Haushalter sollte sie in seiner Wirtschaft einfuehren." Translation from German conducted by the authors: "What an advantage double-entry accounting does offer to merchants! It is one of the most beautiful inventions of the human mind, and every manager should introduce it into his economy."

[12] See von der Becke and Sornette (2017a) for a more refined approach, where credit is typically backed by assets (and trust, as discussed before).

[13] Note that Schumpeter's theory is typically reduced to real economy mechanisms of creative destruction. However, his biggest, and from today's perspective probably most important contribution, might have been to combine credit creation and innovation (see Callegari (2018)).

models, investments depend on prior savings. In monetary economies, in contrast, investments financed by new credit enables others to save (Terzi, 2016 and Senner and Sornette, 2018)[14]. This approach to economics is inherent to different schools of thoughts, notably the Post-Keynesian: "This means that production is made possible by bank advances, while firms go into debt before attempting to recover monetary proceeds" (Lavoie, 2007). More recently, this perspective became also an integral part of the closely related Modern Monetary Circuit Theory (Lipton, 2016) and Modern Monetary Theory (MMT).

In line with this view, a functioning capitalist economy would have net indebted firms and net saving households. Indeed, after World War II, firms were typically net borrowers, households saved, and the government ran relatively small deficits or surpluses to smooth the business cycle. Since the 1980s, however, the financial asset distribution of capitalist economies fundamentally changed due to the "illusion of the perpetual money machine" (Cauwels and Sornette, 2014, Senner and Sornette, 2018): Firms reduced investment despite rising profits, and thus became increasingly net savers in countries like the US, Germany and in particular Japan. At the same time, the public (US and Japan) or foreign sector (Germany) was pushed into higher deficits. In addition, central bank money has been created in unprecedented amounts in various countries, reflecting the unwillingness of the private and public sector to invest, i.e. to borrow and create savings. One of the symptoms of such a "broken monetary circuit" is the deflationary pressure that can be observed among developed countries (see section 4 for a detailed discussion on price stability).

Before analyzing crypto currencies, it is worth combining the static (money as a WOU) and dynamic view (money within dynamic capitalism) to discuss value of fiat currrencies.

It is often argued that money is a social convention, where everyone, somehow, agreed that for example the USD is the preferred means of payment and not something else. The value of money thus reflected a collective believe or convention. "Money is a social convention - it has no intrinsic value which comes before its use; instead, its value is created by its constant exchange and use as money" (Weidmann, 2012). This suggests that, in principle, multiple equilibria with different currencies exist. While there is some truth to it, it is often overseen that, as discussed before, money is backed by a We Owe You, i.e. a debt certificate guaranteed by all citizens. In today's financial system there is an obvious countervalue for every unit of fiat money.[15]

Every Euro or Dollar is backed by some economic agent that owes this Euro or Dollar to her bank. If you have 100 Dollar on a checking account, there exists always some firm or private household that needs these 100 Dollar to pay back their debt. If you saved money on your bank account, you can be sure that there will always be enough firms or households that need the money you saved. Every Euro is backed by the debt of someone else. And that's the beauty: the debt note (the Euro) can be redeemed universally (within the currency area). Because fiat money is

[14] Note that the neoclassical model use real variables, and thus 'savings' refers to 'savings in capital goods or commodities'. You cannot grow another coconut palm if you do not save some of the existing coconuts. Such models might be useful for certain supply-side questions. In monetary economies, in contrast, savings typically refers to financial savings (cash, bonds etc.). On the macro level, these savings were preceded by investments, i.e. certain agents going in debt.

[15] This excludes literal "money printing", i.e. excess issuance of paper banknotes, called 'High Powered Money', by the central bank. In line with most developed economies, we are addressing the case where money in circulation is largely dominated by bank credit creation. Note that other operations like quantitative easing, foreign exchange interventions or asset purchases also create or destroy deposits (see section 3.3). However, these magnitudes are in general way smaller than deposit creation via loans (Source: Thomson Reuters Datastream and national data sources).

the preferred medium of financing, most debtors will be happy to accept it.

As such, taking a dynamic approach, money is a universal claim on *future* output, or future labour / natural resources more specifically. From this perspective, it is unclear why a claim on gold or commodities should be superior in the attempt to generate widespread adoption and trust. (Crypto) currencies backed by gold reflect only a specific claim on some *pre*-defined goods - in start contrast to Schumpeter's perspective, where money provides a claim on future output.

A claim on tomorrow's goods and services is the most universal one and, arguably, the most useful to match the needs of the future economy. It is thus most suited for large scale adoption. Money could be redeemed for Gold *or* commodities. Even more so, the creditor can, according to his preferences, decide and influence the types of goods and services that will be produced and created tomorrow. We will see later that, so far, crypto currencies do not provide similar utility and typically ignore the forward-looking role of today's money[16].

Having that said, trust in fiat currencies, and in particular banks and central banks, is not automatically very high. Financial crises are common, our current financial system is neither inclusive nor fair, and does not provide an optimal framework to foster growth and prosperity. Financial regulation and innovation has to be updated continuously.

Indeed, the universality of today's money comes along with a fundamental asymmetry that continuously threatens stability if not properly regulated: While debt has a specific date at which it has to be paid back, money has no date at which it must be spent for consumption or investment[17].

Within a properly regulated framework, fiat money could function to foster real growth. However, in today's system money is concentrated in the hands of a few, putting debtors under stress. Put differently, because the top 1% of the rich and some multinational corporations are unwilling to spend their profits, debtors have to borrow more, dis-save or work more and more to repay their debt. At the same time, investment in the real economy is flat (Mazzucato, 2018). The capitalist snake is biting its own tail. These distributional aspects are arguably one of the most important challenges of today's financial system. Yet, as we will see in the next section, crypto theories completely bypass such an analysis of the monetary circuit, and, instead, resurrect ideas about a dichotomy between money and the economy.

Before discussing crypto currencies, it appears useful to quickly look at the textbook definition of money. The latter does typically not follow the historical and technical perspective outlined above, i.e. it does not emphasize money creation (via WOUs) and money recordings (on ledgers). In textbooks, money is defined by three functions: a medium of exchange, a storage of value and

[16] A common claim in the crypto community is that fiat money is not trustworthy. If, indeed, the politcal and regulatory framework could no longer provide incentives to pay taxes or repay debt, then today's money could become worthless. But, in such a scenario, it is questionable whether the gold in the vaults etc., backing a (crypto) currency, would still be save. Similarly, high inflation rates can also undermine fiat currencies. But, until today, crypto currencies offer no superior solution to price stability, as we will see later in this section.

[17] Note, however, that this asymmetry is more complex than, for example, suggested by the following proverb: "If you owe the bank a thousand dollars, the bank owns you. If you owe the bank a hundred million dollars, you own the bank". In particular, military and economic power have to be taken into account. Recall how the UK first indebted Egyt, then brought Egypt's finances under control of the 'Commission de la Dette Publique Égyptienne' in 1879 and finally occupied Egypt with its military in 1882 (Luxemburg, 1913). More recently, the Troika, which dominated EU politics, was used to relabel European's private debt crises into a so-called sovereign debt crisis, forcing governments to pay back high-risk private bank credit. In the case of Ireland, for example, no military was needed to convince the government to do a USD 80 billion bailout, because the monetary authority (ECB) threatened to cut liquidity. In September 2008, German banks had interbank exposures in Ireland of around Euro 135 billion (see www.irishtimes.com/news/politics/how-much-european-particularly-german-money-was-in-the-irish-economy-when-the-music-stopped). In this example, the banks owned the debtors, contradicting the proverb's prediction.

a unit of account. But where do these functions come from?

From the historical perspective, the intrinsic demand for money (to pay debt or taxes) supports its storage of value. Price stability, which is vital to serve as unit of account, will be discussed in section 3. What about the medium of exchange? Innovative bookkeeping lowers transaction fees so that money becomes a convenient medium of exchange. Yet, money should not be seen as a more efficient way of transporting gold or seashells back and forth. Instead, transfer of money is nothing but a transfer of obligations.

Those three key properties are widely accepted and intuitive. The key question is whether these properties can arise from a different monetary set-up than the one we have now. Gold, for example, mainly classifies as a storage of value, but its use as medium of exchange and unit of account is much less pronounced. Similarly, for some market participants, repos or stocks are relatively liquid and can be used as medium of exchange and storage of value, while the unit of account is still a fiat currency like the Euro or USD. It is easy to come up with a variety of assets that define one or two of the functions of money - but never all three. In order to replace fiat money, crypto currencies need to enable the three main function of fiat money. What are the functions that crypto currencies bring? Does blockchain enable a new setup that achieves all three functions of money?

3 Monetary Theories behind crypto currencies: In search for stablecoins

In this section, we will introduce the key principles of crypto currencies. We will analyse whether the design of existing ones is suitable for large-scale adoption and, in particular, analyse the proposed mechanisms to generate price stability. [18] In other words, we will analyse the implicit monetary theories behind crypto currencies. In the crypto community, price stability typically refers to being stable vis-*à*-vis the USD or some other fiat currency. However, this pegging seems to defeat the very purpose of crypto currencies to provide an independent or alternative medium of exchange and store of value, precisely when trust in legal tenders could be faltering. Therefore, we argue that it is of particular value and relevance to also analyse those crypto currencies that plan to achieve price stability vis-*à*-vis a CPI (Consumer Price Index) or GDP (Gross Domestic Product) Deflator.

3.1 Fixed supply coins: speculative and deflationary

The media often focus on extraordinary price increases of crypto currencies like bitcoin, distracting from the core innovation called blockchain. Blockchain technology is a decentralized ledger (bookkeeping) system that combines cryptography, the internet and large data storage. The system is maximally distributed or de-centralized in the sense that every participant holds a copy of the

[18] We will see that in the context of most stablecoins, price stability means that the exchange rate between coins and US Dollars is constant, i.e. those stablecoins are pegged to fiat money. Other stablecoins, in contrast, try to peg their value to a basket of consumer goods. In this case, price stability means that one chocolate bar or one unit of the consumer basket always costs the same amount of crypto coins.

ledger - instead of having one or few centralized institutions that manage ledgers[19]. In the case of crypto currencies, this distributed database records flows and stocks of so-called crypto coins.

Why is blockchain particularly interesting when it comes to money? In the analogous world, there is no double-spent problem, i.e. it is trivial to ensure that only one agent receives an asset. If physical assets like gold coins are transferred, it is clear that the same gold coin cannot be spent twice. In the digital world, this is potentially different because it is possible to copy millions of lines of code quickly and cheaply. Until recently, for large areas of the Internet 1.0, it has not been important to ensure exclusive transfer. If you receive an email, you do not mind if the sender keeps a digital copy of the email or not. It is totally fine to receive a copy of the original code as long as it is the identical code. The double spent problem occurs once supposedly unique digital assets are to be transfered. In the case of blockchain, technological advances from cryptography aim at ensuring a safe peer-to-peer (P2P) exchange of different digital assets. The idea is that no banks, clearing institutions or other intermediaries are needed to execute the payment process.

How do participants in the network agree on a change in the ledger? Modifying the ledger has to be so costly that an individual user cannot do it. In the case of bitcoin, changes are accepted via "proof of work", which means that so-called miners solve a complex problem that requires a lot of computational power, and thereby validate a transaction. In principle, no single miner has sufficient computational power to modify the ledger to her benefits[20]. Miners validate transactions by adding new data blocks to the existing chain, which contains all past transfers. Miners are rewarded for their service to the bitcoin ecosystem by receiving newly created bitcoins.

It is typically argued that the proof of work is the collective cost to pay for establishing trust in the system. However, such a mining process does not appear suitable for large-scale adoption because it uses large amounts of energy and is decoupled from real economic activity. Ongoing research tries to replace the "proof of work" with new algorithms such as proof of stake or with memory-hard problems instead of CPU-hard problems. Ethereum, for example, plans to switch from proof of work to a new consensus algorithm[21].

In any case, for the purpose of this paper, we are more interested in the monetary properties of such crypto currencies[22]. For simplicity, we therefore assume that that 'proof of work' or 'proof of stake' works well and is able to ensure trust in the digital payment or transfer system. Given trust along this dimension, what makes market participants trust in the digital token itself? Although closely interdependent, a secure transfer system does not automatically guarantee trust in the value of a coin. For example, you might well trust the US Dollar, but you might not trust some new online payment provider to securely transfer your money. If, on the other hand, the Swiss government and the pope himself would guarantee for a new transfer system for the Venezuelan

[19] The use of decentralized ledgers might have a wide range of applications. Many financial assets such as bonds, stocks or repos, are already recorded in digital ledgers, and it is argued that they could potentially be transformed to distributed ledger systems. In addition, distributed ledgers are claimed to add value to the organization of property rights of land or intellectual property rights like music. However, every particular use case requires careful analysis because all too often blockchain is falsely seen as a wonder tool. As we will see, this is also the case when it comes to stablecoins.

[20] In reality, however, bitcoin mining became relatively concentrated so that the largest bitcoin mining companies could cooperate and attack the network.

[21] see ethereum.org/ether.

[22] As such, we also skip much of the important issues of how crypto currencies are dealt with in real life. Just a word of caution. Over the last years, many of the advocated benefits of crypto currencies have been turned upside down: most crypos are exchanged via a few *centralized* exchanges, mining is dominated by a few companies, many exchanges offer *credit* leverage, fixed supply coins are inherently *exclusive* and not participative, and so on.

bolívar, it is questionable that many people would adopt this highly inflationary currency.

In principle, every individual could issue its own bitcoin-like crypto currency within minutes. Technically, Bitcoin is easy to reproduce. However, bitcoin has a crucial competitive advantage from being the first-mover crypto currency. In addition, its fixed supply of coins ensures that any increase in demand is reflected by rising prices, making it an attractive speculative asset. Yet, despite these advantages, bitcoin has no countervalue in the traditional sense: It is not a debt or equity certificate, neither can bitcoins be exchanged for a commodity. Note that this design is in stark contrast to the fact that money has historically always been (implicitly) backed by some kind of social debt.

Indeed, the theoretical foundations of crypto currencies typically over-emphasize the transaction property of money, often referring to Kocherlakota (1996), where money is seen as a memory. This reflects the communities' focus on static recording on ledgers, emphasizing past transactions, and the security of those past records. This perspective, however, lacks the dynamic perspective on monetary theory that we have emphasized in the previous section. Fiat money is forward-looking, a claim on future output. Indeed, we have seen that a WOU is the optimal backing for money in the sense that it is most universal. From a value perspective, therefore, we can already conclude that bitcoin and similar cryptos are not money. Below, we will analyse more recent cryptos that try to generate value by being backed by different assets. For now, we leave the value perspective aside and discuss fixed supply schemes of crypto currencies.

While it is not an inherent feature of digital currencies per se, most prominent crypto currencies today do have a relatively fixed supply, which is in stark contrast to our current monetary system. We argue that, as a consequence, they will fail to replace today's fiat currencies[23]. Historically, commodity money has not been very successful due to its inelastic supply as well as its disconnection from real economy growth: "New forms of bank money brought a liberating, timely and essential extension to overcome the debilitating constraints of the metallic money supply" (Davies, 2002).

To illustrate this point, let us consider an example from the 18th century. Sea trade between European countries and over-sea colonies increased a lot. London and Amsterdam were the financial centres. In other European harbours, however, access to finance has been limited. Because banks were not able to supply sufficient liquidity, merchants used so-called bill of exchange to finance and pay trading activities. A complex system of trust, non-governmental judges and endorsement was used to make the bill of exchange the number one means of finance and payment for merchants (Santarosa, 2010). However, default, fraud and other risks were common, so that the bill of exchange disappeared as soon as trustworthier, regulated banks spread across the globe. This example illustrates that a large-scale fixed-supply currency will not emerge endogenously. Moreover, if one would try to impose a fixed-supply currency like bitcoin on a large scale, private sector entities would always find (sub-optimal) ways to generate additional liquidity necessary to increase economic activity.

Let us briefly examine another historical example from monetary history that is used by some

[23] The fixed supply of coins, and its tendency for deflation, is sometimes perceived as an advantage compared to fiat currencies: "We can't sit around waiting for a financial crises or a massive inflation in fiat currencies to help bitcoin take off." see www.coindesk.com/fiat-wallets-the-key-to-bitcoin-going-mainstream. This one-sided perspective ignores the threats of economic stagnation.

crypto proponents[24]. Jenssen (2014) argues that the Swiss Dinar, a fixed supply currency used in northern Iraq from 1992-2003, is an example of a stable currency without any (government) backing. However, such analysis typically lacks a holistic macroeconomic perspective. In the case of the Swiss Dinar, it is ignored that Northern Iraq participated in the United Nations food-for-oil program, which replaced part of domestic output. In addition, the US Dollar was widely used, as for example teachers were paid in USD. Not surprisingly, local authorities identified the appreciation of the Swiss Dinar as a big problem, not a great feature. Clearly, the excessively printed new Dinars, which were used in the rest of the country, led to hyperinflation and were also far from optimal[25]. While a detailed discussion lies beyond the scope of this article, it became clear that the case of the Swiss Dinar, as well as many other historical examples, are all too often exploited ideologically with the premise to support cryptos.

More generally, as already discussed in section 1, capitalist economies need new financial liquidity prior to real production. Any currency linked to past output or production is not compatible with a dynamic capitalism. Schumpeter vividly captured this concept, characterising the gold standard as a "golden brake on the credit machine" (Schumpeter, 1927)[26]. However, note that, while Bitcoin and similar crypto currencies cannot replace fiat currencies, they should be seen as a new speculative asset class. Bitcoin could become the preferred digital store of value, similar to gold in the physical world[27]. As a consequence, it remains to be seen whether Bitcoin is the first truly global speculative bubble, or whether it will be the future digital gold.

The assessment that coins with fixed supply are not money is shared amongst increasing parts of the blockchain community: "Ether is to be treated as "crypto-fuel", a token whose purpose is to pay for computation, and is not intended to be used as or considered a currency or asset"[28]. The issuance of ether is currently capped at 18 million a year. Needless to say that such rules have yet little in common with those needed for a crypto currency that could challenge today's fiat currency. Along these lines, the US Internal Revenue Service (IRS) ruled bitcoin not to be money but to be an asset (and therefore capital gains are subject to taxes)[29].

After bitcoin, hundreds of new coins emerged, and some of them are called stablecoins. In the next subsection we will discuss these flexible-supply coins in more detail.

3.2 Classifying stablecoins

In the previous section, we have seen that a flexible amount of coins is a necessary condition for price stability and economic growth. This section will show that coin growth per se is not sufficient to ensure price stability, and that there is no trivial relationship between money growth and prices - contrasting monetarist theories.

The volatility of bitcoin has led to a search for stablecoins. Stablecoins are crypto coins that

[24] See for example medium.com/@FedericoTenga/bitcoin-and-the-return-of-trustless-money, accessed March 2018.
[25] A detailed analysis of Swiss versus new Dinar lies beyond the scope of this article, but it might be the case that the deflationary Swiss Dinar was less harmful than the hyperinflationary new Dinar. Yet, such pepsi-cola comparison leads nowhere, if we already know that other beverages like water (USD or Euro) perform much better.
[26] Note that Schumpeter also acknowledges the good housekeeping character of gold-based money. In countries where excessive public money printing is the norm rather than the exception, a gold standard, although not the first best solution, might be a feasible intermediary solution to improve financial stability.
[27] It is very difficult to judge its technical feasibility in detail.
[28] see ethereum.org/ether, accessed November 2017
[29] see CNBC article cnbc.com/2017/11/30/bitcoin-investors-beware-the-irs-wants-its-cut-and-you-may-not-know-it, accessed December 2017.

seek to keep a stable price measured in US Dollar, Euros or baskets of goods or commodities. How do crypto currencies after bitcoin try to find the holy grail, i.e. price stable tokens that will gain widespread acceptance? We start by classifying existing proposals for stablecoins, see Table 1[30].

Note that we focus on a small subset of all crypto currencies. In particular, we are not interested in any micro-industry utility coins that might be used for energy pro-sumers or intellectual property rights. Moreover, we do not discuss commodity-backed crypto currencies. Given our foregoing analysis, the latter are clearly not suitable to replace fiat currencies. However, such utility and commodity-backed coins might have their use cases in certain areas of the economy[31].

Coin	**Pegged to**	**Type**	**Quantity adjustment**
Dai Havven Alchemint Fragments BitUSD BitCNY	USD USD USD USD USD Remninbi	Crypto-backed	Issuance of new coin worth $1 in exchange for crypto assets worth more than $1 (over-collateralized). Exception: Fragments is under-collateralized.
USDT TrueUSD Stably Saga Arccy	USD USD USD currency basket currency basket & fixed income	Fiat-backed	Creation of new coin with face value $1 in exchange for $1 (or 1 unit of the currency basket).
Basecoin Carbon Kowala	USD/ CPI USD USD	Uncollateralized	Distribution of new coins to bondholders, destruction via bond sales (Basecoin, Carbon). Variable fees and mining rewards (Kowala).

Tab. 1: Classification of Stablecoins

We differentiate stablecoins by whether they use collateral or not. Those that are backed by collateral use either crypto currencies or fiat currencies (Table 1). In the following we will describe different stablecoins and analyse their underlying monetary theories.

3.2.1 Stablecoins collaterized by other crypto currencies

- The Dai Stablecoin, created by MakerDAO, is a collateral-backed cryptocurrency that is pegged to the USD and uses the Ethereum platform[32]. Different crypto assets back the coin and are supposed to prevent a price collapse. More specifically, the coin is over-collateralized. This means that you would have to deposit Ether worth USD 150 to get newly created Dai worth USD 100. Once you exchange Dai back into Ether, Dai is destroyed[33].

[30] We use publicly available information for this classification. However, since cryptocurrencies are largely unregulated, we cannot know with certainty whether some stablecoins are, for example, actually backed by US Dollar as indicated in the white papers.

[31] We will see below that commodity prices are very important when it comes to price stability and a resilient global financial system. As such, a global reserve currency that complements fiat, and potentially uses a large pool of commodities to smooth prices, is an important line of research. See Hardjono et al (2018) for recent work in this direction.

[32] See white paper accessed December 2017, makerdao.com

[33] See also coindesk.com/makerdao-quest-stable-stablecoin-continues and prestonbyrne.com/2017/12/10/stablecoins-are-doomed-to-fail.

- Similarly, BitUSD aims to be able to keep a peg to the USD, or, in the future, any other asset[34]. BitUSD is 200% collateralized with BitShares, a fixed supply crypto currency. If BitShares fall by 25% vis-à-vis the USD, BitUSD would still be overcollateralized with 150%[35].

- In the same way, BitCNY is pegged to the renminbi and also overcollateralized by BitShares.

- More recently, Havven network has created a stablecoin[36]. The token used in this network is again pegged to the USD and over-collateralized by a factor of five with other crypto currencies like Bitcoin or Ether. In addition, transaction fees are used to support the pool of collateral.

- Alchemint is yet another crypto currency that is pegged to the USD and over-collateralized with NEO. NEO is a fixed supply crypto currency, where currently 65 million out of a maximum of 100 million have been created[37].

- In contrast to these over-collateralized stablecoins, Fragments is only fractionally backed with Ethereum[38]. What is the idea behind Fragments? In the past, you might have purchased 1 BTC (Bitcoin) for USD 1 and now you have 1 BTC that is worth USD 8000. In order to create a crypto currency that is fixed to the USD, the number of coins would have to be modified. Fragments proposes that, instead of having 1 BTC worth USD 8000, you would automatically get 7999 more coins so that each coin is worth 1 USD. Put differently, the number of Fragments in everyone's crypto wallet will adjust automatically, so that 1 Fragment is always equal to 1 USD. Today you might have 100 Fragments, tomorrow 110 and the day after tomorrow 90 Fragments, without having conducted a single transaction. If the demand for Fragments falls, you can still be sure that 1 Fragment is equal to 1 USD, but the number of fragments in your wallets might shrink dramatically.

Summing up these crypto-backed stablecoins, it is clear that they all face the same problem, namely large price fluctuations of the underlying crypto assets. If the USD value of the collateral crypto currencies collapses, so does the "stablecoin". Is 100%, 200% or 2000% collateral enough? The history of pegs in foreign exchange markets, as well as the more recent evidence on price fluctuations of Ether, Bitcoin and others (Gerlach et al., 2018; Wheatley et al. 2018), indicates clearly that the design of crypto-backed stablecoins is flawed. Rephrasing the problem as done by Fragments does not help either. Fragments is re-naming or re-normalizing the coins in your wallet, but the USD-value of your basket will still fluctuate heavily. These coins add one level of complexity, and thereby potentially distract from the problems of the underlying crypto collateral. As such, they are not based on a coherent monetary theory, in particular with respect to value, and cannot challenge fiat currencies per se.

[34] See steemit.com/bitshares/@xeroc/what-makes-the-bitusd-than-nubits, accessed March 2018
[35] See coindesk.com/makerdao-quest-stable-stablecoin-continues
[36] See white paper version 0.7 havven.io
[37] See neonewstoday.com/general/alchemint-releases-whitepaper-announces-sdusd-tokens and icomarket-data.com/ico/alchemint
[38] See fragments.org accessed March 2018.

3.2.2 Stablecoins collaterized by fiat currencies

The second category consists of stablecoins that are backed by fiat currencies. Therefore, a centralized institution is needed to manage the fiat currencies - which is not necessary in the case of crypto backed stablecoins.

- The most traded stablecoin is USDT (Dollar tether), which claims to be fully backed by the US Dollar and is used by many crypto currency exchanges to quickly deposit and withdraw Dollar[39]. USDT is therefore an IOU (I Owe You USD) issued by a central authority. Users have to trust the authority to indeed hold one USD for every USDT.
- Similarly, TrueUSD claims to be 100% backed with US Dollar[40].
- Stably is yet another stablecoin that is begged to and is 100% collateralized with US Dollar[41].
- Saga is a cryptocurrency that tries to become a global reserve currency. Saga is backed by a basket of fiat currencies, using the weights that are used for the IMF's special drawing rights[42]. As of 2016, the respective weights of the US dollar, euro, Chinese renminbi, Japanese yen, and British pound sterling are 41.73 percent, 30.93 percent, 10.92 percent, 8.33 percent, and 8.09 percent[43].
- Similarly, Arccy is pegged to a basket of different currencies[44]. Moreover, the coin is backed by fixed income assets and currencies, which are held by a central entity.

Summing up, fiat-backed crypto currencies might provide some benefits like anonymity. At the same time, counter-party risk might stay high without appropriate regulation. From a monetary perspective, these types of stablecoins are not independent currencies, but free-ride on the existing financial ecosytem of, for example, the US Dollar. However, similar to many regional currencies, such coins can be valuable, for instance to enhance the feeling of belonging and exchange within communities, as witnessed by dozens of regional currencies globally. Needless to say, they will not be able to, and not necessarily aim at replacing fiat currencies - the question we are mostly concerned with here.

3.2.3 Stablecoins without collateral

The third category of stablecoins does not use crypto assets or fiat currencies to back new coins. Instead, the amount of coins is dynamically adjusted via the purchase or sales of special bonds. More specifically, new coins are issued to bond holders if the price of US Dollars or chocolate bars, measured in units of coins, falls. Similarly, if the price of the pegged asset rises, new bonds are auctioned to collect and destroy existing coins.

[39] USDT is number 4 after Bitcoin, Ripple and Ethereum in terms of trading volume. See www.coindesk.com/makerdao-quest-stable-stablecoin-continues.
[40] See truecoin.com, accessed March 2018.
[41] See white paper v2 February 9, 2018, stably.io
[42] See www.ft.com, accessed April 2018.
[43] Source: www.imf.org
[44] See www.arccy.org

- Carbon is pegged to the US Dollar but can supposedly be pegged to a consumer price index later on[45]. When a contraction of Carbon Coins is needed, market participants can buy Carbon Credits with their Carbon Coins, thereby destroying the latter. Market participants might want to buy these Credits in times of inflation (the price of US Dollar or consumer goods measured in Carbon Coins goes up) because in the future, once deflation occurs, new coins are issued to those Credit holders. It is unclear, however, which mechanism might convince users today, in times of collapsing demand, to believe that in the future demand will skyrocket again. Concerning price stability, the design of Carbon supposes that a controlling the quantity of coins (quantity control) can achieve stable prices. If an expansion is needed, new coins are distributed to Carbon Credit holders. If a contraction is desired, Carbon Credit auctions collect existing coins.

- Along these lines, Kowala is based on the premise that prices vis-à-vis the USD can be stabilized by controlling the number of coins[46]. The design has a variable fee mechanism for miners: If more (less) coins are needed, miners will get more (less) coins. In addition, a variable fee to coin holders can be used to reduce coins.

- The most prominent stablecoin might be Basecoin (Al-Naji et al., 2017)[47],[48]. Once again, the authors' pricing algorithm is based on the idea that whenever the price of an asset measured in coins does not rise fast enough, the amount of coins has to be increased. If, in turn, prices denominated in basecoin rise too fast, the amount of coins will be decreased. The white paper explicitly talks about long-term prospects to replace fiat currencies. The authors want to peg basecoin to a basket of goods and maintain price stability by controlling the number of coins[49]. How are new coins created? Similar to Carbon, new coins are issued "to holders of Base Bonds and Base Shares" (ibid), and coins are destroyed via Bond auctioning.

- Finally, Ametrano (2016) proposes a new crypto currency design that aims at generating price stability. The number of coins in every individual wallet would be automatically increased or decreased, so that the CPI or the price of a certain basket of commodities would remain stable. A basket with one coin could be altered to 10 or lowered to 0.5 coins in the next period, depending on the evolution of prices. One coin would always be worth one chocolate bar or one unit of a consumer basket. The price of the chocolate bar does not change, but the amount of coins held by users does adjust. Note that this is similar to Fragments, where the number of coins in existing wallets are automatically adjusted. Nevertheless, if demand for such a coin collapses, for whatever reason (maybe because it is not backed by anything), the amount of coins in your basket will collapse, and so will your wealth.

[45] See www.carbon.money

[46] See white paper v.10 www.kowala.tech

[47] See whitepaper called "Basecoin: A Robust, Price-Stable Cryptocurrency with an Algorithmic Central Bank" Version 0.99.1 (October 13, 2017) basecoin.com

[48] Basecoin is supported by well-known investors like Pantera Capital and Horowitz. Every few weeks another proposal for a stablecoin comes up. However, we included only those with an official homepage, a white paper and some media coverage. Augmint, for example, is a new coin where little information can be found. It appears that new coins are created via collateralized loans, but the mechanism could not be found.

[49] In addition, the authors argue that the quantity of coins could be used as an instrument to influence exchange rates to other coins or fiat currencies.

3.2.4 First criticisms

Crypto currencies that eventually want to replace fiat currencies appear to resurrect outdated economic theories. Production of goods or commodities is implicitly assumed to be independent of the crypto currency. As such, the underlying theory is a revival of the dichotomy of money, where money and economic production are assumed to be independent. If the output of chocolate bars doubles, more coins have to be created and are automatically given to wallet holders. How chocolate bars are produced, and whether production needs credit (and thus money) is not discussed.

Similarly, bond auctioning mechanisms are flawed and did not learn from recent experience with Quantitative Easing. The latter is a monetary policy that was implemented in an attempt to increase consumer prices by purchasing assets from only one particular sector. However, QE was not overly effective because it did not channel new liquidity to ordinary people, who would have a high propensity to consume. The design of Carbon and Basecoin is similarly flawed, where only a certain group of bond holders get new coins, without any incentives to actually spend them.

Bond auctioning mechanisms may have been inspired by open market operations of central banks. However, the flaw of the approach is well summarised by the following quote: "the most pervasive and ingrained misconception in this regard is the proposition that monetary policy implementation revolves primarily around the control over quantity aggregates" (Disyatat, 2008).

Indeed, as we have seen, stablecoins focus on controlling the quantity of coins. In economic theory, such ideas are known under the quantity theory of money, to which the authors of Basecoin explicitly refer: "Expanding and contracting the money supply works because the Quantity Theory of Money states that long-run prices in an economy are proportional to the total supply of money in circulation" (Al-Naji et al., 2017).

Given that the quantity theory of money, and the equation of exchange is so central to existing crypto currency designs, we will devote the next subsection to analyzing the traditional quantity theory of money, before discussing crypto-monetarism in more detail.

3.3 Why conventional monetarism failed

We will quickly review conventional monetarism, before discussing why the novel, slightly different 'crypto-monetarism' will also fail. Historically, Milton Friedman has been one of the most popular proponents of monetarism. His following citation sums it up: "Inflation is always and everywhere a monetary phenomenon in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output" (Friedman, 1970). With Friedman, the quantity theory of money quickly gained widespread acceptance.

The argument can be expressed by the simple set-up, which follows Fisher (1911), in the form of the equation of exchange

$$M \cdot V = P \cdot T \ , \tag{1}$$

where M is the amount of deposits, V the velocity of circulation of these deposits, P the price level and T reflects all economic transactions. Clearly, the identity as such does not imply any causal relationship. In its simplest form, monetarism assumes that the amount of money M is controlled by the central bank. Moreover, the velocity of money is assumed to be constant, and

real economic activity is typically assumed to depend on non-monetary factors like productivity, labour force participation and so on (reflecting a "neutrality of money"). As a consequence, the price level could be controlled via the amount of money.

While it is tempting to mechanically associate the amount of money with the price level in the economy, such ideas are theoretically and empirically problematic, as we now show.

Before discussing the theoretical shortcomings of the assumptions associated with expression (1), let us briefly look at the empirics. Until the beginning of the 20th century, economists paid careful attention on how to measure the equation of exchange, developing different indices for each variable. Essars (1895), for example, calculates the velocity of money using data from banks' clearing system. After World War II, however, the velocity of money has been rarely estimated, but rather taken as the residual. Moreover, economic transactions were almost exclusively measured using GDP. The quantity of money was typically estimated using statistics published by central banks, in particular M1 or M2. Using these proxies, economists estimated a relatively stable velocity of money, see for example Schwartz (1973), paving the way for widespread adoption of monetarism. Soon, however, empirical studies found varying velocities. Explaining these variations led to a huge body of literature including articles like "The case of the missing money" (Goldfeld, 1976), a title that speaks for itself. Indeed, economists struggled to explain these variations. More recently, using the conventional estimation approach just described, De Grauwe and Polan (2005) analysed cross-sectional data, i.e. 160 countries over the last 30 years, and found only a weak relationship between inflation and money growth once high-inflation countries are excluded.

The inability to measure a stable relationship between monetary aggregates and inflation caused central banks around the world to no longer target monetary aggregates. In the United States, for example, the target growth rate for M1 was officially dropped in 1987. Much work has been devoted to measuring monetary aggregates differently and to explaining variations in the velocity of money[50]. Yet, these attempts have not provided conclusive answers. Along these lines, Mankiw and Reis (2017) recently summarized the state of the art and explained why monetary targeting is not a good strategy: "The economy is subject to many types of shocks, such as oil price changes, financial crises, and shifting animal spirits of investors". Put differently, targeting M is supposed to be a bad idea because the velocity of money is unstable, and because real GDP is unpredictable.

While the just mentioned economic shocks clearly matter, Mankiw and Reis (2017) fail to mention why other economists have been rejecting the theory for over a century now. The main criticism of monetarism is that M is not exogenous because, as we have seen in section 1, the central bank does not control the amount of money mechanically[51]. In other words, M in the equation of exchange is endogenous and cannot be separated from output (the so-called reverse-causation argument). Output and money might rise due to entrepreneur's borrowing for productive investments, or prices might rise due to money printing in supply-constraint economies. Or, if new money is directed towards non-GDP transactions and does not boost actual output via productive investments, consumer prices might not be affected, but asset prices might rise.

Let us illustrate the relevance of this critique with an example. Figure 1 plots the change in

[50] To explain variations in the velocity, variables like interest rates, measures for uncertainty, income, wealth and others are used.

[51] The central bank could in principle exercise more control over monetary aggregates by introducing helicopter money or even cash-less central bank accounts with flexible (negative or positive) interest rates for all citizens.

M1 against consumer price inflation in Iceland from 1961 to 2012.

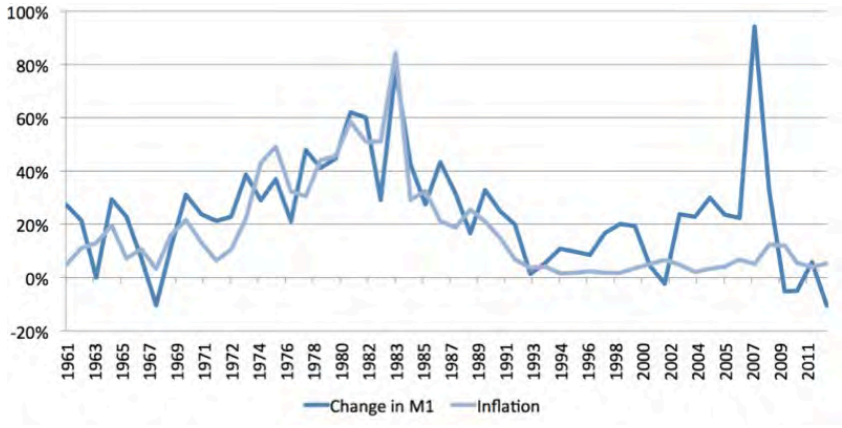

Fig. 1: Changes in M1 and price level in Iceland, 1961-2012. Source: Central Bank of Iceland, Statistics Iceland, Datamarket, reprint from Sigurjonsson (2015)

Until 1994, the relationship between money growth and prices is roughly in line with Friedman's theory[52]. In 1994, Iceland joined the European Economic Area and liberated its financial sector extensively. "By April 2008, loans to investment-related companies accounted for 46% of the loan portfolios of the three largest banks" (Sigurjonsson, 2015). Put differently, new money has been created in the process of lending to financial firms, and did not enter the real economy. Instead, the newly created money stayed within the financial circuit, affecting asset prices. Consumer prices or the GDP deflator, in turn, were largely unaffected by this increase in M1.

Motivated by this example, a modified version of the quantity theory of money looks as follows (see also Corsi and Sornette (2014) for the related concept of the "financial accelerator")

$$M_{real} \cdot V_{real} + M_{speculative} \cdot V_{speculative} = P \cdot T \ , \tag{2}$$

where T reflects all transactions, not only GDP-related ones. Taking non-GDP transactions into account can improve the estimation of the velocity of money. Indeed, the velocity of money is found to be relatively stable in Japan once the housing sector is taken into account (Werner, 1997), because borrowing money to buy existing houses does not affect GDP.

Summing up, while credit is endogenous, policies could try to foster productive credit and reduce speculative credit. Indeed, so-called window guidance might increase financial stability, as conducted in Japan after WWII, where broad guidelines for credit volumes per sector were defined by the central bank.

However, firms or households cannot and should not be forced to borrow and, as a consequence, no mechanical control over the amount of money exists. Even if credit would be controlled more precisely, monetary aggregates vary due to a variety of factors, not only credit creation. Foreign exchange transactions between currency areas, central banks' asset purchases from non-financial actors and banks' purchases of assets affect the amount of deposits. More recently, shadow banking

[52] Note that the price increases until the mid-1980s and in the 1990s are in line with the theory that will be presented in section 4: in the 1970s and 1990s a combination of wage increases and fiscal expansion caused price rises.

became an important factor in, for example, replacing deposits on banks' balance sheets (Michell, 2016). As such, finding the right measure for money is increasingly challenging[53].

Against this backdrop, it is evident that monetary targeting is not a useful policy instrument in today's financial system. Yet, as we have seen, the design of stablecoins tries to use quantity control as a way to create price stability. In the next subsection, we will have a closer look at crypto-monetarism.

3.4 Why Crypto-Monetarism will fail

We define crypto-monetarism as the idea that algorithmic control over the quantity of coins can stabilize prices. Note that, in contrast to today's fiat system, the stablecoins discussed before *do* have a mechanical quantity control. The question is thus whether monetarism will see a revival with such crypto approaches that mechanically determine the amount of money.

In order to answer this question, we can first of all show the macroeconomic similarity of such crypto approaches to a number of 'non-crypto' reform proposals. Indeed, crypto-monetarism has much in common with full reserve banking and positive money (see Fisher (1936) and the literature thereafter, in particular Benes and Kumhof (2012)).

In short, these proposals want to prevent banks from creating deposits and, instead, propose that the central bank somehow controls the amount of money, while banks remain pure intermediaries.

Moreover, designs where new coins are distributed proportionally to every wallet holder resemble 'helicopter money' or 'QE for people'. In the latter approaches, the central bank does directly credit money on (central) bank accounts of individual citizens[54].

More recently, the term central bank digital currency (CBDC) became popular and describes the idea that citizens can hold deposit accounts directly with the central bank. Such CBDC is, for example, supposed to avoid bank runs, and a variety of designs are discussed. It is often argued that, if people hold only CBDC and no cash, negative interest rates could be implemented more effectively so that monetary policy would be successful to encourage consumption and eventually economic growth. As such, the discussion about negative interest rates or automated taxation connects to crypto designs where the amount of coins in one's wallet is automatically reduced.

Finally, crypto-monetarism is related to the discussion about basic income, where fixed amounts of money are distributed to all citizens, potentially again via CBDC.

We contend that blockchain technology does not magically allow to avoid discussing the macroeconomic effects of stablecoins' design. In principle, many different coin creation and destruction mechanisms are possible, not just the bond-issuance or flat distribution discussed above. The question is whether such designs can generate price stability and, more generally, replace today's fiat money.

Some of the non-crypto proposals just mentioned might be used to complement the existing system. Helicopter money, for example, might be a good short-term measure in times of deflationary pressures and reluctance for fiscal spending (Bützer, 2017). Indeed, given the high propensity

[53] While monetary management is not suited to control prices, it is helpful to increase financial resilience. Regulators, policy makers and economists should pay careful attention to the dynamics of balance sheets in the economy.

[54] An analogous term has already been used in the crypto community: crypto airdrops, see venturebeat.com/2017/09/06/the-latest-crypto-pr-craze-airdropping-free-coins-into-your-wallet/

to consume of lower and middle income groups, prices can be stimulated via the demand-pull effect.

However, these reform proposals are not suited to fully replace today's credit-based system. We share the concerns of Fontana and Sawyer (2016) who argue that such proposals take "little consideration for the financing needs of capitalist economies" and "lead to a de facto dominance of monetary policy and unelected central bankers over fiscal policy and democratic decision making."

In this context, and given our review of today's monetary system in section two, we want to highlight two points.

First, many of the above mentioned proposals, including crypto-monetarism, suffers from an analysis of the monetary circuit. Put simply, monetary circuit analysis helps understand the issuance and destruction, as well as the dynamics of monetary stocks and flows in the economy. Current crypto proposals allocate new coins to a particular group or to all wallet holders. This is fundamentally different from today's system, where new money flows mainly to households, via mortgages, and businesses. Changing this allocation of money requires careful analysis of its consequences. First, how will the sector behave that suddenly receives more money then before? Second, how will the sector behave that does no longer have the same access to new money?

Regarding the first question, let us consider a very simple hypothetical example: what happens if all wallet holders get new coins due to falling consumer prices? The fraction of the population with a high propensity to consume will spend money. Firms might rise prices because increasing production might take some time. A substantial amount of new coins will therefore stay with rich individuals, or flow to (typically oligopolistic) firms. However, without any changes in firms' taxation or wages, firms do not face higher costs, and can thus increase profits. In the end, a 'broken monetary circuit' might occur, where more and more money is created that piles up at rich individuals and firms. Firms would get financialized, because they do not need the profits, and would use it for speculation, excessive lobbying and so on. In the extreme case, inequality would rise dramatically and social cohesion would suffer. Workers would barely get compensated for their work but instead receive coins for free, completely changing the market incentive structure. This example of subsidizing workers can be observed in Germany, for example, where 1.4 million workers receive governmental support, while at the same time firms' profits are at record heights and investment is flat[55].

Let us now look at the second question raised above, i.e. at the private sector that would no longer have access to newly created money via bank lending. Where would a firm, which is traditionally financed by banks, get liquidity from in the new system? Proponents of stablecoins argue that new forms of crowdfunding, P2P networking and ICOs would provide liquidity to firms and households. However, following Lipton (2017), we have to be careful and distinguish between financing, where existing liquidity is moved around, and lending or creation, where actually new liquidity is created. This distinction is illustrated in table 2 in a simplified form[56].

Proposals to reform our monetary system have to discuss how (much) new liquidity is created.

[55] High lump sum distribution of coins to all people would then be similar to a basic income. In this case, the effects depend very much on the level of basic income. If the level is relatively high, redistribution might distort important market forces. Some people would do whatever they want, not what society agrees on to be valuable. Others, instead, would work in the productive circuit, subsidizing the others. An appropriate, country-specific level is often similar to existing social protection systems.

[56] Note that government spending adds very safe financial assets, but is in general neutral with respect to its effect on deposits. The effect on the economy depends on a number of other factors.

	Effect on amount of money	Effect on economic activity
Financing (P2P, ICO, crowd-funding...)	None (individual coins/shares are not liquid enough to qualify as money due to information asymmetry, lack of trust: existing money is transferred)	Expansionary (by cutting out intermediaries) or inflationary if the economy is supply-constrained. One-time effect on "effective liquidity"
Bank lending	Expansionary if net credit positive.	Expansionary or asset price inflationary
CBDC, helicopter money, flat distribution	Expansionary	Expansionary if economy is not supply-constraint, but broken monetary circuit

Tab. 2: Financing versus Lending

Ametrano (2016), for example, raises the question of sufficient liquidity without answering it. Against this backdrop, it is unlikely that a central authority knows the 'right' amount of money for the economy. A macroeconomic quantity rule appears problematic. If, in contrast, risk-sharing banks lend to customers, and are rewarded for competitive monitoring of their clients, profitable and innovative businesses will flourish. Indeed, financing is inherently endogenous and should not be controlled by a central authority.

This assessment does not exclude the possibility that P2P lending or 'smart' banking can improve today's system. New data management, for example, can be used to increase the efficiency of bank's risk management. Moreover, businesses rely less and less on commercial bank loans, and more and more on other sources of financing, such as bond issuance, trade credit, retained earnings and, in particular, crowd funding and P2P financing. Financing through P2P lenders like Zopa has grown a thousand-fold in the UK from 2009 to 2014[57]. For instance, Zopa passed the milestone of £2 billion worth of loans on its online platform[58]. Blockchain might further simplify financing. Along these lines we agree with Andrew Haldane from the bank of England: "The mono-banking culture we have had since the 1990s is on its way out. Instead, we are seeing a much more diverse eco-system emerging with the growth of new non-bank groups offering peer-to peer lending and crowd-funding, which are operating directly with a wider public"[59].

Summing up this section, we share the assessment of Lipton: "The other possibility is to relegate money creation to central banks. I just don't believe that central banks are even remotely equipped for this endeavour. I prefer private enterprise to central planning. Removing fractional banking completely would, in the end, result in a type of central planning"[60]. The private sector would, once again in history, try hard to overcome central planning. We should therefore embrace the advantages of today's market-determined money creation process and try to make it evolve further.

The next section shows that price stability is still a weak point not only in the design of stablecoins, but also in today's financial architecture that needs reform. We will go beyond monetarism in explaining prices. We will see that a powerful policy instrument exists that helps stabilize prices and, at the same time, does not interfere with productive market forces, but further

[57] See ositivemoney.org/wp-content/uploads/2015/07
[58] "Peer-to-peer lender Zopa passes milestone", Business Insider. See uk.businessinsider.com
[59] Haldane in the Telegraph telegraph.co.uk
[60] See for-fusion.xyz/mits-alexander-lipton-discusses-monetary-circuit-theory-central-bank-digital-currency.

unleashes them.

4 Price Stability beyond Monetarism: Theory and Evidence

So far, we have seen that stablecoins either follow a fixed supply rule or are based on crypto monetarism. Both are arguably unable to replace today's fiat currencies. In this section, we will see that discussing price stability in capitalist economies requires, once again, to take the interdependence between the financial and real circuit into account.

4.1 A short critique of interest rate based policies

As mentioned before, mainstream economic theory has replaced monetary targeting with interest rate targeting to achieve price stability. Economists typically estimate different channels on how variations in interest rates and expectations about future interest rate changes affect inflation. The general idea is that the central bank should choose the optimal interest rate along a Philips curve. In the original contributions, central banks face "the menu of choice between different degrees of unemployment and price stability" (Samuelson and Solow, 1970, p.192 quoted in Mankiw (2014)). In more recent New Keynesian DSGE models, the optimal interest rate depends on expected inflation and the output gap (Woodford, 2003). Non-neutrality of money in the short-run is introduced via sticky prices, while long-run neutrality of money is typically maintained.

In principle, this is one step in the right direction, given that central banks do actually set the short-term interest rate, but do not mechanically control the amount of money (as suggested by monetarism and also e.g. by the most widespread formulations of the so-called money multiplier theory). At the same time, much of the intellectual and modeling framework has not yet moved towards a better understanding of the interaction between the financial and the real economy. This is grounded in the fact that DSGE models are traditionally pure exchange economies, with no nominal variables, only coconuts (see p.200 ff, Taylor (2004) for a more detailed exposition). Against this backdrop, conventional macroeconomics still lacks a view for a holistic approach to monetary policy, price stability and macroeconomics more generally. Unsurprisingly, the lag of a holistic macrofinancial perspective in combination with an exclusive reliance on the interest rate channel has proven insufficient in dealing with both deflation and excess inflation globally.

On the one hand, high inflation rates were countered by higher interest rates in many developing countries such as Mexico, Turkey, Hungary and South Africa, as well as in the US and Europe in the 1970s. Inflation eventually decreased but has typically been accompanied, in the emerging countries, with sever side effects like currency crises and economics downturns (UNCTAD, 2008)[61]. Brazil is a recent example where a focus on conventional interest rate based policies proved insufficient (Araujo et al., 2012). Setting high interest rates to lower inflation fueled an overvalued Real in the early 2000s, followed by a rapid (over)correction of the currency in 2015, so that GDP contracted by 3.6% in 2016. In contrast, developing countries like South Korea and China did not follow conventional interest rate based policies and typically performed better (see Cimoli et al., 2017).

[61] This perspective slowly gains acceptance. Consider for example Calvo (2017) with a neoclassical model where interest rate based stabilization programs tend to be associated to recessions and currency crises.

On the other hand, zero or negative interest rates in many developed countries have failed to bring inflation back to target rates in recent years. Unconventional monetary policies, like Quantitative Easing, have also not yet brought inflation back. However, these policies have severe side effects like boosting asset prices and distorting important market forces (Koo, 2015).

Apparently, monetarism has been replaced with a new paradigm, which focuses almost exclusively on interest rates to achieve price stability. This new paradigm proves, yet again, to have severe shortcomings. Against this backdrop, it appears reasonable to step back, question conventional wisdom, and ask the obvious question: how are prices set in the economy?[62] Answering this question is vital for the design of (crypto) currencies.

4.2 Theory: markup pricing

For the most parts, monetarists did not have a short-run or microeconomic price theory (See Goodfriend and King (1997), part 3.2). For monetarists, prices adjust according to the equation of exchange (1) with M being exogenous and V being mostly stable. Neoclassical economists filled this gap by postulating that the price is set so that marginal returns equal marginal costs, building on the marginal revolution in economics from the late 19th century. However, Keynes (1939) argues that it is "rare for anyone but an economist to suppose that price is predominantly governed by marginal cost". Similarly, Means (1935) rejects pricing via marginal costs, but emphasizes pricing outside markets done through strategic decisions: "a price which is set by administrative action and held constant for a period of time". In contrast, a market price is made from the interaction of buyers and sellers. Building upon these distinctions, Kaldor (1976) argues that, in the primary sector, the market price is given to the individual producer (e.g. a certain corn price), and pricing works as described by Adam Smith: Changes in prices act as signals to increase or decrease production. However, in the industry sector, prices are administered, production is dominated by large corporations which set prices, and they are therefore cost-determined, not 'market-determined'[63]. We follow Lavoie (2001) where "firms fix prices based on some measure of costs, rather than as a reaction to demand fluctuations"[64]. Adopting notations from Kleinknecht and Vergeer (2014), we start with the equation for the firm's total costs:

$$Xc = W \cdot L + RK \tag{3}$$

where X is total output, c is cost per unit of output, W is wage per unit of labour (e.g. one hour), L is amount of labour, R is cost per unit of capital and K is amount of capital used. Dividing this

[62] In general we refer to consumer goods and services prices.

[63] From a different perspective, neoclassical economics can be seen as a theory on how to distribute scarce resources. As such, prices reflect scarcity and clear markets. Post-Keynesians have a more nuanced view where firms face large uncertainty about demand schedules. Moreover, neoclassical economics' focus on scarcity is clearly less relevant if we think about how Apple can tripple its production in a few months if demand is surprisingly high (while keeping prices stable!). Apple expected to sell 5 million Iphone 5s, but sold 9 million. The price did not increase, but Foxconn introduced extra shifts. See asymptosis.com/real-businessmen-respond-to-quantity-signals-not-price-signals. So most businesses set a fixed price, and then observe quantity signals. Financial markets, in contrast, are more neoclassical in the sense that the amount of bonds and shares is less flexible and prices adjust quicker.

[64] See also Taylor (2004), in particular page 62 and page 125, and references therein for a detailed discussion of different pricing theories used by different schools of thought.

equation by output gives us unit costs:

$$c = \frac{WL}{X} + \frac{RK}{X} = \frac{W}{\rho_l} + \frac{R}{\rho_k} \tag{4}$$

where $\frac{WL}{X} = \frac{W}{\rho_l}$ is unit labour costs, ρ_l is labour productivity (output per hour worked) and $\rho_k = X/K$ is capital productivity. In words, unit labour costs (ULC) are defined as the ratio of total (nominal) labour costs per unit of real output.

In the literature just mentioned, firms set prices P according to mark-up pricing rules:

$$P = (1 + \tau) \cdot c \tag{5}$$

where τ is a constant, called mark-up. As usual, inflation is defined as the relative change in prices:

$$\pi_{t+1} = \frac{P_{t+1} - P_t}{P_t} \ . \tag{6}$$

Moving from the firm to the aggregate level, we define

$$I = \sum_{i=1}^{J} \omega_i P_i \ , \tag{7}$$

as the price index, with P_i being the price of good i and ω_i being the weights we associate to good i. Looking at a specific basket of final goods and services, for example, I could be the well-known consumer price index.

In order to understand how different input factors (costs) affect the overall price index, we build a very simple pricing model for a closed and developed economy. Developed economies are characterized by having vertically integrated stages of production. We order firms according to their rank in the supply chain form 1 to J, where firm 1 uses only labour as well as (domestic) natural resources as inputs[65]. Firm j uses both the output from firm j-1 and labour as input factors. Firm J produces a final good. [66] Figure 2 illustrates our simple model.

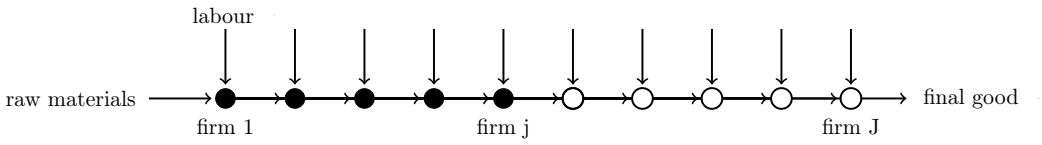

Fig. 2: Sequence of a vertically integrated economy.

[65] A simple extension to the model introduces imported raw materials with changing prices and exchange rates. Higher oil prices can thus, depending on mark-ups, quickly penetrate through the production chain, as will be discussed in the next subsection. A further extension would introduce imported capital goods. However, for our purposes, we want to stick to the simplest model possible, whose prediction are, as we will see, empirically very stable.

[66] See Pasinetti (1981) for a more general formalization of vertically integrated economies with multiple consumption and capital goods.

Let c_j be the unit cost for firm j. Following equation (4), we have

$$c_j = \frac{W_j}{\rho_l} + \frac{R_j}{\rho_k} \tag{8}$$

where R_j is the cost per unit of input capital for firm j, bought from firm j-1. Firm j-1 sets the price for its good according to

$$R_j = (1+\tau)\left(\frac{W_{j-1}}{\rho_l} + \frac{R_{j-1}}{\rho_k}\right) \tag{9}$$

Plugging the equation for R_j in equation (8), and doing this repeatedly until firm 1 uses only labour to extract raw materials, we end up with

$$c_j = \sum_{n=0}^{j-1}\left(\frac{1+\tau}{\rho_k}\right)^n \cdot \frac{W_{j-n}}{\rho_{l,j-n}} \ . \tag{10}$$

Using this expression in combination with $P_j = (1+\tau_j)\cdot c_j$, we find that unit labour costs, capital productivity and mark-ups determine prices. Putting c_j (10) in (7) yields

$$I = \sum_{j=1}^{J}\omega_j \sum_{n=0}^{j-1}\left(\frac{1+\tau}{\rho_k}\right)^n \cdot \frac{W_{j-n}}{\rho_l} \ . \tag{11}$$

Rearranging terms, we get

$$I = \sum_{s=1}^{J}\widetilde{\omega_s}\frac{W_s}{\rho_l} \tag{12}$$

where

$$\widetilde{\omega_s} = \sum_{i=s}^{J}\left(\frac{1+\tau}{\rho_k}\right)^{i-s}\omega_i \ . \tag{13}$$

Finally, defining Unit labour costs as

$$U = \frac{W}{\rho_l} \ , \tag{14}$$

we obtain an expression for inflation (6)

$$\pi = \frac{\sum_s \widetilde{\omega_s}\cdot U_{s,t+1} - \sum_s \widetilde{\omega_s}\cdot U_{s,t}}{\sum_s \widetilde{\omega_s}\cdot U_{s,t}} \ . \tag{15}$$

If we assume constant $\widetilde{\omega_s}$, i.e. constant mark-up and capital productivity, inflation is equal to the change in national Unit Labour Costs. Depending on the price index we are interested, i.e. the GDP deflator or CPI, we can use different weights ω[67]. Our model is in line with, but simpler, than for example that of Garbellini and Wirkierman (2010) who build on the seminal work of Pasinetti (1981), and also find that "prices are completely determined by labour costs". In the next subsection, we test the model's prediction empirically.

[67] The model could be extended to make τ and ρ_l depend on j and t.

4.3 Empirics: Regressing inflation and changes in Unit Labour Costs

Figure 3 shows a regression of average changes in unit labour costs against changes of the GDP deflator for 20 countries from 1970 to 2016[68]. This empirical result is in line with previous

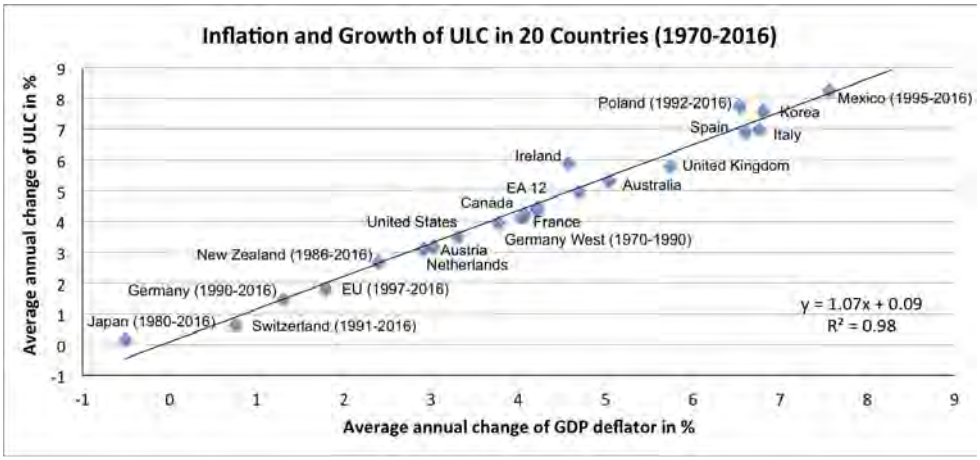

Fig. 3: Average annual change of Unit Labour cost (y-axis) as a function of the average annual change of the GDP deflator (x-axis) for 20 countries from 1970 to 2016. Source: Ameco, own calculations.

empirical studies. Mehra (1991) uses US data from 1959 to 1989 and finds that unit labour costs and prices are well correlated in the long-run. Along these lines, Lown and Rich (1997) use data from 1965 to 1996 and show that both variables correlate well, replacing a conventional Philips Curve that has little explanatory power. The ECB concludes that "persistent movements in unit labour cost growth, as captured by the eight-quarter moving average [...], tend to be associated with corresponding shifts in inflation" (ECB (2004), p.51,52)[69]. More recently, the BIS (2017) acknowledges a stable relationship in the long-run. While the relationship is clearly very strong in the medium to long-run, i.e. periods extending two-year averages, the literature is generally inconclusive when it comes to short-term predictive power (see Brauer (1997) and Bidder (2015) for an overview).

Before discussing why the relationship might be less stable in the shorter run up to two years or so, we will quickly look at the micro-empirical literature on firms' price setting behaviour. One of the earliest empirical studies is documented in the seminal paper of Hall and Hitch (1939), who find no evidence that businesses set prices based on demand. The authors interviewed 38 entrepreneurs about how they set prices for output goods and find that prices "will be changed if there is a significant change in wage or raw material costs, but not in response to moderate or temporary shifts in demand". More recent studies confirm these findings. Hall et al (2000) review UK firms using a survey from 1995. The authors find that higher costs lead to higher prices, while

[68] The R squared does not change significantly if we use the CPI instead of the GDP deflator.

[69] Note that the authors state that labour costs on average comprise approximately 30-40% of total input costs of euro area firms. However, they fail to mention that other input costs (from euro area companies) have previously used labour as an input.

higher demand does less so[70]. Moreover, higher demand did not strongly lead to price increases, but lower demand led to a fall in prices. Similarly, Fabiani et al (2007), using a large survey among European firms, found that most firms continue to employ a cost-based method to set their prices, and confirm the just mentioned asymmetry in price changes to demand shocks. Greenslade and Parker (2010) review the results of a survey amongst 700 UK firms and the evidence supports "the use of the mark-up over costs form of pricing". Again, wages and raw materials are key drivers, while less demand causes lower prices, more than higher demand causes higher prices. D'Arcy et al (2010) find that costs constitute the most important factor for price setting of Australian firms.

Summing up, we have seen that, in general, costs matter, and quantities adjust to changes in demand, while prices do less so. We have identified the most important factor of prices, namely unit labour costs. However, in the short-term, many different effects can distort the empirical relationship between unit labour costs and prices. While an exhaustive discussion lies beyond the scope of this paper, we will name a few important ones. First, exchange rate fluctuations as well as commodity prices play an important role, in particular for small open economies. Second, demand-pull effects can of course raise prices if the economy is close to full capacity utilization. Examples for such changes in demand can be excessive money printing, rapid dis-saving of households or debt-burdened growth. Third, adjusting prices is costly, so that higher ULC might need some time to translate into higher prices (Barro, 1972). Indeed "inflation seems to vary considerably less than unit labour cost growth" (ECB, 2004). Fourth, global firms face global competition and can quickly change pricing strategies and production locations (BIS, 2017). Analyzing prices on the national level becomes increasingly difficult, not least because of statistical challenges. In conclusion, while short-term fluctuations can have a variety of causes, the overall role of ULC is well documented, empirically and theoretically.

The next step is to ask about the drivers of Unit Labour Costs, which is done in the next section. Clearly, this analysis is fundamental for any proposal to reform our financial system, in particular for stablecoins that want to replace fiat money.

4.4 Unit labour costs in practice

The previous section has shown that unit labour costs (ULC) are key for understanding inflation. Surprisingly, ULC are rarely discussed when it comes to monetary policy and price stability. The reason is that wages are typically seen as a 'market outcome', not as a variable that can or should be influenced. The labour market is typically assumed to function like a commodity market, where supply and demand determine prices (i.e. wages). If unemployment is too high, wages will fall and increase employment, and vice versa. The seminal OECD (1994) job study promoted such a negative relationship between labour demand and labour costs that is required to get an equilibrium in the labour markets. The real wage is assumed to depend on supply-side forces like productivity, and the equilibrium wage is assumed to be equal to the marginal productivity of labour.

In reality, however, the labour market is different from commodity markets because employees are not only a cost but, on aggregate, also a source of income. Wages are costs for the individual firm, but source of demand for the economy as a whole. Fazzari (1998) notes that "it is not at

[70] Note that few respondents rated menu costs as material to their price-setting decisions, a popular justification for stickiness in many macro models. Contractual arrangements, however, were found to be important.

all clear that nominal deflation, no matter how fast and deep, is capable of curing the problem of insufficient aggregate demand"[71]. It appears more realistic to overcome the illusionary dichotomy between (labour) market and government, and see the former as a result of previous historical forces and policy interventions. By no means can the (labour) market be seen as a separate entity that adjusts passively and mechanically towards an equilibrium outcome (Taylor, 2010, p.125). We see wages as a path-dependent variable that is shaped by a variety of factors. In particular, taxes and transfers, price and import controls as well as different market regulations affect the level and distribution of wages. For example, the opening of China and of the former Soviet Union, the entering of women into the work force and rapidly increasing productivity in the agricultural sector provided a seemingly unlimited supply of labour over the last decades (Marglin, 2017). Such a process clearly weakens bargaining power of workers in many advanced economies: "Opening up trade with countries where labour is abundant and cheap puts pressure on wages in those where it is scarcer and more expensive" (BIS, 2017). In such a context, defining migration and integration is a policy choice that directly affects wage and price setting.

Indeed, labour market institutions differ across countries and can explain much of the cross-country differences in inflation. Consider the 1970s to illustrate this. Kaldor (1976) shows that the US inflation in 1972 and 1973 was caused by a rise in commodity prices, not a rise in wages. Indeed, the oil price shocks in 1973 and 1979/1980 were important causes for rising prices in advanced economies. When commodity shocks translate to higher consumer prices, this means a loss in real income (i.e. better terms of trades for the oil exporters). The question is whether higher commodity prices translate into a one time price increase, or whether they trigger a series of events. Following the oil price shocks, nominal wage flexibility, i.e. real wage rigidity, proved particularly harmful in France and Italy. In those countries, backward-looking indexation schemes caused continuous inflation pressure (Flassbeck, 2001). Put differently, labour unions tried to compensate for the loss in real income by demanding higher wages. However, given the negative supply side shock, firms had to raise prices to compensate for higher labour costs. In Italy, the so-called Scala Mobile automatically adjusted wages to past inflation rates. Following the oil price shocks, this scheme was pro-amplifying so that a potentially one-time price increase turned into a permanently higher inflation rate (Davidson et al., 2013). Germany and the US were much better equipped in bringing ULC and inflation down, benefiting from better arrangements of the labour market, i.e. less demanding unions.

More generally, Lefort and Schmidt-Hebbel (2002) survey (backward-looking) indexation schemes and find that "the empirical evidence [...] indicates that the adoption of indexation practices tends to increase the persistence of inflation, making stabilization more difficult"[72]. For these reasons, the ECB (2008) is concerned about index schemes where nominal wages are indexed to consumer prices. "These schemes involve the risk of upward shocks to inflation, such as those currently observed in energy and food prices, lasting longer and even leading to a wage-price spiral. Such a spiral would complicate the ECB's task of maintaining price stability [...]. The Governing Council

[71] Nominal cutting costs is bad because (i) wealth redistribution from creditors to debtors, and because the latter have by nature a higher propensity to spend than creditors, and (ii) redistribution of real wealth therefore lowers aggregate demand (Tobin 1975, Palley 1996) (p.549), and (iii) deflation lowers the value of collateral relative to debt contracts.

[72] A different, forward-looking indexation scheme is possible that would stabilize inflation, see section 5.

of the ECB has therefore called for such schemes to be avoided" (ECB (2008), Box 5)[73]. In the 1970s, policy makers were largely unaware of the links between ULC and inflation, and reacted to the inflationary pressures with monetary policy alone, namely by raising interest rates. Even in Germany, for example, the short-term interest rate was raised to 7% in 1973. Why is it problematic to focus on interest rate policy in a context of oil shocks and wage price spirals?

Following Wicksell (1898), we separate between the interest rate on the market, directly influenced by the central bank, and the rate of return on capital in an imaginary economy without money. The former has to be below the latter to spur investment and growth[74].

If inflation is caused by wage price spirals, which have in turn been triggered by a negative supply side shock, then a focus on interest rates to bring inflation down can be very harmful for economic growth. Along these lines, Fortin (1996) argues that the "great slump" in the 1990s in Canada occurred due to "old-fashioned monetary contraction". Moreover, he shows that "the large and persistent short-term real interest rate differential between Canada and the United States is the only factor that has been sufficiently important, persistent, and powerful to explain the coincident sharp and prolonged divergence between the output and employment performances of Canada and the United States"[75].

The ignorance of the relationship between ULC and inflation was particularly harmful in the euro area. The ECB chose interest rates in order to achieve 2 percent inflation for the euro area in total. However, German ULC persistently undershot the 2 percent target in the run-up to the crisis, while Greek, Spanish and Italian ULC overshot the target. Thus, in order to deal with the macroeconomic imbalances today, we need a process of adjustment in which wage moderation in the deficit countries is complemented by substantial wage increases in the surplus countries. And the latter should be stronger than the former, given that deflationary adjustment is more harmful than inflationary (see also Davidson et al. (2013)). Against this backdrop, low inflation in the Euro Area is no surprise because policy makers chose to adjust exclusively in the South[76]. Mario Draghi, the President of the European Central Bank since 2011, understands these links, and is continuously pointing them out[77], but German policy making remains particularly unwilling to implement new policies and remove old ones, which would involve German wage growth and public investment expansion.

[73] However, this is yet another halfway perspective on the euro area: policies with the threat of upward price spirals are called to be avoided (yet all too long ignored), while excessive upward rigidity in wages, as exercised in Germany, is still not called out, i.e. no call to implement policies that raise wages if an undershooting occurs. Similarly, the European Commission (2012) argues in favour of an "overall reduction in the wage-setting power of trade unions" without discussing the problems if wages rise too slowly, demand for a "decrease" in collective bargaining coverage.

[74] However, we reject Wicksell's approach to prices, where he follows a simple Philips-curve logic.

[75] Note that high market interest rates cannot be taken as an indicator for high potential returns on capital. Decades of ill-guided development policies were based on the idea that high nominal rates in developing countries indicate profitable investment opportunities. Typical policy recommendations consisted of opening up capital markets to allow foreign investments, and of increasing the domestic savings rate. The former policy has often been associated with short-term speculative capital flows (see literature on carry trades and the risk of foreign currency denominated borrowing), and the latter with a contraction of economic activity.

[76] Given the policies in Europe, it is clearly not the case that low inflation causes low wage growth, as suggested by e.g. Donayre and Panovska (2018).

[77] See speech by Draghi 20014 ecb.europa.eu/press/key/date/2014/html/sp141121

4.5 Benefits of targeting unit labour costs

What does the preceding discussion tell us about effective monetary policy making? The answer is that, ideally, national wages should grow in line with the trend in productivity plus the inflation target. Put differently, economic policies should pay careful attention to their effects on ULC, and should be designed in order to ensure price stability. After the 2008 crisis, this view is slowly getting wider attention. For example, after years of low growth and low inflation, policy recommendations for Japan are shifting, with the IMF (2016a) calling for structural reforms that reduce labour-market duality, and thus improve the bargaining power of workers in order to escape low growth and low inflation (recall Japans's position in Figure 3). Moreover, the IMF (2016b) calls Japan in yet another recent publication to 'soft target' private sector wage growth in line with the inflation target. Such policies were state of the art in many countries after World War II, and are still explicitly and successfully used in, for example, Singapore.

The advantages of such a policy go beyond stabilizing prices[78]. Indeed, as will be discussed in the following subsections, monetary policy gets more flexible, aggregated demand is sufficient and productivity increases.

4.5.1 Implications for monetary policy...

If ULC would grow in line with productivity plus the inflation target, conventional monetary policy would gain more degrees of freedom. Put differently, a suitable wage policy on the macro level fosters price stability. Similarly, Dullien (2004) argues that wage setting is responsible for price stability while central banking is responsible for the level of output. Indeed, while interest rate policy will still be needed to control prices after larger shocks, monetary policy can include employment and growth targets in their mandate. This is in particular the case if fiscal policy complements monetary policy. Short-term fluctations are ideally smoothed by fiscal policy (see Hein (2010) and Rochon (2016))[79],[80].

This perspective is in stark contrast to the prevailing economic paradigm because "the belief that, in the long run, the central bank can do little about real variables is still canon for most macroeconomists, and few would suggest that monetary policy should have targets for labour force participation, inequality, or the long-term real interest rate" (Mankiw and Reis, 2017). However, as a first step in the right direction, Mankiw and Reis (2017) acknowledge that fiscal policy plays an important role next to monetary policy.

Adequate wage setting in combination with growth-oriented interest rate policy and counter-cyclical fiscal policy has also implications for the unemployment rate. Indeed, the NAIRU (non-accelerating inflation rate of unemployment) concept collapses, i.e. the idea that there is a natural rate of unemployment below which inflationary pressures are too strong. Attempts to lower the unemployment below this threshold, for example via deficit spending, is assumed to fail and would only cause higher inflation (Mitchell and Muysken, 2008). This is because the NIARU

[78] Generally speaking, price stability should only seen as an intermediate target to support economic development at large.

[79] A further important pillar is the FX market, where a crawling peg to set off ULC differentials and interest rate differentials is needed. A detailed discussion, however, lies beyond the scope of this paper. See Senner and Sornette (2017) for more information on the international dimension.

[80] Note that this assessment also questions the conventional view on central bank independence. While central banks should clearly not 'print money' in an unsustainable way, they should ideally complement fiscal and wage policy.

is determined by supply-side factors like skill mismatches, excessive regulation and so on. As a consequence, conventional labour market policies were "limited to ensuring that individuals are employable" (OECD, 1994). However, the empirical evidence is weak, and the theoretical construct flawed. Given the relationship between ULC and inflation, it is not surprising that low unemployment and stable inflation are possible simultaneously, given adequate policies (see Naastepad and Storm (2012) for a detailed discussion)[81].

4.5.2 ... macroeconomic stability...

Moreover, if wages grow in line with average productivity plus an inflation target, the wage share remains stable and "the economy as a whole creates a sufficient amount of demand to fully employ its productive capacities" (UNCTAD, 2014).

Indeed, a close relationship between wage growth and labour productivity helps preserve external competitiveness while limiting inflationary pressures through wage-price spirals. In contrast, a decoupling of productivity and wages fuels unstable savings-investment paths (Kalecki, 1965; Pasinetti, 1974) and financial crises (Senner and Sornette, 2018).

Moreover, a coupling of wages and productivity ensures that new technologies are implemented. "A dual focus on demand and digitization could unleash a powerful new trend of rising productivity growth that drives prosperity across advanced economies for years to come" (McKinsey, 2018).

4.5.3 ...and productivity

It is typically assumed that low productivity growth causes lower wages[82]. Many economists, like Mankiw in his famous textbook "Principles of Macroeconomics", 7th edition, simply claim: "If productivity is the primary determinant of living standards, other explanations must be of secondary importance." However, it is not trivial that the causality runs from productivity to wage growth. It appears reasonable that the causality (also) goes the other way around: If wages are too low, investments in labour-saving capital will not pay off. Therefore, higher wages can induce higher productivity. Along these lines, Allen (2016) attempts to explain why the industrial revolution happened in Britain and not elsewhere: "What commercial success did for Britain was to create a structure of wages and prices that differentiated Britain from the continent and, indeed, Asia: In Britain, wages were remarkably high and energy cheap. This wage and price history was a fundamental reason for the technological breakthroughs of the eighteenth century whose object was to substitute capital and energy for labour." He argues that scientific breakthroughs were necessary conditions for the industrial revolution, but not sufficient conditions, given that France had similar access to new innovations.

Moreover, as described by Schumpeter and others, innovation is accelerated if firms face fixed input prices[83]. If energy, labour and capital prices are the same for all firms, only the most innovative firm can lower prices, and gain market share / increase profits. This is what we call 'creative competition'. In contrast, today, many firms become more competitive by avoiding taxes, moving to low-wage countries, avoiding environmental regulation or lobbying for public subsidies.

[81] The concept of NAIRU is still widespread. See for example financial times amp.ft.com.
[82] See IMF's assessment telegraph.co.uk
[83] For wages this means that we need fixed nominal wages and flexible real wages.

These insights are shared by Webb (1912), the founder of the London School of Economics. He says that "What the employers appreciate is the fact that the Minimum Wage is fixed by law and thereby really forced on all employers: the security that the Act accordingly gives them against being undercut by the dishonest or disloyal competitors." Webb continues arguing that no reasonable person can therefore oppose a minimum wage. As a consequence, "It [the minimum wage] does not even limit the intensity of such competition, or the freedom of the employer to take advantage of it. All that it does is to transfer the pressure from one element in the bargain to the other: from wage to the work, from price to quality" (ibid). We refer the reader to Kleinknecht and Verdeer (2014) for a recent overview on productivity and wages, including a panel data analysis.

With short-term investment horizons, most businesses only invest in capital that pays off soon. Investing in labour-substituting machines that, given the low wages, only pay off in 20-30 years, is not very attractive and too risky. This "tragedy of the horizons" results in a lack of investment in for example climate-related issues.[84]

As a consequence, wage policies that ensure a coupling of wages and of productivity trend on the aggregate level supports further productivity growth[85].

5 Concluding Remarks

This paper has reviewed today's monetary system and contrasted it with crypto currencies. We have presented evidence demonstrating that, as of today, crypto currencies are inferior to fiat money for three reasons.

First, crypto currencies have either no collateral, or are collateralized by assets that are inferior to a WOU ('We Owe You').

Second, crypto currency allocation is centrally/algorithmically planned, similar to basic income or positive money approaches. While blockchain might facilitate different kinds of financing (P2P, smart banking, ICOs), existing designs of stablecoins do not enable productive liquidity expansion *à* la Schumpeter.

Third, crypto currencies' pricing theories are built on simple quantity rules (crypto-monetarism). As such, crypto currencies revive the dichotomy between money and production. This dichotomy, however, remains illusionary. Blockchain technology does not overcome the challenges of formulating adequate policies and designs for monetary economies. In fact, so far, it appears that crypto currencies have not even identified the major monetary challenges.

We have seen that price stability is a major challenge for crypto currencies and, less so but also, a challenge for fiat money. In the real world, prices are set following a mark-up rule on firms' costs. As a consequence, inflation co-moves with changes in unit labour costs (ULC), and the latter are driven by historical and institutional forces. We have argued that controlling inflation via ULC on the national level can have various benefits besides stabilizing prices, in particular growth-supporting low interest rates.

Looking ahead, our research calls for a transformation of the wage bargaining system with a view to solve the collective action problem in the labour market, that is to avoid that wage agreements lead to an under- or over-shooting compared with the inflation target. Future research could

[84] See www.tragedyofthehorizon.com for a recent research initiative and more information.

[85] Yet, firms do not sufficiently invest in very high risk and very uncertain projects. As a consequence the government has to complement by implementing Apollo-type projects. See Senner and Sornette (2017).

explore digitalized and decentralized bargaining processes that are subject to algorithmic macro constraints, ensuring that, for example, digitally recorded wages grow in line with productivity plus the inflation target.

Indeed, transforming wage bargaining at a global level appears to be the most urgent pillar of a comprehensive approach to financial resilience, involving fiscal, wage, foreign exchange and interest rate policies. A further step in this context would be to think about a bancor-like global reserve currency. Such a reserve currency could guide exchange rates to offset diverging competitiveness amongst countries, offsetting the intrinsic asymmetry between debtors and creditors. Given commodity prices' central role, alongside with exchange rates and wages, as drivers of inflation in many countries, future research could also focus on smoothing commodity prices, for example via a global commodity stock (Kaldor, 1976).

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3 Global Imbalances and Sovereign Wealth Funds

The analysis in this paper has been motivated by the rapid appreciation of the Swiss franc after 2008 and the interventions of the Swiss National Bank (SNB) on the foreign exchange market in an attempt to weaken this upward pressure. The SNB's interventions were massive and resulted in a balance sheet of the size of Swiss GDP.

This situation, which is unprecedented in the Swiss context, has raised multiple questions among academics, professionals, politicians and citizens. For how long will the upward pressure on the Swiss franc last and what can be done about it? Should anything be done about it? If so, for how long should the SNB intervene? Does the appreciation hurt Swiss GDP? Are there other options, besides central bank intervention, to weaken the upward pressure? Can the SNB's assets be used to boost investment in Switzerland? Is the SNB just 'printing' money or are liabilities associated with its interventions?

The rapid appreciation of the Swiss franc can be discussed from various perspectives. This paper focuses on the macro-financial dimension. In particular, it seeks to address three issues. First, it shows that both the public and academic discussion in the context of the upward appreciation of the Swiss franc have violated simple macroeconomic logic. Foreign and domestic currency denominations, for example, have been mixed up. It has wrongly been argued that the foreign exchange reserves could be used to boost investment in Switzerland. Such a view disregards the fact that the foreign currency dominated assets figuring on the SNB's asset side cannot be used to pay Swiss salaries without first having to be exchanged back into Swiss francs. This, in turn, would annihilate the effect of preceding SNB interventions and, hence, constitute a zero sum game.

Second, this paper seeks to contribute to filling a gap in the academic literature about the macroeconomic role of Sovereign Wealth Funds (SWF). In the context of the rising SNB's reserves, the Norwegian Oil Fund has been mentioned as a potential role model for a new Swiss sovereign wealth fund (SWF). The set up of such a public entity, which has significant assets under management and is regulated in a way to exclusively invest abroad, influences a country's balance of payments and international investment position. Against this backdrop, this paper provides a consistent framework to analyze the macrofinancial role of central bank interventions and sovereign wealth funds by looking at financial stocks and flows, paying particular attention to accounting standards, valuation effects and currency denominations.

The third objective of this paper is to go beyond analysis and diagnosis, and come forward with a concrete macroeconomic solution for Swiss policy making. With that in mind, we outline steps to create a Swiss sovereign wealth fund that could benefit both Switzerland and the rest of the world. The question about how to design its institutional and political set-up such that it is both in line with the Swiss ordoliberal tradition but does not threaten Swiss integrity and avoids political abuse, is left for future research.

Research Paper

(1) Senner, R. and Sornette, D. The 'new normal' of the swiss balance of payments in a global perspective: Central bank intervention, global imbalances and the rise of sovereign wealth funds. *Swiss Finance Institute Research Paper No. 17-22*, 2017

Swiss Finance Institute
Research Paper Series
N°17-22

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The 'New Normal' of the Swiss Balance of Payments in a Global Perspective: Central Bank Intervention, Global Imbalances and the Rise of Sovereign Wealth Funds

Richard Senner[1] and Didier Sornette[1,2◇]

Discussion Paper

June 2017

keywords: surplus countries, central bank interventions, sovereign wealth funds, mercantilist critique, Swiss franc, current account imbalance

JEL: E5; F31; F32; O24

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◇This paper would not have been possible without the insights of, and discussions and fruitful collaboration with, Peter Wuffli. All remaining errors are ours.

Abstract

Since the global financial crisis, the Swiss National Bank has been accumulating reserve assets amounting to the size of the Swiss GDP. Yet, the Swiss franc is still considered to be significantly over-valued. This paper analyzes the drivers behind the new situation and discusses challenges and opportunities for Swiss policy making, drawing on comparisons with other surplus countries. Our findings are fourfold. First, the recent upward pressure on the Swiss franc cannot be explained by safe haven effects alone, but has been driven by a pronounced decline in Swiss residents' foreign investments. Second, other surplus countries typically purchase and manage significant amounts of foreign assets via central banks and sovereign wealth funds. Third, from a global perspective, such public intervention is subject to a mercantilist critique. Fourth, given the need to invest in the real economy to foster growth and avoid the present excess flushing of the financial system that boost asset prices in an insufficient productive way, we conclude that Switzerland should assess room for re-balancing and highlight the opportunity of building a Swiss sovereign wealth fund. This would be beneficial both for Swiss residents and for the world at large.

Introduction

Between 2008 and 2011, the Swiss franc appreciated from 1.6 CHF/EUR to less than 1.1 CHF/EUR. As a response to this "massive over-valuation" and in order to maintain price stability, the Swiss National Bank (SNB) introduced a price floor of 1.2 CHF/EUR in September 2011 (Jordan (2014)). The floor was abolished on January 15th 2015, partly due to upcoming expansions of the European Central Bank's asset purchase programme[1], which raised fears about the SNB's balance sheet becoming too large and reaching "dangerously high volumes for a small country" [2]. Indeed, the easing in the Eurozone was estimated to push the level of Switzerland's foreign reserves to nearly the value of its GDP (Bernholz (2015)). After the floor was dropped, the Swiss franc resumed its appreciation vis-à-vis the Euro, reaching 1.07 CHF/EUR at the end of 2016. However, this appreciation was not the result of a freely floating currency. Rather, the SNB continued to intervene on the foreign exchange market, as shown in figure 1. Reserve assets were larger than GDP in 2016 and have continued to rise in the first quarter of 2017. As a consequence of its interventions,

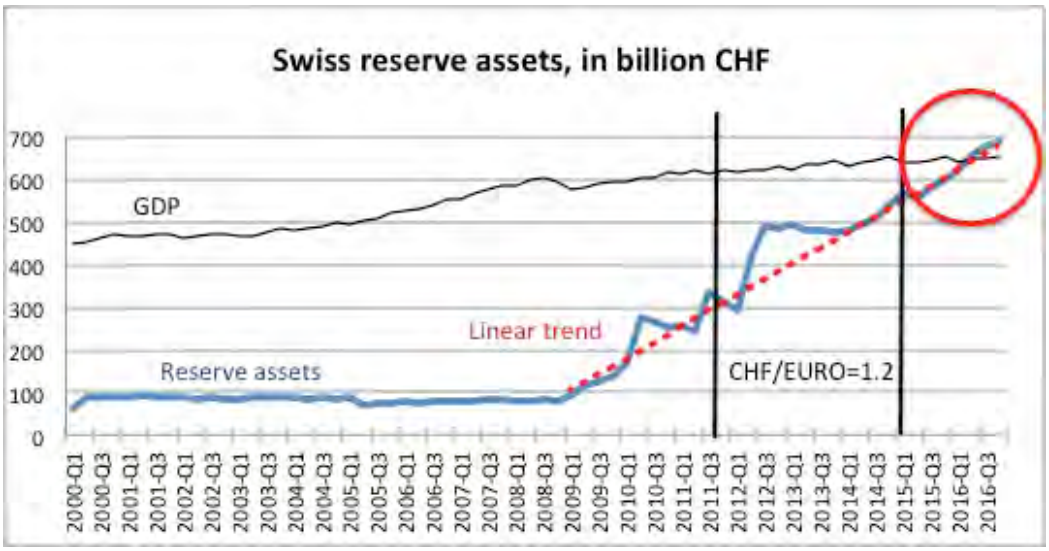

Fig. 1: Total net foreign reserve assets, quarterly data. Quarterly GDP, quarterly data annualized. The period of the floor is indicated by black bars. The red, dotted line shows the linear trend from 2009 Q1 to 2016 Q4, with a slope of CHF 6.2 billion per month. Source: SNB.

the SNB became a large public investor globally, holding, for example, United States shares worth

[1] ECB press release, January 22nd 2015

[2] In order to maintain the floor, it was estimated that the SNB would have had to "supply about CHF 100 billion for the month of January [2015] alone" (Bernholz (2015)). Note that there are two common misunderstandings related to the central bank's balance sheet, which are worth mentioning briefly. First, a central bank's balance sheet is unique among all economic actors because the sight deposits on the liability side of its balance sheet are created by the central bank itself. This implies that the central bank owes something to other economic agents, which it can create itself. Technically, therefore, the SNB could have defended the 1.2 floor forever. Second, the monetary base increases during non-sterilized foreign exchange interventions as conducted by the SNB in recent years. Some commentators have raised unjustified concern that this will lead to an increase in broad money measures (M1 or M2) and thus to inflation (see the Economist and Krugman in the New York Times, accessed March 2017). However, such inflationary concerns are typically based on a textbook version of the money multiplier theory that has theoretically and empirically been proven wrong (see for example McLeay et al (2014)).

USD 67 billion at the end of 2016 [3].

Both the interventions prior to 2011 as well as the necessity to defend the floor were expected to be short-term[4], offsetting temporary safe haven inflows due to global uncertainty (particularly in Europe). The ongoing interventions after January 2015, however, suggest that Switzerland might not only be confronted with a temporary change in its economic environment, but face more fundamental long-term challenges. Indeed, the European crisis and 'global uncertainty' may, in itself, not be sufficient to explain the symptom of persistent upward pressure despite massive central bank intervention. The question that arises is hence: what are the underlying drivers of this new situation and how can Swiss economic policy respond?

This question is relevant not the least because the new US president revived the debate about global imbalances and currency manipulation. Along with China, Japan, Korea, Taiwan and Germany, Switzerland is on the 2016 US treasury's monitoring list because it meets two out of three (rather arbitrarily set) criteria for currency manipulation [5]: Switzerland spent 9% of its GDP on the foreign exchange market, which is above the 2% threshold. In addition, the 10% current account surplus as a share of GDP was higher than the tolerated 3%. The third criteria, in contrast, has not yet been met by Switzerland, whose USD 13 billion trade surplus vis-à-vis the US remains below the USD 20 billion threshold (see US department of the Treasury (2016)). Against this backdrop, and given an export of goods and services-to-GDP ratio of over 63% [6], this paper aims at analyzing the recent threats to Switzerland's export-led growth model and at rethinking policy options, drawing upon insights from other surplus countries.

This paper is structured as follows. Section 1 discusses cyclical safe haven and long-term structural drivers that have contributed to the upward pressure on the Swiss franc since 2008. The analysis suggests that the current situation is not only an abnormally long temporary regime but may constitute the 'new normal' for Switzerland. Section 2 puts the Swiss situation in a global perspective, describing the balance of payments of other surplus countries. We find that official purchases of foreign assets via the central bank or via so-called sovereign wealth funds are the norm rather than the exception. Section 3 discusses the effects of public intervention from an individual country's growth perspective as well as from a global growth point of view. We find that surplus promoting policies benefit some countries, including Switzerland, while the simultaneous pursue of such policies by several countries leads to a 'race to the bottom'. Section 4 rethinks Switzerland's policy options in consideration of global growth and discusses the possibility to create a sovereign wealth fund. Section 5 concludes that, given Switzerland's export-led economy as well as Swiss politics being unlikely to implement re-balancing policies, Switzerland should address the'new normal' by creating a sovereign wealth fund that would invest long-term in tangible, growth-promoting assets.

[3] Recent numbers on the SNB's stock holdings in the US can be found at www.asdaq.com, accessed March 2017. At the end of 2016, for example, the SNB owned more than USD 2 billion in Apple, and more than USD 1 billion in Microsoft, Exxon Mobil and Johnson and Johnson each.

[4] See for example the SNB's press release from September 6th 2011 (accessed March 2017) where the valuation of the Swiss franc is seen as an acute threat and where the franc is expected to depreciate soon. In April 2009, former president of the SNB, Thomas Hildebrand said in the NZZ that the foreign exchange intervention was an emergency instrument of monetary policy.

[5] Switzerland might however become the first country to meet all three criteria.

[6] For comparative purposes: The share of exports in goods and services in GDP is 47% in Germany and 30% in France. Source: Worldbank

1 Explaining the Swiss franc's recent upward pressure: the role of safe haven flows and more structural drivers

1.1 The SNB's intervention and the Swiss balance of payments

Taking a closer look at the Swiss balance of payments sheds light on the recent SNB's interventions from a macroeconomic perspective. Generally speaking, the balance of payments records all the economic transactions between the residents of Switzerland and the residents of the rest of the world[7]. The balance of payments consists of the current account and the financial account[8]. The current account records income from trade in goods and services, labor income as well as investment income. A current account surplus means that the income received from non-residents exceeds the expenses paid to non-residents. The positive difference between income and expenses is reflected in a net acquisition of foreign assets, which is recorded in the financial account. More generally, the financial account records all gross changes in asset ownership between residents and non-residents, i.e. the ownership of shares, bonds, direct investments and reserves. A current account surplus always comes along with a financial account deficit, indicating that residents accumulate net positive foreign assets. The size of the net current account is thus equal to the negative size of the net financial account[9]. Note that the balance of payments records *flows* during a specific period, typically during one year. In contrast, the s*tocks* that are associated with the flows of the financial account are recorded in the international investment position, which will be discussed in section 1.4. Indeed, it is important to distinguish between stocks and flows as the two are often confused[10].

For now, we focus on the flows, i.e. the annual balance of payments as shown in figure 2. Let us recall that the recent interventions of the SNB are recorded on the financial account. To illustrate the magnitude of the interventions, we plot both the financial account excluding the reserve assets as well as the reserve assets alone[11]. The current account surplus averages around 10% of GDP and mirrors the financial account deficit. More specifically, from 1980 to 2008 the persistent current account surplus is mirrored by the accumulation of net claims of Swiss residents vis-à-vis non-residents. On aggregate, private sector residents are willing to re-invest their net foreign income into foreign assets. As emphasized by Sornette (2015), this situation changed after 2008 when the financial account of the private sector (the financial account excluding the SNB) turned positive, i.e. when the private sector started net selling foreign assets. Since 2008, net income from the current account has been largely mirrored by net foreign investments of the SNB. Put differently, the SNB acts as a 'foreign asset holder of last resort'[12]. The question is hence why the private sector is no longer sufficiently investing its net income abroad.

[7] Residents include all kinds of individuals and public or private organizations as defined in the balance of payments manual (BPM) of the IMF.

[8] Note that, in some countries, the financial account is called capital account.

[9] While this is true theoretically, differences due to statistical discrepancies can arise in practice.

[10] In this context, Kalecki can be quoted, who stated that "[e]conomics is the science of confusing stocks with flows" (Michael Kalecki, quoted by Joan Robinson in "Shedding darkness" , Camb. J. Econ. (1982) 6 (3): 295-296, University of Cambridge Cambridge Journal of Economics 1982, 6, 295-296)

[11] Note that the sum of the annual reserve asset flows from figure 2 is equal to the total stock of reserve assets shown previously in figure 1. However, to be precise, the stock of foreign assets is subject to valuation effects, so that there is no strict equality. This issue will be discussed in section 1.4 in more detail.

[12] Note that we chose this term in analogy to the common description of the central bank as being the 'lender of last resort' in times of financial turmoil.

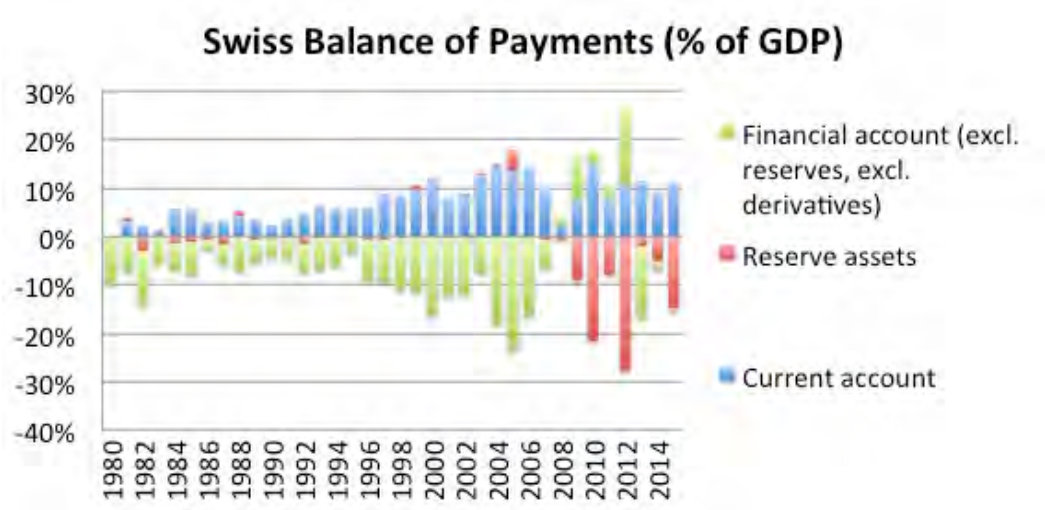

Fig. 2: Since 2008, the private sector's net foreign asset investments do no longer mirror the current account surplus. Instead, the SNB acts as an 'foreign asset holder of last resort' and accumulates net foreign assets, enabling the private sector to have net income from abroad and yet investing this income in Swiss assets. Source: SNB

Figure 3 illustrates the shift in the balance of payments graphically. Figure 3 (a) shows the stylized situation before 2008, while figure 3 (b) displays the stylized situation after 2008[13]. Since 2008, and with the exception of the year 2013, the SNB has intervened by purchasing foreign assets in amounts larger than the current account surplus. Put differently, in recent years, the SNB has enabled Swiss residents to have a positive net income from abroad while at the same time investing this income in Swiss assets. The SNB thus became the 'foreign asset holder of last resort', i.e. the only actor in Switzerland that is willing to hold the financial claims on non-residents that are generated by the net current account surplus. Without the intervention of the SNB, the Swiss franc would have appreciated more, and the surplus would eventually have shrunk[14].

How is it that the private sector's financial account no longer mirrors the current account surplus? Standard economic theory suggests that surplus countries receive upward pressure on their currency so that the surplus eventually shrinks. Taking this perspective, the question can be re-phrased to ask why the private sector was willing to reinvest net income abroad prior to 2008? Subsection 1.2 discusses the literature associated with the increasing demand for Swiss franc assets, while subsections 1.3 and 1.4 empirically analyse the change in the Swiss investment environment, looking at interest rate spreads and the evolution of Switzerland's foreign wealth.

[13] Note that non-resident banks and 'others' (as defined in the SNB's statistics) also do have accounts at the SNB. However, sight deposits of these entities are relatively small with CHF 37 billion compared to a total of CHF 497 billion in January 2017 (source: SNB). For simplicity, claims of non-residents on the SNB are thus ignored in the graphical representation.

[14] The current account's elasticity vis-à-vis exchange rate movements is relatively small in Switzerland. However, while some sectors - and in particular the investment income - are insensitive in the short- to medium-run, other sectors, such as industrial productions, are already operating under reduced profit margins and consider shifting production abroad (see section 4 for a more detailed discussion).

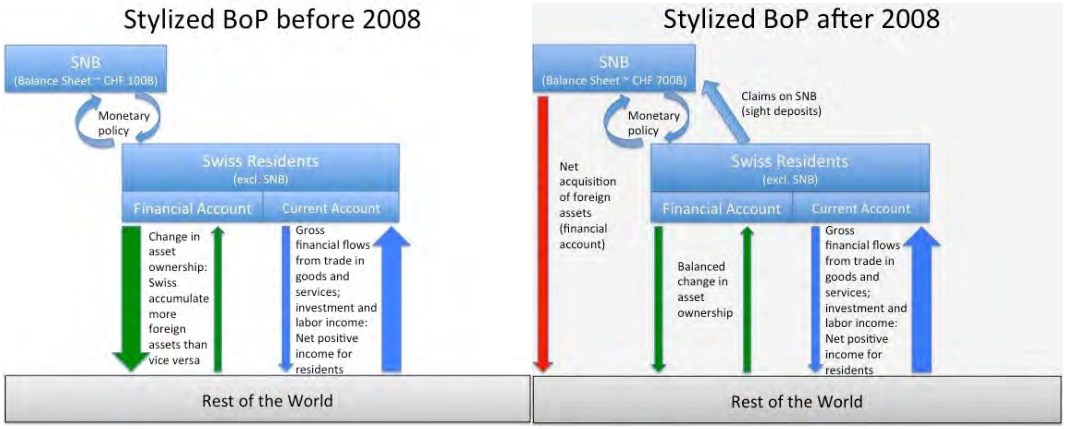

Fig. 3: Stylized balance of payments for Switzerland with the SNB, Swiss residents, as well as non-residents (rest of the world). Net current account income is mirrored by net foreign asset acquisitions of the private sector (figure (a)), or respectively of the SNB (figure (b)).

1.2 Safe haven inflows matter but even more so does domestic demand for Swiss assets

Why has the private sector no longer been willing to recycle net income abroad? What has been driving up the demand for Swiss francs? To what extent are safe haven effects or rational investment decisions causing the upward pressure? Two sets of arguments have been discussed in the literature. The first one refers to safe haven inflows from foreigners and from Swiss residents. The second one discusses more structural changes in the portfolio (re-)allocations of Swiss residents, reflecting a shift in the investment environment that is partly driven by an unwinding of foreign carry trade positions.

Concerning the first set of arguments, Switzerland is usually considered a safe haven due to its political, economic and monetary stability (see for example Ranaldo and Söderlind (2010) and Baltensberger and Kugler (2016)). Against this backdrop, economists have argued that non-residents demanded more Swiss franc denominated assets as a consequence of the 2008 financial crisis and the Eurozone crisis of 2011 (see e.g. WTO (2013) and IMF (2015c)). As a result, the Swiss franc experienced considerable upward pressure. The argument is that, in order to protect the economy from these cyclical inflows that are not driven by economic fundamentals, the SNB has to intervene via a peg or via 'managed floating'[15]. Note that, if safe haven flows were indeed the only driver of the upward pressure on the Swiss franc, the latter would decrease and the SNB could potentially get rid of its foreign assets as soon as growth and stability prospects increase in the world economy, and particularly the euro area [16] . Indeed, between August 2011 and January 2013, foreigners increased their Swiss assets by CHF 174 billion, especially around the elections

[15] The SNB's policy after January 2015 has often been described as a managed floating policy, see for example NZZ online, accessed March 2017.

[16] Note that while risk-averse investors might *structurally* keep a certain fraction of their portfolio in safe haven currencies like Swiss franc, the discussion here refers to a *cyclical* increase in demand for the safe haven asset Swiss franc.

in Greece (Auer (2015), IMF (2015c)). However, this foreign demand, which was likely driven by Switzerland's safe haven status, is not the only cause of the Swiss franc's appreciation. Shortly after the 2008 financial crisis, Yesin (2015) documents net capital inflows of Swiss residents, i.e. repatriations of foreign assets in 2008[17]. Moreover, while domestic demand for the Swiss franc also grew in the above mentioned period between 2011 to 2013, it became in fact the driving force for the Swiss franc's appreciation after 2013, when foreign Swiss franc positions actually decreased (Auer and Tille (2016) document the net claims on the Swiss banking system in detail).

The foregoing discussion suggests that the ongoing interventions of the SNB should not exclusively be seen as a sterilization of safe have inflows. Instead, the SNB's interventions mirror Swiss repatriations and a decrease in foreign asset purchases by the private sector, as indicated in section 1.1. Sornette (2015) argues that "Swiss investors, pension funds, large firms and private persons find it less attractive to invest abroad amid political and economic risks." Along these lines, Yesin (2015) suggests a 'home bias' to explain the repatriations. Beyond that, the literature discusses (part of) the portfolio re-allocation as a result of rational return maximization considerations as well as an unwinding of foreign carry trade positions. In the next two subsections, we will take a look at the investment universe from the perspective of a Swiss investor. First, we will see that favorable interest rate spread returns started to vanish around the millennium [18]. Second, we will adopt a more holistic approach and look at all asset classes via the evolution of the foreign wealth of Swiss residents (the total net international investment position).

1.3 The end of the 'Swiss interest rate island'

In addition to safe haven flows and 'home bias' effects, the literature emphasizes other more structural explanations related to the so-called 'Swiss interest rate puzzle' or 'Swiss interest rate island'. The latter phenomenon refers to the historically lower returns on the Swiss franc compared to other major currencies: Feld and Köhler (2015) review several studies that document lower returns on Swiss franc denominated short-term assets during the 1980s and 1990s compared to other currency returns (evaluated in Swiss franc). This phenomenon contradicts conventional theory, which states that financial markets will equilibrate return differentials between different currencies. Put differently, theory expects uncovered interest rate parity (UIP) to hold[19]. Figure 4 shows the average return differentials between one-month deposit rates evaluated in Swiss franc. Positive values indicate that investors achieve a higher return by exchanging their Swiss francs for the foreign currency, earning the yield on the foreign currency deposit, and finally exchanging the foreign currency holdings back to Swiss francs. Positive values thus indicate higher returns for Swiss residents if they invest in foreign currencies [20]. Mean differentials are positive on average

[17] In this context, note that small capital movements can result in large price changes. This is in line with the literature on asset pricing where prices can move dramatically without major re-allocations of portfolios. Yesin (2015) documents that after 2009 gross capital in- and outflows of Switzerland have actually decreased, debunking the common perception of large amounts of money flowing back and forth. In line with that, Yesin (2016) shows that the size of capital flows have little explanatory power in tracking the movements of the CHF exchange rate. "Findings of this study suggest that the appreciation of the CHF may have been due to a mechanism other than higher capital (in)flows during the recent global turmoil." Part of the answer is that Swiss residents were reluctant to be paid in foreign assets, i.e. were reluctant to invest abroad.

[18] Note that returns refer to total income from a Swiss perspective and thus take exchange rate effects into account. Yields, however, are measured in domestic currency.

[19] Uncovered means that the exchange rate risk is not hedged. Covered Interest Rate parity is rarely violated.

[20] Swiss residents typically evaluate their portfolio in Swiss franc.

Mean rate of return differentials for one-month currency investments vis-à-vis the Swiss franc (% per year)			
	1980-1998	1999-2008	2009-2016
US Dollar	2.34 (3.04)	0.10 (3.14)	-1.64 (4.24)
Euro (DM before 1999)	0.89 (1.10)	0.96 (1.09)	-3.82 (3.12)
Yen	2.91 (2.58)	-2.53 (2.99)	-4.57 (4.93)
British Pound	3.18 (2.36)	0.98 (2.22)	-3.64 (4.37)

Fig. 4: Mean return differentials of one-month Eurocurrency investments vis-à-vis the Swiss franc. A positive value indicates a higher return for the non-Swiss currency. Standard errors are in brackets. Source: One-month Eurocurrency and monthly exchange rates data from Thomson Reuters Datastream.

from 1980 to 1998, in line with Feld and Koehler's (2015) meta analysis. From 1999 to 2008, the average return spread decreases but remains positive vis-à-vis the US Dollar and the British Pound. The return spread vis-à-vis the Yen turns negative, whereas it remains roughly constant vis-à-vis the Euro. After 2009, the spreads are negative on average vis-à-vis all currencies. The shift largely reflects the appreciation of the Swiss franc, but is in addition driven by declining interest rate yield spreads[21]. Kugler and Weder (2009) attempt to estimate a breakpoint between 1980 and 2008 but do not find a statistically significant one, suggesting that the decline cannot be associated to a single event.

More generally, the literature is neither conclusive on how to explain the positive spreads nor on how to explain the decrease in the return differentials over time: Possible factors leading to a decline in the spreads until 2008 include a lower risk premium on the Swiss franc due to higher political stability or due to higher 'competition' from other (temporarily) stable currencies like the Euro or the Yen (see discussion in Kugler and Weder (2009)). In addition, the literature discusses a build-up of international carry trade positions as well as their sudden unwinding as an explanation for both the predominantly positive spreads prior to and the negative spreads after 2008. In general, uncovered interest rate parity violation is often associated to carry trades where investors borrow in low-yielding currencies and lend (invest in) high-yielding currencies. Carry trades are profitable if the funding currency appreciates by less than the positive yield spread. They tend to re-enforce themselves in the upswing by putting upward pressure on the high-yielding currency and depreciation pressure on the funding currency. As a consequence, the total return of carry trades might consist of both an interest rate spread and an exchange rate yield. The evolution of carry trades is typically unstable as domestic macroeconomic characteristics tend to be less important (Forbes and Warnock (2012)). Eventually, either the decoupling of capital flows from economic fundamentals takes the upper hand or global factors like risk or contagion cause an (over-)appreciation of the funding currency. Indeed, the literature documents that the sudden unwinding of carry trades can result in fast exchange rate movements and currency crashes (see for example Brunnermeier et al (2008)). While carry trades, not least in their magnitudes, are

[21] Note that the mean values are to be regarded with caution, as the standard errors are very high due to the monthly exchange rate volatility. Yet, given monthly data and observations for several years, the decline in return spreads is robust.

typically hard to identify, Galati et al (2007) as well as UNCTAD (2007) provide evidence of the Swiss franc's and the Yen's significant roles as funding currencies. Against this backdrop, the relatively weak Swiss franc prior to 2008 can be situated in the context of an international carry trade, whose sudden end was triggered by the outbreak of the US financial crisis (Vallet (2016))[22]. In line with this, OECD economists Jarret and Letremy (2008) warned that the reversal of large carry trade positions might cause considerable appreciation pressure: "If at some point Swiss holders of huge foreign assets decide to repatriate them at a rapid pace or foreign investors choose quite suddenly to unwind their carry-trade positions [...] then the franc exchange rate would appreciate." Yesin (2015) and Auer and Tille (2016) document that bank lending flows explain large parts of the changes in Swiss private capital flows until 2015.

Summing up, it becomes evident that the end of the Swiss interest rate island is difficult to explain. Predicting whether the positive return spreads will return is consequently even harder. In order to obtain a more holistic picture of the returns on assets and liabilities of Swiss residents, the next subsection will complement the foregoing discussion with an analysis of Switzerland's international investment position.

1.4 The gap between cumulated income flows and actual foreign wealth

This subsection compares the annual net current account income flows with the actual net foreign wealth to shed further light on the origins of the Swiss franc's appreciation. Comparing the flows and stocks of foreign wealth allows us to infer the aggregate return of foreign assets held by all Swiss residents, as well as the aggregate return of Swiss assets held by foreigners. If, for example, the net foreign wealth stock does not rise despite net foreign income flows, this might reflect lower returns of Swiss residents' foreign assets relative to the returns of Swiss residents' liabilities vis-à-vis the rest of the world.

The international investment position (IIP) records Swiss residents' foreign assets as well as their liabilities vis-à-vis the rest of the world. Except for foreign direct investment, which is estimated at book value, all other components (portfolio equity, portfolio debt, and so-called 'others') are estimated at market value. Note that the IIP is denominated in Swiss franc. As mentioned in section 1.1, the IIP thus records the stocks, while the balance of payments keeps track of the associated flows. In this context, net foreign wealth, or the so-called total net international investment position (NIIP), is of particular interest. A positive NIIP indicates that Swiss residents have net claims on the rest of the world. Figure 5 shows that the Swiss NIIP is clearly positive, amounting to around CHF 600 billion in the early 2000s. The size of total net foreign wealth has been comparable to that of the SNB's net foreign assets over recent years. In other words, it is no longer the private sector that is holding Swiss net foreign assets, but the SNB. The moderate upwards trend in NIIP since 2000 has been reversed in 2012. This appears somewhat puzzling as one would expect foreign wealth to rise due to the persistent current account surpluses. Figure 6 takes a closer look at this and shows the actual gap between the cumulated income flows from the current account surplus and the actual net foreign wealth position, using historical data from 1985 to 2005. Until around 1999, the cumulated current account surpluses are roughly in line with the NIIP. This co-movement of both variables appears intuitive as one would expect a country

[22] The CHF/EUR exchange rate changed from 1.45 in 01/2003 to 1.66 in 01/2008, i.e. the Swiss franc depreciated by 14.5 %.

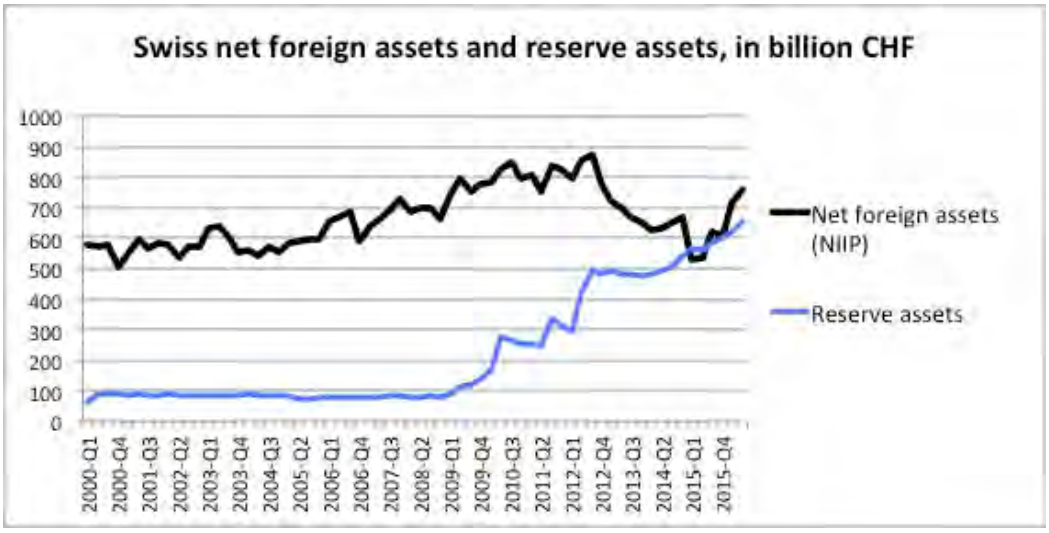

Fig. 5: Total net international investment position (NIIP) and total reserve assets in absolute values, quarterly data. Source: SNB

that acquires, for instance, net foreign assets worth 50 billion annually over ten years to end up with additional net foreign assets worth 500 billion. In the Swiss case, however, the actual net foreign wealth has been subdued from 1999 to 2005 (see figure 6)[23]. Updating this figure with more recent data from 2000 to 2015 suggests that the gap between the cumulated flows and actual net wealth remains (see figure 7)[24]. Particularly noteworthy is that the NIIP as a percentage of GDP was smaller in 2015 than in 2000, although Switzerland had pronounced current account surpluses in the meantime. This stands in stark contrast to what an analysis of the accumulated flows would suggest, according to which net foreign wealth should exceed actual foreign wealth by more than 100% of GDP. Where did all the foreign wealth go? Or more precisely: What explains the difference between the accumulated current account surplus and the NIIP? In order to answer this question, we will discuss (i) statistical measurement issues, (ii) exchange rate movements and (iii) other valuation effects in more detail.

(i) Statistical bias

Statistical measurement issues explain part of the gap between the cumulated net foreign income and the actual net foreign wealth. First, the IIP data are estimated via surveys. Over time, the samples that are surveyed as well as the methodology can vary. Second, cross-border shopping is partly unaccounted for in the import statistics of the current account (IMF (2014)). Data from SIX on the payment volumes of Maestro Cards indicate an increase in cross-border shopping since 2009[25]. However, to the knowledge of the present authors, no estimates are available that would allow one to infer to what extent this effect overstates the current account surplus.Finally, an

[23] Note that this decoupling roughly coincides with the decline in the interest rate spreads discussed in section 1.3.

[24] These data are consistent with the IMF's BPM6 statistical standard. Data prior to 1999 are only available for the previous BPM5 standard and can therefore not consistently be compared with the most recent data which are only estimated according to BPM6. See www.snb.ch for more information.

[25] See here handelszeitung.ch, accessed March 2017

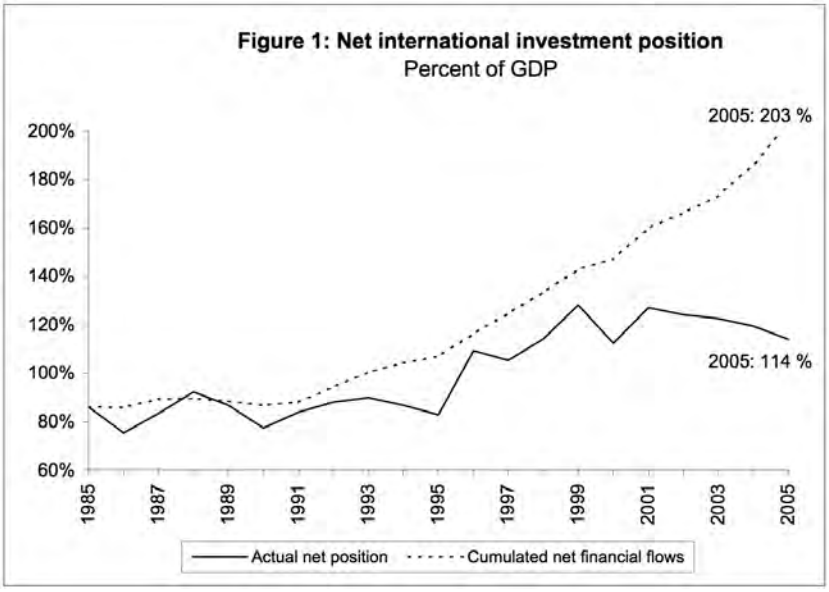

Fig. 6: Net international investment position ('Actual net position') and cumulated net current account surpluses ('cumulated net financial flows'). Persistent net foreign income fails to increase the actual net foreign wealth of Switzerland after the millennium. Reprint from Stoffels and Tille (2007).

important statistical bias is associated with the official conventions about how to measure international income flows and stocks. Recall that, if a non-resident owns less than 10% of the equity of a Swiss firm, this is called 'portfolio investment'. However, once more than 10% is owned, it is called 'foreign direct investment'. Now consider a non-resident holding portfolio investment in a Swiss firm (around 60% of Swiss multinationals are actually owned by foreign portfolio investment). In the balance of payments, dividend payments from the Swiss firm to the foreign portfolio investor are recorded as 'investment income' for the non-resident. By accounting convention, retained earnings of the Swiss firm, i.e. earnings minus dividend payments, are not attributed to the foreign investor and do not show up in the balance of payments. However, when it comes to the international investment position, the fact that the firm is partly owned by a non-resident is taken into account. As a consequence, the current account income overestimates the wealth that is actually accumulated by Swiss residents. To give an illustration, assume that Swiss firms have a payout ratio of one third[26]. Furthermore, assume that Switzerland has portfolio investment expenses of CHF 20 billion. The retained earnings associated with these expenses are thus CHF 40 billion and are treated as Swiss investment income in the balance of payments. However, in order to properly capture Swiss wealth accumulation in a way that is consistent with IIP data, these CHF 40 billion should be associated with non-residents.

Note that the effect on how to treat retained earnings goes in both directions: if a Swiss resident has portfolio investments abroad, the retained earnings should also count as investment income. Both effects could potentially offset each other, so that the net effect depends on the asset-liability composition of Switzerland's foreign positions. Note further that this effect does

[26] The payout ratio is defined as the dividends paid per share divided by the earnings of the firm per share.

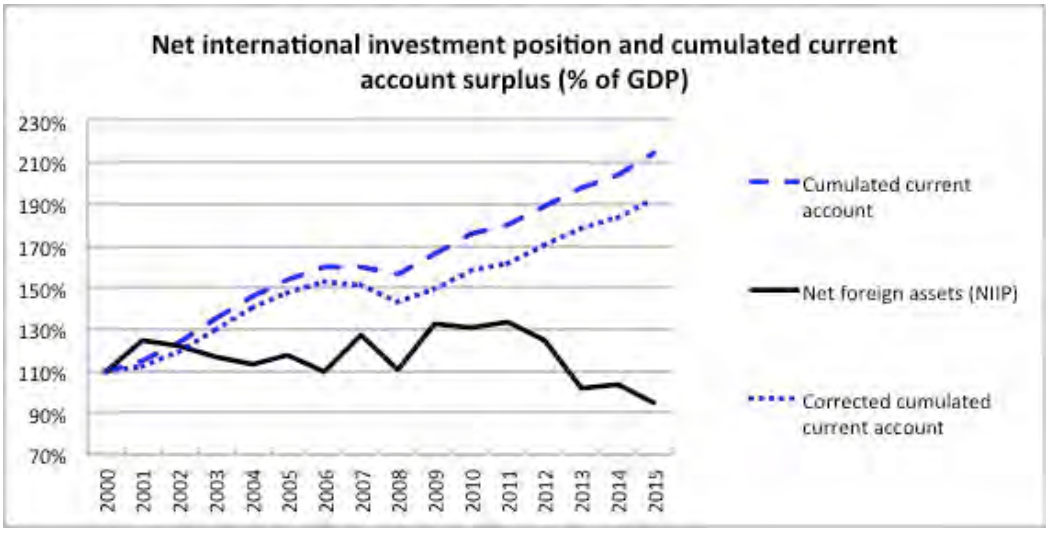

Fig. 7: Total net international investment position (NIIP) and cumulated current account surpluses, as a percentage of GDP. The 'corrected cumulated current account' takes into consideration a statistical bias that overstates the current account due to the treatment of retained earnings in the balance of payments. Exchange rate movements and other valuations explain a significant part of the gap between the income flows and the actual foreign wealth of Switzerland. Source: SNB, SECO, Thomson Reuters

not occur in the case of foreign direct investment, i.e. once the investor holds more than 10% equity of the company. In this case, retained earnings are actually attributed to the investor - consistent with the IIP statistics. However, if the investor is a Swiss multinational largely owned by foreign portfolio holdings, the foreign direct investment income of this firm should proportionally be attributed to the foreign shareholders. Put differently, the earnings of foreign branches of Swiss multinationals qualify as foreign direct investment income (since the Swiss firm trivially owns more than 10% of its branch) and are therefore completely attributed to Swiss multinationals, i.e. to Swiss residents - instead of being partly recorded as income for the foreign portfolio investors.

Empirically, Swiss equity liabilities are larger than equity assets, such that the net effect overestimates the current account surplus. In order to correct for the different treatment of foreign direct investment income and portfolio income, we estimate the upward bias using the payout ratios for the major stock market indices[27]. We find that the current account surplus overestimates wealth accumulation by on average 1.8% of GDP annually from 2000 to 2015. Figure 5 shows the 'corrected cumulated current account', which takes this effect into consideration. Note that the estimates are subject to uncertainty as the exact portfolio compositions are not known. Yet, it is clear that the bias due to the treatment of retained earnings is non-negligible, explaining roughly

[27] Payout ratios for the US portfolio are estimated using the S&P 500, the Euro portfolio is estimated based on the DAX, and the 'other currency equities' are proxied using the FTSE. We hence assume that residents and non-residents invest on average according to stock market indices, which is a common assumption in the literature and seems reasonable. Annual equity assets and liabilities are taken from the SNB data of the IIP.

20% of the gap between 2000 and 2015[28]. In the next paragraphs we will see that exchange rate and other valuation effects explain large parts of the gap between the 'corrected cumulated current account' and the actual net foreign wealth.

(ii) Exchange rate movements

The NIIP is denominated in Swiss franc, which means that foreign assets are evaluated in Swiss franc using the current exchange rate. As a consequence, an appreciation of the Swiss franc lowers the value of foreign assets. An appreciation of the Swiss franc can also lower the value of liabilities if they are denominated in foreign currencies. However, since Switzerland has net foreign currency assets, an appreciation of the Swiss franc has a negative effect on the NIIP. Between 2000 and 2015, Switzerland's net foreign currency assets increased from around CHF 1'100 billion to CHF 2'500 billion. A one percent annual nominal appreciation of the Swiss franc against all foreign currencies would have reduced the NIIP by on average 2.9% of GDP per year over the fifteen years considered. Due to data limitations, however, a detailed estimation of the historical exchange rate effect on the net foreign wealth is not possible. The NIIP data is only broken down into Dollar, Euro and 'other currencies'. The composition of 'other currencies' is not known but the latter make up more than one third of total net foreign assets. Consequently, while the total negative exchange rate effect on foreign wealth remains unknown, the negative effect of the Swiss franc's appreciation vis-à-vis the Euro and the Dollar can be estimated and stood at 9% of GDP in 2015. Overall, Euro and Dollar effects lowered the NIIP by on average 5% of GDP annually from 2000 to 2015. Between 2000 and 2008, the appreciation of the Swiss franc was less pronounced, reducing net Euro and Dollar assets on average by 2.6% of GDP per year.

(iii) Valuation Effects

Besides exchange rate effects, other valuation effects also play an important role in explaining the gap between the cumulated income flows and the actual foreign wealth. Except for foreign direct investment, which is estimated at book value, the NIIP records the market value of assets and liabilities. Consequently, a foreign equity investment that looses value will have a negative effect on the Swiss NIIP. Similarly, if Swiss firms are (partly) owned by non-residents, and if the equity value of these firms raises, the liabilities of Swiss residents vis-à-vis the rest of the world will increase, lowering the NIIP. A simultaneous rise in Swiss and non-Swiss stock markets could thus result in either an increase or a decrease of Switzerland's foreign wealth. In order to find out which of the two scenarios applies to Switzerland requires us to take a closer look at the Swiss asset-liability composition. IIP data is broken down into three broad groups: i) direct investments, ii) portfolio investments, and iii) other investments[29]. Within portfolio investments, equity

[28] Our estimates are roughly in line with other studies on this topic: Provisional estimates by Mancini-Griffoli and Stoffels (2012) find an average upward bias of 3.5% of GDP between 2000 and 2011, while our estimate for the same period is 1.9% of GDP. These authors assume the same payout ratio for expenses and receipts over the whole period. Note that the SMI's payout ratio increased from less than 30% in the early 2000s to more than 50% in recent years (while the weighted payout ratio of the US and European stock market indices remained roughly constant). Neglecting this increase will lead to a higher upward bias and might thus explain why our estimates are smaller. Furthermore, our estimates are roughly in line with the IMF's estimates, although the IMF does not describe the method used, which means that we could not investigate the origins of the bias. The IMF (2007 and 2015c) estimates the one-sided upward bias (not the net effect) as up to 7% of GDP (IMF 2007) and 3% respectively (IMF 2015), whereas our estimates for the the same years are 6% and 4% of GDP, respectively.

[29] An investment qualifies as foreign direct investment if the investor owns more than 10% of the shares of the foreign firm, otherwise the investment is a portfolio investment.

liabilities make up around 90% of total portfolio liabilities. Portfolio assets, however, consist of debt securities (55%) and equity assets (45%). Put differently, Swiss portfolio liabilities are mainly equities, while portfolio assets are mostly debt securities. Comparing the levels of portfolio equity assets and liabilities shows that non-residents own 55% more Swiss equities than vice versa. As a consequence, based on portfolio equity data from 2015, a 5% homogeneous rise in global stock markets would have decreased the Swiss NIIP by around 3.5% of GDP.

These numbers indicate that valuation effects play an important role in explaining the gap between foreign income flows and foreign wealth. Unfortunately a detailed estimate of the historical impact of valuation effects on the Swiss NIIP faces empirical obstacles as official data on the detailed portfolio compositions as well as on market valuations of foreign direct investments are missing. For the period between 1986 and 2005, however, we can build upon detailed estimates of Stoffels and Tille (2007). These authors find that estimating foreign direct investments at market rather than book value and taking into account exchange rate movements and equity valuations explain up to 54% of the gap observed in 2005. In addition, the authors estimate the yields (excluding exchange rate effects) and total returns on foreign assets and liabilities, documenting changes in the global investment environment from a Swiss perspective that are in line with our previous analysis of the Swiss interest rate puzzle[30]. More specifically, Stoffels and Tille (2007) find on average favorable yields on portfolio investments (which includes debt securities), foreign direct investments and other investments from 1986 to 2005[31]. However, the yields decrease between 1986 and 2005. Moreover, total returns (which include exchange rate effects) are actually negative on average over the entire period. Prior to 2000, the total return spread between all assets and liabilities is zero on average. Between 2000 and 2005, the average return difference turns negative, reaching -3.2%. This result is not surprising given that the cumulated current account has started decoupling from the net foreign wealth around 2000.

So far, we have seen that exchange rate and asset price movements have produced pronounced losses in Swiss foreign wealth over the past 15 years. However, more refined national data would be needed to reduce uncertainty about the estimates discussed so far. Let us now briefly consider the IIP category 'other investment', which deserves closer attention, and, as we will see, links to the discussion in section 1.2. According to Stoffels and Tille (2007)'s estimates, the 'other investment' category has recorded continuous positive return spreads until 2005, while portfolio and foreign direct investment spreads have been negative. Note that 'other investments' include inter-bank investments (loans), the assets of which have decreased from CHF 813 billion in 2007 to CHF 448 billion in 2008 and CHF 279 billon in 2015. In line with this, the SNB (2015) emphasizes that the reduction in capital stocks abroad after 2008 has been particularly pronounced for banks. This is reminiscent of our previous discussion about the fact that bank lending explains a large part of the change in private investment flows (see section 1.3)[32].

[30] The previous discussion about the Swiss interest rate island indicated that the favorable returns on short-term interest rates have decreased over time and turned negative in recent years. Looking at the total portfolio of foreign assets and liabilities, Stoffels and Tille (2007) take a more holistic approach, analyzing spreads for all investment categories.

[31] In the case of portfolio investments, this means, for example, that Swiss residents pay on average less on their portfolio liabilities than they earn on their portfolio investments, measured in local currency.

[32] See also Auer and Tille (2016), who document the increase in the Swiss banking sector's international activities prior to mid-2007, as well as the following bust in more detail.

Summing up this section, we can conclude that cyclical safe haven effects alone cannot account for the recent upward pressure on the Swiss franc, but have to be complemented by more structural factors. The decrease in foreign investment reflects both the end of the 'Swiss interest rate island' as well as Switzerland's subdued foreign wealth. From a Swiss perspective, the foreign investment environment deteriorated already prior to 2008, and significantly worsened after 2008, partly driven by an unwinding of banks' foreign positions. Despite the uncertainty associated with the estimates of the different drivers of the Swiss franc's appreciation, the overall picture that emerges suggests that the current situation is likely to stay[33]. Even if Europe and the rest of the world would experience a strong acceleration in growth that would preclude further safe haven pressures, it is not clear if Swiss residents and in particular banks could and would return to their pre-2008 investment and lending patterns [34,35]. While precise predictions remain speculative, this section suggests that Switzerland has reason to consider the steady pressures on the Swiss franc and the associated central bank interventions as a 'new normal'. The next section will support this interpretation, drawing upon insights from other surplus countries.

[33] Such an interpretation is also in line with economic theory, according to which UIP violation is theoretically rather puzzling (see section 1.2). In addition, see for example chapter 12 in Godley and Lavoie (2007) for a simple macroeconomic model, in which the surplus country experiences endogenous upward pressure on the exchange rate. In the long-run, the former surplus country runs a trade deficit driven by a relatively strong currency. The overall current account is balanced because the negative trade balance is compensated for by net investment income. Put differently, after living below their means, the country lives above their means. So-called inter-temporal consumption smoothing theories will be discussed briefly in section 4.

[34] A growing body of literature suggests that the post-crisis slow economic growth scenario is secular as opposed to being cyclical or short-term.

[35] Auer and Tille (2016) suggest that, due to the losses suffered by the banking sector and potentially due to new regulations, the Swiss banking sector might not return to its pre-crisis lending patterns.

2 Insights from other surplus countries: central bank intervention and the rise of sovereign wealth funds

In the previous section, we have seen that the Swiss private sector is on aggregate no longer investing its net foreign income abroad. At its place, the SNB has become the 'foreign asset holder of last resort'. This section compares Switzerland's new situation with that of other surplus countries on an aggregate level. We find that the structure of Switzerland's balance of payments after 2008 is not exceptional. More specifically, we show that:

- In the eight surplus countries under consideration, the central bank is often mirroring (part of) the current account surplus, thereby accumulating foreign assets.
- Moreover, most of the countries under consideration either already have or consider to implement sovereign wealth funds (SWFs) that purchase and manage increasing amounts of foreign assets - in addition to the central bank.

2.1 The precautionary and the mercantilist motive: central bank's acquisition of foreign assets goes hand in hand with a current account surplus

The literature discusses two broad motives for holding foreign reserves. The first is a precautionary motive that aims at increasing financial stability. In this regard, foreign reserves serve as an insurance against volatile capital flows, such as stops and reversals of (short-term) capital inflows in particular. The second motive is a mercantilist one and reflects an economic policy that keeps the exchange rate at a lower and stable level in order to support and boost growth via the tradable sector.

The precautionary motive is well-documented and explains significant parts of foreign reserve movements (see for example Obstfeld et al (2010) and Gosh et al (2012)). A growing body of literature, however, argues that a large part of the increase in foreign reserves in the 2000s has been driven by a mercantilist motive[36]. Delatte and Fouquau (2012) find that a mercantilist motive is the major driver of increasing foreign reserves between 2000 and 2012 in emerging economies (including e.g. Israel, China, Taiwan, Korea). Similarly, Cruz and Kriesler (2010) argue that the accumulated reserves since 1997 in many developing and developed countries are in excess of what is needed for precautionary measures. Along these lines, Borio (2014) documents an increase in global reserves and associates it to 'beggar-thy-neighbour' policies.

Figure 8 shows the balance of payments for countries that typically run current account surpluses. The increase (or decrease) in reserve assets is recorded in the financial account and is indicated separately from the total net financial account. Negative values indicate a net acquisition of foreign assets. East Asia's four major economies, China, Japan, Korea and Taiwan, together with Singapore, feature a combined current account surplus of USD 700 billion in 2015[37]. Overall, figure 8 shows that a current account surplus is often accompanied by foreign reserve

[36] However, given the difficulties to empirically identify the different motives, studies do not always coincide in their results. Cheung and Ito (2009), for example, do not find much evidence for excess reserve holdings in East Asian economies, including China and Japan, prior to 2005.

[37] This value is similar to the levels before the outbreak of the global financial crisis

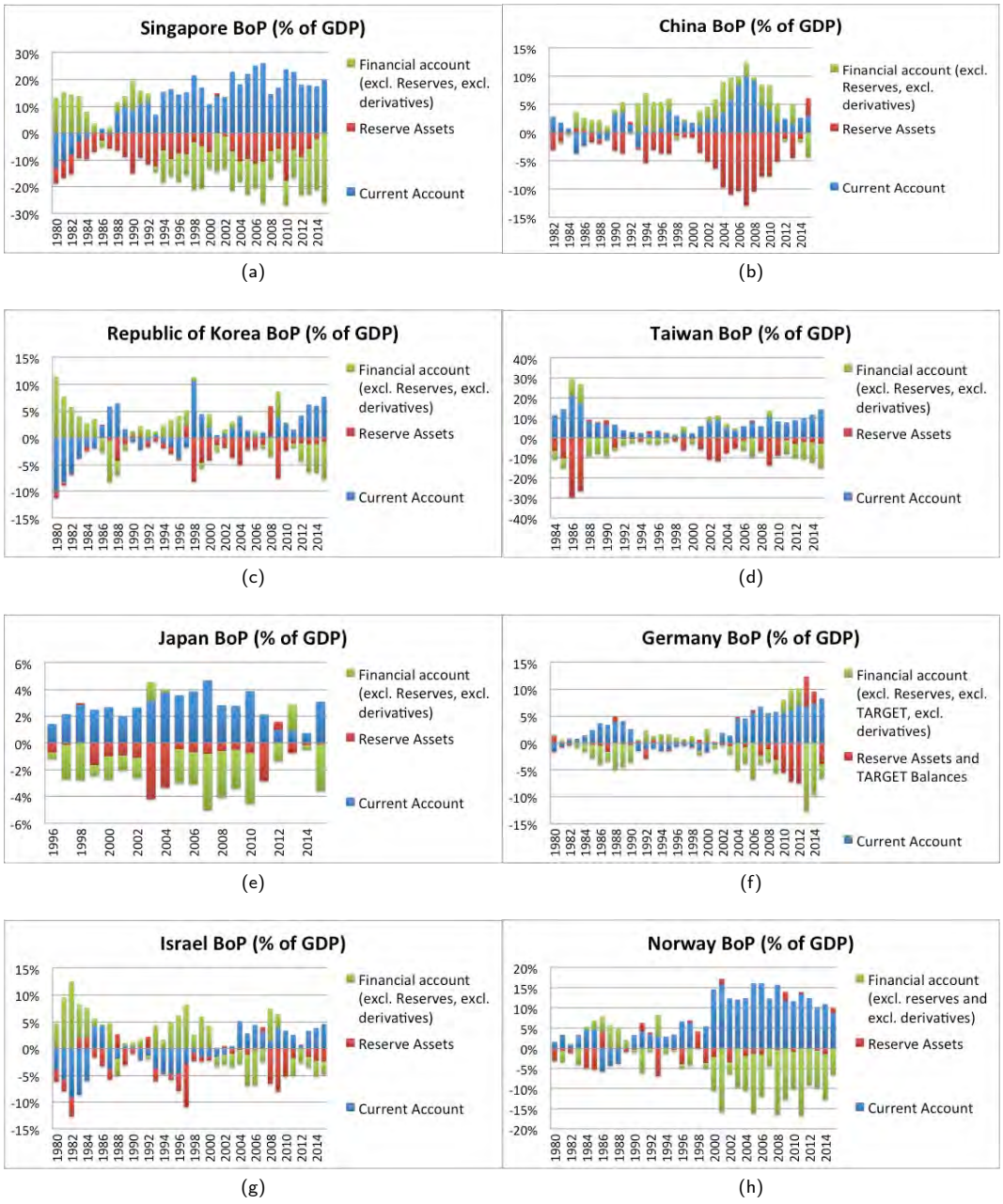

Fig. 8: Balance of payments (BoP) as a percentage of GDP for major surplus countries between 1980/1982/1984 and 2015, (1996-2015 for Japan due to data limitations). The accumulation of reserve assets, which is part of the financial account, is indicated separately to illustrate the extent of central bank intervention. Note that reserve assets do not include purchases of foreign assets by other public entities, such as sovereign wealth funds. Note further that, in the case of Germany, the TARGET2 (Trans-European Automated Real-time Gross Settlement Express Transfer System) balances are plotted in addition to reserve assets. TARGET2 balances are to be interpreted differently from reserve assets (see text). Source: International Monetary Fund (IMF), Worldbank, European Central Bank (ECB), Bank of Taiwan

accumulation. Nevertheless, some countries run large current account surpluses during certain periods with little central bank intervention, as for instance Norway over the past fifteen years. A country-by-country discussion follows to refine this broad picture.

The Monetary Authority of **Singapore** (MAS) has been intervening continuously since 1980. At the same time, the deficit of the financial account excluding the central bank is considerably pronounced as well - the reason for which will become clearer in section 2.2. **China**'s current account surpluses in the 2000s have been more than offset by the increase in reserve assets by the People's Bank of China. The financial account excluding reserve assets has been positive most of the time, indicating that Chinese residents (excluding the central bank) have been net selling domestic assets (figure 8 (b)). Since 2015, however, China has supported its currency and sells foreign exchange reserves.

In the Republic of **Korea**, during the 1997-1998 Korean financial crisis, short-term capital from abroad was withdrawn within a few days, so that the country ran out of reserves quickly. Reserve assets were accumulated in subsequent years, helping shift the current account deficit from the early 1990s into a surplus (figure 8 (c)). In line with the previous discussion, the magnitudes and continuity of Korea's foreign exchange interventions are difficult to justify from a financial stability point of view alone. Recently, however, foreign reserve accumulation has slowed down. Similarly, **Taiwan**'s continuous interventions cannot be justified with precautionary motive (figure 8 (d)). While recent years have seen a decrease in the financial account deficit excluding the central bank, Taiwan remains on the US treasury's monitoring list because of its engagements in persistent foreign exchange purchases in 2016. In **Japan**, foreign reserve acquisition has also been persistent until a recent slow-down.

Besides China, Korea, Taiwan and Japan, **Germany** is the fifth country on the US watch list for currency manipulation. Foreign exchange interventions have been limited in the 1980s and 1990s despite current account surpluses in the late 1980s. After the creation of the Eurozone, Southern European countries were running deficits, while the Northern ones - and in particular Germany- ran persistent current account surpluses. The reserve assets of the German Central Bank do not reflect the full picture of these imbalances. Instead, the TARGET2 (Trans-European Automated Real-time Gross Settlement Express Transfer System) balances are indicative: "When banks in the surplus countries started to cut lending to banks in the deficit countries, the latter strongly increased their refinancing operations with the Eurosystem. The resulting payment flows were then reflected in the (in)famous TARGET2 balances." (Unger (2017)). Put differently: before the European Crisis, the banks of European surplus countries were willing to lend their excess reserves - created through net payments from deficit to surplus residents - to banks in the deficit countries. This situation changed in 2008, and persists with the exceptions of 2013 and 2014 until today (end of 2016). Note that the TARGET2 balances are to be interpreted differently than foreign reserve acquisitions because the former are not the result of an active intervention of central banks. Instead, TARGET2 balances simply record refinancing in the Eurosystem. Yet, and this is indicative for our analysis, if local currencies had not been replaced by the Euro, the German Bundesbank would have had to intervene massively after 2008 in order to maintain a fixed exchange rate vis-à-vis deficit countries.

Finally, figures 8 (g) and 8 (h) show the balance of payments of **Norway** and **Israel**, two countries that are large exporters of natural oil and gas. Israel has been accumulating large

amounts of foreign reserves, especially over the last years as part of an active central bank policy that sterilizes sales from gas extraction. Put differently, the Bank of Israel purchases foreign reserves at the same amount as gas is sold to foreigners. Interestingly, "this operation is expected to continue until a wealth fund will start to operate" (IMF (2015a)). Norway, on the other hand, runs very large current account surpluses but does not show much foreign reserve accumulation compared to the other surplus countries discussed so far. In other words, over the last decade, the financial account (excluding reserves) has largely mirrored the current account surplus. At first sight, this bares much resemblance with the Swiss statistics prior to 2008 (see section 1.1). Is the private sector in Norway - similar to the private sector in Switzerland prior to 2008 - accumulating net foreign assets at an amount equal to the current account surplus? So far we have ignored the fact that the Government of Norway also sterilizes its oil sales - not via the central bank, but via the Government Pension Fund of Norway (the 'Norway Oil Fund'). The Norwegian balance of payments in recent years can therefore not be compared to the Swiss balance of payments prior to 2008 since we have not considered the extent to which Norway's Oil Fund is contributing to the net purchase and management of foreign assets. While annual flow data of the Oil Fund are not available, we will take a closer look at the stock data, i.e. at the total asset under management of Norway's Oil Fund in the next section. In fact, the next section will consider sovereign wealth funds more generally in light of their importance for our analysis: If a government sets up a sovereign wealth fund in order to, for example, channel oil income or pension contributions abroad, this will impact the balance of payments. Consequently, analyzing exclusively the reserve assets of central banks does not provide the full picture of governments' purchase and management of foreign assets.

2.2 Oil- and surplus-based sovereign wealth funds and their rising role in purchasing and managing foreign assets

So far, we have shown the balance of payments for various surplus countries and found that central banks tend to play an important role in purchasing foreign assets. However, the central bank is not the only sovereign entity that can purchase and manage large amounts of foreign assets. Sovereign wealth funds (SWFs) have become increasingly important globally with total assets under management estimated to have grown from USD 3 trillion in 2008 to more than USD 6 trillion in 2015 (Preqin (2015))[38].

SWFs can be broadly categorized as being 'oil-based' or 'surplus-based'. Historically, oil-based SWFs were created to stabilize fluctuating commodity prices. In later stages, however, these funds have not only smoothed income but actually preserved income from natural resource extractions[39]. It is commonly argued that the income from non-renewable resources should (partially) be saved for future generations. Another argument in favor of creating oil-based SWFs relates to their impact on the exchange rate. Oil-based SWFs typically recycle oil or gas earnings abroad and thereby avoid a currency appreciation that would occur otherwise, i.e. that would occur if the income had been spent domestically[40]. The phenomenon of an appreciating currency in oil- or gas-

[38] Since many SWFs do not publish their data, estimates are subject to uncertainty. However, the hike in assets under management is well-documented. See Fotak and Megginson (2015) for a recent survey on SWFs.

[39] The rise in global oil prices from USD 10 per barrel in 1998 to USD 148 per barrel in 2008 boosted assets under management of oil-based SWFs.

[40] Previously, we have discussed both the precautionary and the mercantilist motive to purchase foreign assets. Using this classification, large oil-based SWFs are subject to the mercantilist motive.

rich countries is commonly known as the Dutch Disease, named after the economic consequences of a large gas field discovery in the Netherlands in 1959. The extraction of the newly discovered gas resulted in a loss of competitiveness via currency appreciation, and ultimately caused a decline of the manufacturing sector[41].

Besides commodity-funded SWFs, 'surplus-based' SWFs have also gained in importance. These separate sovereign entities manage mainly foreign reserves, but also pension assets as well as government surpluses. As we have seen in the previous section, global foreign reserves have increased substantially since 2000. As a consequence, some governments have decided to establish SWFs as separate entities from the central bank, in order to manage (part of) their foreign assets (see discussion below on e.g. Korea, China or Israel). Regarding the international investment position, it does not matter whether the central bank or a SWF holds an *existing* stock of foreign assets - as long as foreign assets are not repatriated[42]. When it comes to the purchase of *new* foreign assets, however, the economics of the central bank are different from those of a SWF. A central bank typically purchases large amounts of foreign assets in an unsterilized way. In other words, the central bank creates (technically unlimited amounts of) new reserve money to buy foreign assets, but does not sell any of its existing (domestic) assets, which could lower the monetary base. In contrast to the central bank, a SWF cannot create new purchasing power itself. A SWF that wishes to purchase additional foreign assets has to pool existing funds, for instance domestic pension funds, or re-invest investment earnings. Keeping this in mind, let us summarize the literature's main arguments in favor of creating a SWF in addition to the central bank (see for example Kim (2011)):

- Institutional advantages: A central bank is typically not equipped and set up to manage large amounts of assets. Creating a separate SWF specialized in these tasks allows one to clearly distinguish between asset management and monetary policy, thus avoiding a potential conflict of interest.

- Portfolio optimization: Central banks typically hold highly liquid, low-risk and low-return assets. If it becomes clear, however, that the foreign reserves will not have to be sold in the near future, they may, in fact, be swapped into a separate vehicle for optimized long-term investment.

- Economies of scale: A SWF can issue bonds in order to pool pension as well as other domestic funds. The concentration of funds and investment expertise gives rise to economies of scale, enhances risk-taking capabilities and develops the domestic financial industry.

While a detailed discussion of the legal and political aspects of SWFs lies beyond the scope of this paper, it is worth mentioning that SWFs face specific operational challenges. In order to address concerns of investors and regulators regarding transparency, independence and governance of SWFs, many countries follow specific principles - such as those outlined in the so-called 24 Santiago Principles. The objectives of the latter are fourfold: First, helping to maintain a stable global financial system. Second, complying with regulatory and disclosure agreements. Third, ensuring that SWFs "invest on the basis of economic and financial risk and return-related considerations",

[41] The Dutch Disease was named after an article in The Economist: "The Dutch Disease" (November 26, 1977). The Economist, pp. 82-83

[42] The investment strategy, however, might affect a country's foreign wealth through future investment returns.

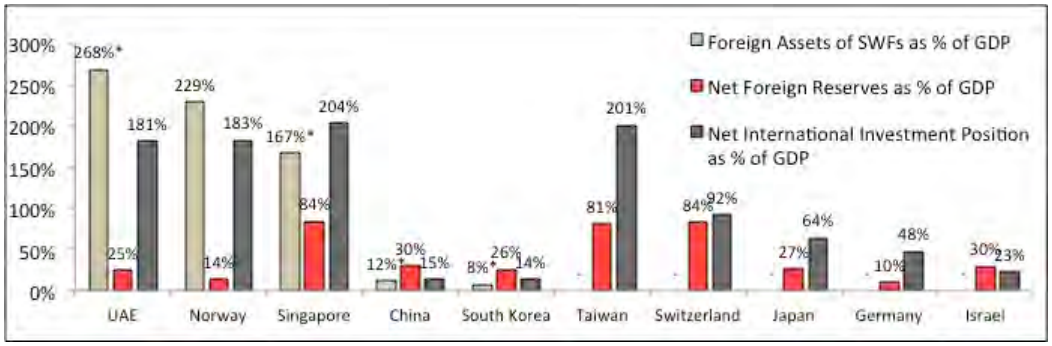

Fig. 9: Foreign assets of Sovereign Wealth Funds (SWFs), net foreign reserves and total net international investment position (NIIP) as a percentage of GDP in 2015. In the case of Singapore, 71 % of Temasek's assets are invested abroad and 100% of GIC's assets. In the case of the United Arab Emirates (UAE), China and Korea, 100 % of the SWFs is assumed to be invested abroad. '-' indicates that the country has no SWF.
Source: IMF, Worldbank, National statistical offices and central banks, official reports of the SWFs, Sovereign Wealth Fund institute.

and fourth, ensuring that "SWFs have in place a transparent and sound governance structure that provides adequate operational controls, risk management, and accountability" [43] . The Santiago Principles include annual reporting, independent auditors, public transparency and commercial orientation, to name a few.

Before analyzing the SWFs of major surplus countries, let us introduce another helpful classification of SWFs (besides the oil/surplus-based one) that is based on the asset-liability profile. On the one hand, a government can set up a SWF that manages funds on behalf of somebody else, for example on behalf of the central bank or domestic residents. In this case, the SWF is an intermediary, issuing bonds (liabilities) and receiving funds such as foreign reserves or pension contributions (assets). On the other hand, a government can actually own the assets of the SWF without incurring liabilities. This is typically the case for oil-based SWFs, whose assets stem from actual income.

Figure 9 shows the foreign reserve assets, the net international investment position, as well as the SWF's foreign assets, each as a percentage of GDP[44]. Again, we show all countries whose balance of payments have been discussed previously[45]. We find that a significant part of the total NIIP, sometimes even more than the NIIP, is held by the public sector, which consists of both the central bank as well as the SWF(s). Let us briefly take the example of Israel to illustrate figure 9: The central bank holds net foreign assets worth 30% of GDP, the overall NIIP is 23% of GDP and Israel has not (yet) a SWF. This implies that Israel's private sector has a negative NIIP, i.e. incurs net liabilities vis-à-vis the rest of the world. Against this backdrop, and keeping the theoretical discussion about SWFs in mind, we will now briefly discuss each country.

The **United Arab Emirates** (UAE) established two sovereign wealth funds to manage oil

[43] The full list of the Santiago Principles can be found at the official homepage of the International Forum of Sovereign Wealth Funds

[44] Some of the large SWFs also invest domestically. However, to assess the magnitude of publicly managed foreign assets, domestic funds are excluded from our analysis.

[45] Note that, due to data limitations, the flows of SWFs' investments, i.e. the annual purchase of foreign assets, have not been discussed in the previous section.

revenues: the Abu Dhabi Investment Authority (established 1976) and the Investment Corporation of Dubai (established 2006). For similar reasons, **Norway** has created the Government Pension Fund of Norway. The fund is commonly referred to as the 'Oil Fund' and is financed by the surpluses of the publicly owned petroleum sector. The Oil Fund holds foreign assets worth more than Norway's total NIIP. This partially explains the low foreign reserves despite the fact that Norway has run large current account surpluses[46]. In 2015, the fund was worth USD 885 billion. It is managed by a part of the central bank on behalf of the Ministry of finance. The fund is a passive investor, currently investing 60% in equities, 35% in fixed income and 5% in real estate[47]. The portfolio allocation of the fund is constrained by social and environmental considerations of the Norwegian government, for which purpose a separate ethical council was founded in 2015.

Singapore is also a very indicative example of how central bank intervention is not the only way in which public authorities can increase the purchase of foreign assets. Compulsory pension contributions from employers and employees are very large in Singapore, amounting to 35 percent of gross salaries[48]. The pension fund (Central Provident Fund) invests these contributions in Special Singapore Government Securities with guaranteed returns (in Singaporean dollars). The Singaporean government, in turn, invests the proceeds of these funds mainly in foreign assets via the Monetary Authority of Singapore (MAS, Singapore's central bank) and the GIC Private Limited (formerly known as Government of Singapore Investment Corporation). On top of GIC, Singapore has a second sovereign wealth fund called Temasek. While the balance sheets of the central bank (MAS) and Temasek are published, Singapore does not reveal the official foreign assets held by GIC. The reason is that the disclosure of all three portfolios would reveal the exact amount of foreign asset purchases, and thereby potentially allow currency speculators to take advantage - something the government is keen to avoid. With foreign assets amounting to 84% of GDP, or USD 246 billion in 2015, the central bank does play an active role besides the two Sovereign Wealth Funds. Besides the above mentioned securities, the GIC has received funds from government surpluses, funds from government's land sales, and re-invested earnings[49]. The GIC has generally invested abroad with the goal of achieving high long-term returns. Unlike Norway's Oil Fund, the GIC is a not a passive, but a strategic investor[50]. Temasek originally inherited the proceeds from several privatizations of companies. In addition, Temasek issues long-term bonds to finance itself[51]. Contrary to the GIC, Temasek is also investing domestically. In 2015, domestic investments made up 29% of the total USD 194 billion.

In **China**, two sovereign wealth funds, the China Investment Corporation (CIC) and SAFE Investment Company, have managed foreign assets worth 12% of GDP in 2015. The pronounced increase in foreign reserves led the government to rethink its foreign investment portfolio, in a search of higher-yielding investments. In this regard, the SAFE Investment Company, a Hong Kong subsidiary of the State Administration of Foreign Reserves (SAFE), is estimated to manage a portfolio of USD 470 billion that takes more risk than the conventional foreign reserve investments

[46] Note furthermore that the private sector has net liabilities of 70% of GDP vis-à-vis the rest of the world (See figure 9: 70% is the difference between total public foreign wealth (243%) and the NIIP (183%).
[47] 70% of fixed income is invested in government bonds and the remaining 30% in corporate bonds
[48] See www.pensionfundsonline.co.uk, accessed March 2017
[49] See official homepage of the GIC, www.gic.com.sg, accessed March 2017
[50] Source: See official homepage of the government of Singapore here and here, accessed March 2017
[51] For example, bonds worth USD 9 billion were issued between 2004 and 2015. Source: Temasek's official homepage, accessed December 2016.

of SAFE. Similarly, CIC was created to better manage a part of the foreign reserves. CIC issued governmentally guaranteed bonds amounting to USD 200 billion that were swapped with part of the foreign exchange reserve in 2007[52]. The newly issued bonds helped meet the demand for safe treasury bonds from financial institutions like pension or insurance funds and enhanced risk-taking capabilities by pooling funds[53]. Currently the fund manages USD 814 billion.

Similar to China, **Korea** decided to manage part of its foreign reserves via a SWF. In 2003, the Korea Investment Corporation (KIC) was created with USD 3 billion public assets and USD 17 billion foreign reserves. As in other countries, this decision was driven by the insight that the central bank would not need all foreign reserves to be liquid and accessible in the near future[54]. Currently the KIC has USD 90 billion under management, but the government's goal is to increase its size to USD 200 billion. The plan is to issue new bonds to domestic pension funds in order to enhance overall investment performance as well as to develop Korea's domestic financial industry (Kim (2011))[55].

The remaining countries in figure 9 have not set up a sovereign wealth fund but some have launched discussions to do so. **Taiwan** considers the creation of a SWF given its excessive foreign reserves. However, a proposal has been rejected by the central bank[56]. Concerning **Switzerland**, the possibility to create a SWF will be discussed in detail in section 4.2. **Germany** has no reason to discuss a SWF, given its special situation within the euro area.

Similar to Taiwan, **Japan** also discusses the possibility to build a SWF, given its large foreign reserves[57]. Note furthermore that Japan's Government Pension Investment Fund (GPIF) is already relatively influential regarding Japan's external position, with USD 1300 billion under management, of which 40% is invested abroad. Finally, **Israel** is likely to join the list of countries with SWFs. As discussed in section 2.1, the central bank sterilizes income from fossil fuel extraction. The IMF and the OECD therefore advise Israel to set up a SWF, which is expected to be built in the near future (OECD (2011)).

Summing up, insights from other surplus countries show that the public sector, consisting of the central bank as well as of sovereign wealth funds, typically purchases and holds a significant part of net foreign assets. An analysis of the balance of payments and the international investment position illustrate that foreign reserves of central banks have significantly increased over the past 15 years, in excess of what is needed for precautionary measures. Further, while financial flow data for SWFs is limited, stock data indicates that SWFs play an important role in the public sector's foreign interventions. We have also seen that sovereign wealth funds are not only created to recycle natural resource income abroad or in order to improve management of foreign reserves, but to pool domestic funds - mainly pensions funds - for foreign long-term investments. Moreover, the implementation and operation of SWFs typically follow specific principles regarding transparency, independence and governance. While current account imbalances as well as the more or

[52] See section 4.2 for a more detailed description of how such a swap looks like.
[53] See Jin (2008) as well as www.china.org and www.wsj.com, accessed March 2017
[54] Rozanov (2005) emphasizes that the KIC has been set up as an independent, transparent and commercially oriented fund to receive political support.
[55] See Pensions & Investments, accessed March 2017
[56] See Taipei Times Online, accessed March 2017. Note furthermore that Taiwan discusses the possibility to merge several pension funds into one big fund, see Financial Times Online, accessed March 2017
[57] See Bloomberg, accessed March 2017

less strongly connected exchange rates can be driven by a variety of factors, we share the conclusion of Gagnon (2013), who finds that "the large current account imbalances [...] of more than 100 countries probably would not have occurred, and certainly would not have persisted, without massive official net purchases of foreign assets"[58]. Against this backdrop, the Swiss current account surplus prior to 2008 appears rather unique, while the recent interventions of the SNB are much more in line with the situation observed in other surplus countries[59]. Before discussing policy options for Switzerland, the next section will assess these insights from a global growth perspective.

[58] In general, the positive effect of foreign currency purchases on the exchange rate is very robust. See for example Adler et al (2015), who find in a large panel study that a 1 percentage point of GDP purchase of foreign currency leads to a 1.7 to 2.0 percent depreciation.

[59] Prior to 2008, the total foreign wealth of Switzerland was held by private sector residents, which is exceptional in international comparison. Figure 9 is available for the year 2000 upon request to the authors.

3 Assessment of central bank intervention and sovereign wealth funds from a global growth perspective: imbalances and the fallacy of composition

The previous section illustrated that, in surplus countries, the central bank and sovereign wealth funds typically purchase and hold a significant part of net foreign assets. This section discusses the effects of such public intervention on growth, both from an individual country's point of view and from a global perspective.

3.1 The impact of devaluation policies on individual countries: insights from wage- versus profit-led regimes.

Do individual countries benefit from official foreign asset purchases? Can they expect increased output and employment as a consequence of official foreign asset purchases? Consider the following example. Official exchange rate management is one of the most prominently cited explanatory variables for the rapid growth observed in China and the four Tiger states (Singapore, Hong-Kong, South Korea and Taiwan) (Rodrik (2005)). Nonetheless, the question to what extent depreciation policies can boost output and employment remains a controversial topic in economics [60]. Generally speaking, it is difficult to assess the effects of devaluation policies as they can be significantly influenced by country-specific fiscal or monetary policies as well as, for example, global risk perceptions.

In theory, currency devaluation affects the economy in various ways. The most prominent channel emphasizes positive demand effects from abroad as exports become cheaper. If the economy does not run at full capacity, meaning if abundant production capacities exist, additional demand from abroad will raise total output (Cruz (2015). More specifically, if depreciation policies leave unit labor costs in national currency unaffected, unit labor costs measured in international currency will decrease[61]. This increase in global competitiveness raises sales and profitability, stimulating additional investment and attracting firms[62]. In addition, the literature emphasizes that, following a devaluation, the boost in the tradable sector gives rise to increasing returns to scale. In other words, expansion of the market size via the export channel enhances productivity growth in the tradable sector. Spill-overs to non-tradables, in turn, raise overall productivity and living standards (see e.g. Kaldor (1966))[63].

However, the expansionary effects of a devaluation policy do not stand alone. There is a long literature on so-called contractionary effects of devaluation following, inter alia, Krugman and Taylor (1976). The potential redistribution of income against wage earners does not only increase competitiveness, expected sales and profitability of firms, but also lowers domestic consumption

[60] Clearly, depreciation policies do not necessarily result in an actual currency devaluation, but can, instead, lower the slope of the appreciation.

[61] Unit labor costs are the labor costs paid per unit of output.

[62] While there is no universal definition of competitiveness in economics, we define it in this context as the labor costs per unit of output. Note that this is a relative concept, meaning that the world as a whole cannot become more competitive. Note also that, due to the 'per unit of output' in the denominator, productivity increases per se do not say much about competitiveness, since they could, for example, be offset by excessive wage growth.

[63] The benefits of boosting exports in the manufacturing sector are often discussed in the context of developing countries 'moving up the ladder'.

demand, since wage recipients have a higher propensity to consume (Bowles et al (1995)) [64]. The reduction in domestic consumption, in turn, will have a negative effect on output. Other negative channels of devaluation policies are related to higher price levels, higher input prices, as well as balance sheet effects if debt is denominated in foreign currency and unhedged (Cruz (2015)).

An exhaustive discussion of the positive and negative effects of devaluation policies lies beyond the scope of this paper. Yet, the discussion so far shows that devaluation policies can, in theory, entail both contractions and expansions of output. As a consequence, it is up to the empirical literature to estimate the overall effect on output in a particular country. Before discussing empirical studies, we will introduce some helpful terminology that builds upon the preceding theoretical discussion. Following Blecker (2010) and Lavoie and Stockhammer (2012), a country is called profit-led if income redistribution towards profit recipients increases output. If, on the other hand, a redistribution of income towards wage recipients increases output, the country is called wage-led. Note that a country being in a profit-led growth regime does not imply that 'profits are driving growth'. Instead, given the current state of the economy, a change in the income distribution in favor of profit recipients would boost economic growth. Note that, while this is a simplified conceptual framework to help structure the debate, other variables also matter and have to be taken into account in any particular case[65]. Important for our analyses, a depreciation of the exchange rate is contractionary in a wage-led economy, while it enhances growth and employment in a profit-led economy (Blecker (2010))[66]. Clearly, as discussed above, the effects of devaluation can potentially be either offset or reinforced if other policies, including fiscal and monetary policies, change simultaneously[67].

The empirical literature finds that both large-sized economies, such as the US and the euro area, as well as medium-sized economies, such as the UK, Germany and France, tend to be wage-led (albeit less pronounced in the case of the latter country group). Small open economies, on the other hand, such as Austria and the Netherlands, are profit-led according to some studies (see Hein and Tarassow (2010) and Lavoie and Stockhammer (2012) for an overview)[68]. Along these lines, Hartwig (2012)'s estimates suggest that Switzerland is profit-led[69]. More specifically, he finds that a higher wage share increases domestic consumption but lowers investment and exports. Even if one ignores the negative contribution from investment, however, the overall effect of an increase in the wage share on output remains negative, underlining the extent of the negative contribution to the export sector. Given the importance of external demand for output, Switzerland can be labeled an 'export-led' country. Ceteris paribus, an appreciation of the Swiss franc is therefore

[64] More precisely, if domestic wages in national currency are unchanged and if imports become more expensive due to an depreciation of the domestic currency, wage recipients will demand less domestic goods and services. Profit recipients in the export industry, in turn, can increase their margins and/or cut prices to grow sales

[65] "Whether an economy is under a profit-led or a wage-led regime depends on the economic structure of the economy. It will depend in part on the existing income distribution in the country, but also on various behavioural components, such as the propensity of the various income recipients to consume, on the sensitivity of entrepreneurs to changes in sales or in profit margins, and on the sensitivity of exporters and importers to changes in costs, foreign exchange values, and changes in foreign demand, as well as the size of the various components of aggregate demand - consumption, investment, government expenditures and net exports." (Lavoie and Stockhammer (2012))

[66] Note that the concept of wage- and profit-led regimes takes open economy effects, i.e. export demand, into account.

[67] The ultimate effect of devaluation policies "depends on the characteristics of the economy such as the price elasticity of import and export demands; the extent of reliance on imports; availability of substitutes (!) for imports; the nature and structure of domestic production; and the extent to which increased import prices feed through into domestic prices." (Palley (2013))

[68] More recently, Hartwig (2014) finds that the regime in the average OECD country is (slightly) wage-led.

[69] Further studies are needed to test the robustness of these estimates.

likely to reduce output. Section 4 discusses the Swiss case in more detail.

Summing up, we have seen that some (albeit not all) countries benefit from keeping the exchange rate at a relatively low level in order to promote overall growth[70]. The next section analyzes devaluation policies from a global growth perspective.

3.2 The impact of devaluation policies on the global economy: fallacy of composition and race to the bottom call for new policies

Economic policies that boost output via the net export sector are not feasible if pursued simultaneously by all countries in the world. The trivial reason is that current account imbalances sum up to zero, which means that a surplus in one country is accompanied by a deficit in another country. Devaluation policies can hence be beneficial for single countries (potentially at the expense of others), but might lower overall output if simultaneously applied by several countries. As so often in economics, and complex systems more generally, this example shows that it is misleading to infer that some finding is true for the whole from the fact that it holds for a part of the whole. Not adjusting a finding in the process of aggregation or dis-aggregation might be subject to the so-called fallacy of composition.

Empirically, Obst and Onaran (2016) find that while Austria, Denmark, Ireland and Belgium would benefit from a falling wage share, the EU15 as a whole is a wage-led economic area[71]. Ceteris paribus, Austria and Ireland can increase growth by decreasing the wage share. However, if the whole EU 15 pursued this policy, i.e. if every country in the EU 15 lowered the wage share, growth in Austria and Ireland would decrease. Similarly, Blecker and Razmi (2008) find contractionary devaluations as well as domestic growth gains at the expense of others for a group of 17 developing countries. Along these lines, Griffith-Jones and Ocampo (2008) document the large increases in foreign reserves and find that "counter-cyclical policies to manage export booms by a large group of developing countries generate [...] 'fallacy of composition' effects".

More generally, and in particular after 2008, Naastepad and Storm (2012) as well as Hein (2015) find insufficient demand for the global economy as a whole, and call for coordinated stimuli. Put differently, if many countries try to become more competitive via moderate wage growth or mercantilist devaluations, all countries will end up being worse off (Palley (2011)). As stated earlier, we define competitiveness by the relative unit labor costs between countries, measured in international currency. As such, comparing the labor price per output is a *relative* concept. The world as a whole cannot become more competitive. Instead, competitive devaluations result in a contractionary 'race to the bottom'. In line with our previous analysis, Borio (2014) interprets the strong increase in foreign reserves and the low to negative interest rates globally as a resistance to currency appreciation. The author calls for coordinated monetary policies that lean up against financial imbalances.

Indeed, economists are rethinking global growth strategies. In February 2016, the G20 Finance ministers and central bank governors agreed for the first time to use all policy tools including fiscal stimulus to revive growth. Particularly, surplus countries were asked to boost domestic demand

[70] Note that, while some economic sectors in a wage-led economy might of course benefit from a devaluation, overall GDP is reduced.

[71] As we have seen in section 3.1, a falling wage share is ceteris paribus likely to increase a current account surplus (decrease a deficit). The EU 15 comprises the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

and stop 'free-riding' on other countries' import demand. Palley (2011) argues that the export-led growth strategies of many countries came to an end in 2008 due to the debt saturation of US consumers (Palley (2011)). Along these lines, Cauwels and Sornette (2014) document the 'illusion of the perpetual money machine', which has built on growing debts since the 1980s, while not giving sufficient importance to the real economy. Indeed, the reliance on exports and on the growing debt in other countries, such as the US, the UK and the Southern European countries, turned out to be unsustainable. A growing literature emphasizes the fragility of imbalances, see for example Valdecantos and Zezza (2015), and finds that large current account imbalances are good predictors of future crises (Gagnon (2014)). Note that the 2008 financial crisis has been (partly) associated with imbalances (see for example Obstfeld and Rogoff (2009)).

In line with this, empirical evidence suggests that imbalances are often associated with a mis-allocation of capital. For example, it is now clear that the growing deficits in the Southern European countries were not part of a 'catching up' process, but rather the result of an unsustainable situation caused by diverging competitiveness within the common currency union. Indeed, European debt- and export-driven growth ended with the euro area crisis in 2011, and has since not been revived by an effective new growth strategy (Stockhammer (2016)). In agreement with the above, McKinsey (2015) summarizes that, in the aftermath of 2011, "[c]orporations are piling up cash despite low interest rates, households have cut investment since the bubble, and governments have adopted austerity policies. [...] [C]ollectively they are causing weak demand that means output is still 15 percent below pre-crisis trends". As a matter of fact, the results of labor market flexibilization in combination with fiscal austerity have been modest, raising calls for public investment and adjustment of wage structures (Capaldo and Izurieta (2013)).

After years of low growth, policy recommendations for Japan are also shifting, with the IMF (2016a) calling for "structural reforms that reduce labor-market duality, and thus improve the bargaining power of workers" in order to escape low growth and low inflation. Indeed, the relationship between changes in nominal unit labor costs and inflation is empirically stable and can thus be used as an additional policy tool if conventional monetary policy fails. The IMF (2016b) thus calls Japan in yet another recent publication to 'soft target' private sector wage growth in line with the inflation target. In a similar vein, the IMF (2016c) asks Korea to re-balance in order to contribute to global resilience and in order to reduce dependence from volatile external demand.

Against the backdrop of slow global growth, it is not surprising that surplus countries' central banks and SWFs are criticized not only for accommodating imbalances, but also for investment strategies that do not revive real economic activity (Gagnon (2014)). As Setser puts it, "the cash, instead of being spent on building bridges in, say, Germany, or individual shopping sprees in China and Japan, is accumulating and being recycled into global capital markets, keeping interest rates artificially low"[72]. Clearly, it therefore matters how countries invest their net current account income from abroad. The respective policy implications for Switzerland will be discussed in section 4.

[72] Brad W. Setser, who has worked for the United States Treasury from 2011 to 2015, quote from the New York Times, accessed March 2017

3.3 Excess savings, inter-temporal optimization and the current account surplus

The previous discussion contradicts theories that see (temporary) deficits as the optimal market outcome of global capital flows. Countries with attractive opportunities for foreign investment will naturally run deficits to fund productive investments (see for example Krugman and Obstfeld (1994)). In theory, the increasing productive capacities will eventually turn the deficit into a surplus again. These findings are theoretically underpinned by models, in which rational representative agents optimize their inter-temporal consumption plans[73]. Accordingly, a surplus arises optimally when domestic savings are higher than domestic investments. However, such models typically ignore the role of finance and are subject to the fallacy of composition. As a result, they are unsuitable to analyze the dynamics of a monetary economy[74]. While an extensive discussion of those models lies beyond the scope of this paper, let us emphasize some simple accounting relationships related to the balance of payments to shed further light on this issue.

Recall from section 1 that the financial account simply records the ownership of financial assets. Purely financial transactions do not change the current account, nor the net financial account. The following example illustrates this: If a Swiss resident exchanges his or her Swiss franc asset with a US Dollar asset, this is a purely financial transaction. In this process, nothing will be recorded on the current account, leaving it unaffected. The Swiss resident either buys the US asset from a non-resident or from a resident. In either case, the net financial position of all Swiss residents does not change. In the first case, foreign liabilities increase because non-residents have more Swiss assets. At the same time, foreign assets increase as Swiss residents own more US assets. In the second case, the net position does not change either since the assets are simply exchanged among two residents.

Such financial transactions only affect the current account via two secondary effects[75]. First, the newly purchased financial asset may pay dividends or interest payments over subsequent years, which are then recorded in the current account under 'investment income'. Second, if many Swiss residents want to buy US assets, the Swiss franc might depreciate via simple supply-demand considerations. A weaker Swiss franc, in turn, might ultimately increase exports[76]. In our example, the US resident might later decide to purchase a Swiss good with his Swiss asset. Such a purchase will have a positive net effect on the current account, and a negative net effect on the financial account.

Against this backdrop, causal statements, such as 'high savings lead to a current account surplus' or 'because Switzerland saves more than it can invest domestically, these savings are lent to people abroad and cause a surplus' are misleading[77]. As we have seen, however, residents' net

[73] Consider, for example, the so-called Ramsey model (Cass (1965)).

[74] See Taylor (2004) for a critique of those models. See Borio and Disyatat (2011) for a critique on the recent debate about a global 'savings glut'. See also Corsi and Sornette (2014) on the role of money as an important factor in economics.

[75] Of course, once the US resident uses the Swiss franc asset to purchase for example Swiss goods or services, this will directly be recorded on the current account. However, the point here is to separate the effects of a portfolio re-allocation from the effects of goods or service income.

[76] See for example UNCTAD (2007) on how real effective exchange rates and macro shocks explain current account surpluses, while household savings do not.

[77] However, they remain widespread in the public debate in German speaking countries, as opposed to Anglo-Saxon countries. See for example Roth in the NZZ (accessed march 2017), describing excess savings as a sign of financial health.

positive savings simply reflect net positive income from the current account. As Terzi (2016) puts it: "Net exports are not the consequence of pre-existing available funds that the nation is lending. In fact, the opposite is true: by selling abroad more than it imports, the nation acquires new savings that would not have been otherwise available!" [78].

Against this backdrop, it is also misleading to state that 'high savings' due to demographics directly explain the Swiss current account surplus. Even if there was a clear connection between demographics and surpluses, "the evidence is fairly clear that the speed of future ageing pressures is no more rapid in Switzerland than elsewhere in the OECD, arguably less so[...]." (Jarret and Letremy (2008)). Yet, as we have seen in section 2, the way pension schemes are organized does have an impact on the current account. Large capital-based pension schemes, such as in Singapore, that invest largely abroad are supportive of a current account surplus by weakening the currency and providing foreigners with the purchasing power to buy domestic goods and services. The contributions from Switzerland's mandatory second pillar retirement savings amount to 50% of household savings, of which around 40% are invested abroad (Jarret and Letremy (2008)). Yet, according to the Credit Suisse pension index, the share of foreign assets decreased from 40% in 2002 to 22% in 2015[79]. This trend might have contributed to an upward pressure on the Swiss franc. Increasing pension contributions or channeling existing funds abroad, for example via a SWF like Singapore, would, in turn, support a weaker Swiss franc.

Summing up, while surplus promoting policies benefit economic growth in some countries, including Switzerland, the simultaneous pursue of such policies by several countries leads to a 'race to the bottom'. Against this backdrop, official purchases of foreign assets are subject to a mercantilist critique, which is all the more pronounced if investments envision a short-term horizon that does not stimulate real economic activity. As a consequence, collective action as well as multilateral rules and agreements are needed to avoid a global race to the bottom. While implementing such global policies lies beyond the power of Swiss policy making, the next section discusses feasible solutions for Switzerland.

[78] Consider yet another simplified example of a Swiss bank providing a loan to a US resident. After the loan is made, the Swiss bank has a new foreign asset, the loan contract, but likewise does the US resident have a new claim on Swiss residents, namely the Swiss francs on his checking account. At this point in time, the current account is not affected, nor does the loan change the net financial account position. Only once the US resident buys a Swiss good or service (with the Swiss franc, or of course also with any other currency if the Swiss exporter is willing to accept it) will the current account record a surplus.

[79] See Credit Suisse Pensionskassenindex

4 Policy implications for Switzerland: rethinking the interests of an export-led economy in consideration of global growth

So far, we have seen that, prior to 2008, the pronounced Swiss current account surplus was mirrored by the net accumulation of foreign assets by Swiss residents. Following our analysis, the new situation since 2008 can be summarized along the following three levels of aggregation:

- **The perspective of Swiss residents**: Given the difficulties and uncertainties in Europe, in particular, it appears rational to repatriate a part of foreign assets, invest less abroad and reduce lending to non-residents. While this behavior can change in the future, section 1 and 2 suggest that it is unlikely that Swiss residents will and can return fully to their pre-2008 investment patterns.
- **The perspective of the Swiss economy**: The behavior of both Swiss residents and foreigners puts upward pressure on the Swiss franc. This, in turn, threatens overall growth because Switzerland is 'export-led' (see section 3). Government intervention via the purchase of foreign assets as conducted by the SNB is optimal in order to maximize GDP[80]. Other countries established sovereign wealth funds to optimize the purchase and management of foreign assets.
- **The perspective of the global economy**: Swiss policy is subject to a mercantilist critique. Growth strategies that try to boost output via the net export sector are subject to the fallacy of composition. If pursued by several economies, devaluation policies become a drag on the global economy and result in a 'race to the bottom'. Surpluses are most criticized if the net foreign income is not invested in the real economy.

Against this backdrop, we will now assess to what extent Switzerland is subject to the mercantilist critique and discuss policy options, including room for re-balancing and the creation of a Swiss sovereign wealth fund.

4.1 New policies for Switzerland and the 'true' size of the Swiss current account surplus

To what extent is Switzerland subject to the mercantilist critique? Jordan (2013) and the IMF (2015c) argue that non-conventional components of the Swiss current account must be stripped away in order to obtain the 'true' size of the current account surplus. Consequently, accusing Switzerland of a 'beggar-thy-neighbor' policy is not (fully) justified. More specifically, it is argued that the 'true' current account is overestimated for three reasons. First, the current account has to be corrected for a statistical bias in the balance of payments, as explained in section 1.4. Second, the role of merchanting as well as the financial services surplus overstates the current account[81].

[80] Note that other variables besides GDP might as well be targeted by policymakers. An increase in the current account surplus reflects a higher GDP (if imports do not decrease). However, if the net income from abroad does not lead to an increase in foreign wealth, domestic residents are basically providing goods and services for free.

[81] Merchanting as defined in the BPM5 (Balance of Payments Manual, 5th edition): "Merchanting is defined as the purchase of a good by a resident (of the compiling economy) from a nonresident and the subsequent resale of the good to another nonresident; during the process, the good does not enter or leave the compiling economy. The difference between the value of goods when acquired and the value when sold is recorded as the value of merchanting services provided." Since the BPM6, however, merchanting is re-classified as trade in goods and not services.

Third, net foreign investment income, being part of the current account, overstates the surplus. Building on our analysis in previous sections, let us briefly comment on these three arguments.

Concerning the first argument, we have seen in section 1.4 that, due to the statistical treatment of retained earnings, the income of Swiss residents is indeed overestimated in the balance of payments. Taking this effect into account reduces the surplus by on average 2% to 8% of GDP. In addition, cross-border shopping is partly unaccounted for in the import statistics, but the magnitude is not known (see section 1.4). Second, it is true that financial services are the most important component of services exports and merchanting income stood at 34% of the net current account in 2015[82]. In addition, pharmaceuticals make up more than 40% of total exports. While this composition is unique in the world, it is not clear why any of these incomes should be deducted from the current account. The firms and employees receiving income from these sectors remain Swiss residents[83]. Finally, the net investment income is indeed very pronounced, accounting for about half the size of the total current account surplus. However, the investment income of today partly reflects past current account surpluses. Moreover, if recipients of net foreign income are not willing to recycle the latter abroad or even decide to repatriate some of the foreign assets, the Swiss franc is likely to experience upward pressure. Such an outcome of market participants can be seen as a natural driver in re-adjusting global competitiveness[84]. Public interventions that offset net investment income, i.e. the associated market forces, do not seem to be justified from an international perspective. From the Swiss perspective, however, the non-conventional components of the current account result in a phenomenon that can be called the 'Swiss version of the Dutch Disease': On the one hand, it is true that (i) income earned on Switzerland's existing stock of foreign assets does not depend on the exchange rate (unless Swiss recipients of this investment income decide to leave the country), and (ii) the elasticity of demand to the exchange rate is relatively low for some Swiss goods and services, including for example life-saving pharmaceuticals (Sauré (2015)) [85] . On the other hand, parts of tourism and industrial production, as well as cross-border shopping and commuting, are likely more responsive to exchange rate movements. Put differently, similar to the Dutch disease in oil-rich countries, the non-conventional factors of the net foreign income exert upward pressure on the exchange rate and thereby weaken more exchange-rate sensitive sectors of the economy. Auer and Sauré (2011) estimate that the appreciation of the Swiss franc has indeed lowered Swiss exports [86] : Without the post 2008 appreciation, Swiss exports would be around CHF 2.7 billion (or 17%) higher per month than actual exports. The authors conclude that the rebound in global demand has "completely masked the effect of the CHF strength".

For example, more than 80% of manufacturing firms stated that the appreciation of the Swiss

[82] However, the share of financial services in total exports of services declined from 34% in 2007 to 19% in 2015.
[83] It would appear similarly arbitrary if Germany would argue that the USD 271 billion positive trade balance is not 'true' and should be reduced by the contributions from the car sector (USD 163 billion). Source: National Statistics.
[84] Indeed, as mentioned in section 1.4, such repatriations can theoretically result in a (temporarily) overvalued currency that even turns the goods and services surplus into a deficit.
[85] In addition, it is often argued that merchanting is relatively insensitive to exchange rate movements because commodity trading is conducted in US Dollar (Jordan (2013), Beusch et al (2013)). Yet, it is not straight forward why merchanting companies, which are paying salaries and taxes in Swiss franc, will not consider re-allocating their operations once the Swiss franc becomes too strong. Empirical studies that analyze the sensitivity of merchanting would be needed.
[86] In general, it is a well established result that exchange rate depreciation increases the current account balance, although sensitivities vary from country to country, see IMF (2015b).

franc had a negative effect on their business and that this effect was mainly adjusted by lowering profit margins (IMF (2016d)). In line with this, the KOF business situation indicator has declined since January 2015 from around 20 to 10[87]. Furthermore, a study by the Lausanne Federal Institute of Technology (EPFL) analyses 208 publicly-listed Swiss firms and finds that revenues declined by 16.3% and profits by 20.4% on average for export-oriented companies. In addition, export-oriented firms decreased investments by 30%, whereas the remaining investments were focused outside of Switzerland: "The proportion of infrastructure and production sites bought abroad increased from 45% to 63% of total acquisition outlay"[88]. More recently, the Swiss Manufacturing Survey conducted by the University of St Gallen finds that 46% of all industrial companies consider moving productions abroad throughout the next three years. At the same time, around one quarter of Swiss mechanical and electrical engineering industries (MEM) firms registered a loss at the EBIT level at the end of 2016 - compared with 7% in 2014[89]. Against this backdrop, it becomes clear that some, albeit not all, components of the Swiss current account surplus are little responsive to exchange rate effects in the short-term.

Summing up, Switzerland's 'true' current account surplus remains large in international comparison, even after correcting for statistical effects. From a global perspective, Switzerland is thus subject to criticism and should either adopt measures that reduce its surplus or abandon policies supporting the latter[90]. In particular, Switzerland should assess the scope for domestic investment that benefits not only Switzerland but contributes to global re-balancing at the same time[91]. Along these lines, the IMF (2016d) calls for more fiscal spending under the Swiss debt brake rule. However, given Switzerland's sectoral balances, it is questionable whether such spending would be sufficient to significantly reduce the surplus[92]. If Switzerland desires to re-balance without abandoning the debt brake rule, it should thus consider policies that reduce household savings or increase firms' investment expenditures (borrowing).

Concerning monetary policy, negative interest rates in Switzerland pose a challenge for policy makers and the economy more broadly. To improve control of inflation and gain more leeway on the foreign exchange market, Switzerland could draw upon the IMF's recommendations for Japan or the economic policies implemented by Singapore since the 1980s[93]. These policies build upon the insight that nominal wage growth is key in determining the inflation rate in vertically integrated economies. The same logic appears to inform recent attempts to revive inflation in the euro area, with Draghi emphasizing that "[w]e will start seeing that wage growth [...] is the lynchpin of a self-sustained increase in inflation. That is the key variable that we should look

[87] See KOF business situation indicator

[88] See Swissinfo Online

[89] The study has not been published as we draft this paper. However, Swiss mechanical and electrical engineering industries (MEM) summarize the most important results on their homepage here, accessed March 2017

[90] With Swiss GDP being 0.5% of global GDP, the effect of domestic stimuli on the world economy will be relatively small.

[91] A detailed assessment of the scope for such domestic investment lies beyond the scope of this paper and is left for future research.

[92] Sectoral balances are financial flows that represent an accounting identity. The identity is as follows (Swiss numbers as a % of GDP in 2013 in brackets): the sum of the financial balances of the household sector (+12%), the firm sector (-2%), the government sector (0%), and the foreign sector (-10%) is zero. Bringing the foreign sector close to 0% requires significant borrowing by firms, households or the government. By accounting identity, a more or less balanced government sector cannot change the foreign sector's balance as long as the private sector does not increase borrowing.

[93] See discussion in section 3.2

at; it's not the only one but it's certainly key"[94]. Singapore's conventional monetary policy, for example, is traditionally "complemented by a proactive and flexible wage policy" (Chow (2008)). The tripartite National Wages Council, founded in 1972, publishes wage recommendations to make sure that wage growth is in line with productivity growth plus the inflation target in the long-run[95].

Moreover, the SNB could implement a so-called crawling peg to optimize its monetary policy[96]. A crawling peg, as implemented for example by the Monetary Authority of Singapore (MAS), is defined as follows. First, the exchange rate is analyzed against a basket of other currencies - and not only against one single currency like the Euro. Pegging the exchange rate to a basket of other currencies will be less volatile. Second, the exchange rate is kept within a policy band to accommodate short-term fluctuations. Third, the crawl feature is characterized by a growth rate of the exchange rate that is in line with interest rate, i.e. in line with uncovered interest rate parity (UIP) ((Tee (2013))[97]. As discussed in section 1, UIP was violated 'in favor' of Swiss residents in the 1980s and 1990s, but turned negative since 2008[98]. In Singapore, UIP has never been strongly violated and is kept within two standard error bounds, reducing both uncertainty for market participants and the risk for financial disruption[99]. Very much like Switzerland, Singapore has typically lower interest rates than abroad. As a consequence, the MAS allows the Singapore Dollar to appreciate slowly over time[100]. While the *slope* of the Singapore Dollar's appreciation is in line with UIP, the *level* of the Singapore Dollar is kept relatively low in order to accommodate current account surpluses. As discussed extensively in section 2, the Singaporean government, as most other governments of surplus countries, cannot rely on sufficient private sector investments abroad, but uses the central bank as well as sovereign wealth funds to increase foreign asset purchases and accommodate the surplus.

4.2 A sovereign wealth fund for Switzerland

We have seen in section 1 that the Swiss private sector is unlikely to return to its pre-2008 investment pattern. At the same time, Switzerland's export-led regime makes it politically and economically unlikely that a pronounced re-balancing of the Swiss surplus will occur. Against this backdrop, this section discusses the opportunity to create a Swiss Sovereign Wealth Fund (SWF)[101].

[94] ECB press conference on March 9th, 2017, see full speech online here, accessed March 2017

[95] The wage council consists of representatives from the government, the employers and the employees. See official homepage of the Singapore Ministry of Manpower for further details, accessed March 2017

[96] Similar proposals have been made for example by Bernholz (2015) and Sornette (2015). It may well be possible that the SNB has currently adopted such a measure without communicating it officially.

[97] See official homepage of the MAS for more details on this policy, which has been in place since 1981, accessed March 2017

[98] Given the rising CA surplus, Cline and Williamson (2008) have argued that Swiss policymakers should have stepped in to avoid an under-valued Swiss franc that could suddenly (over)correct.

[99] As a small and open economy, Singapore's price level is particularly exposed to international capital flows. Government efforts to gain better control build on a threefold policy consisting of interest rate policy, foreign exchange rate interventions and wage policy. See MAS online for more details on the interest rate policy.

[100] Note that due to this appreciation, foreign assets constantly loose value evaluated in Singaporean Dollars. As a consequence, the goal of Singapore's sovereign wealth funds (Temasek and GIC) is to (over)compensate for these losses by income and valuation gains on foreign assets. Put differently, an integrated policy ensures that wealth actually accumulates in line with net foreign income - in contrast to the situation in Switzerland over the last 15 years. (Source: MAS data).

[101] Note that such a fund is not to be confused with other sovereign funds discussed in the public debate in Switzerland, such as public venture capital funds for domestic investments.

The idea of a Swiss SWF was first put forward when the Swiss franc floor was introduced in the fall of 2011, given the expectation of a significant expansion of foreign exchange reserves at the Swiss National Bank (SNB). The concept has reappeared after the floor was lifted on 15 January 2015 and is the subject of a large debate[102] with distinguished opponents (Roth (2015); Swiss Federal Council (2016)) and supporters (Höfert (2015); Sornette (2015)). Recently, a report by the Swiss Federal Council (2016) discusses this policy option in the context of a low interest rate environment and a 'strong Swiss franc'. While the authors are not generally opposed to the creation of a SWF, they are not convinced that the potential benefits outweigh the losses, and thus do not see a need to modify the SNB's policy. What is missing from their analysis, however, is a detailed account of i) the upward pressure on the Swiss franc, ii) insights from other surplus countries, and iii) the macroeconomic role of sovereign wealth funds[103].

Section 2.2 discussed the global rise of sovereign wealth funds (SWF) in purchasing and managing foreign assets. In line with this discussion, setting up a SWF would bring institutional advantages as it would allow Switzerland to clearly separate monetary policy and foreign asset management, thereby avoiding a potential conflict of interest[104]. In this regard, as discussed in section 2.2, the successful operation of a Swiss SWF would have to follow best practice principles regarding governance, accountability and transparency. Moreover, implementing a Swiss SWF would optimize portfolio allocation and benefit from economies of scale. In addition, it would allow Switzerland to build upon as well as further strengthen its financial sector[105]. In a similar vein, as in Singapore, the Swiss SWF could be part of an integrated and holistic approach to tackle the new challenges facing the Swiss economy. At the same time, implementing a Swiss SWF would improve Switzerland's position vis-à-vis the mercantilist critique: At the end of 2016, the SNB invested 86% of its foreign exchange reserves in AAA and AA rated assets[106]. With 69% government bonds and 20% equity, this passive investment strategy contributes to the global abundance of finance, driving down bond yields and driving up equity prices. As discussed in section 3, the trend to liquid assets can become a drag on economic growth, worldwide. Policy making that wishes to enhance growth should consequently aim at diverting financial resources to real economic activity. A Swiss SWF could contribute to this objective by investing in long-term tangible assets, such as "private and industrial real-estate, forests, farming, production units, foreign blue chip companies, private equity [...]" (Sornette (2015)). It could take pioneering steps to foster a new wave of innovations to get out of the growth bottleneck (Gordon (2016)) and develop bold initiatives such as "super-Apollo" projects in energy production[107] and storage, green technologies, health care, information, artificial intelligence, ocean and space exploration, and so on. Before discussing further opportunities associated with a Swiss SWF, let us briefly describe how

[102] See for instance the article "Le fonds souverain pourrait-il être un antidote au franc fort?" Le Matin Dimanche 6 Septembre 2015; accessed April 2016

[103] For example, the authors state that funds like the Chinese Investment Corporation are "by the way rare" (p.21, ibidem, translation by the author) and that a Swiss sovereign fund would be subject to exchange rate risks - ignoring the overall economic objective (p.24, ibidem). Furthermore, the authors state that the SNB should be able to sell all their assets within a short period of time (section 5.1, ibidem), which ignores the likely scenario of a 'new normal'.

[104] Jean-Pierre Roth, previous chairman of the SNB, has pointed out that the SNB is already a sovereign fund ("La BNS est déjà un fonds souverain"); see the summary by Sébastien Dubas, LE TEMPS, 18 octobre 2016, `https://www.letemps.ch/economie/2016/10/18/bns-deja-un-fonds-souverain`; accessed April 2017. By this statement, Roth means that the SNB invests abroad akin to a sovereign fund both in terms of size and investment style.

[105] These advantages were discussed in more detail in section 2.2.

[106] See SNB's official homepage, accessed March 2017

[107] In the spirit of Sornette, D. (2015), "A civil super-Apollo project in nuclear R&D for a safer and prosperous world", Energy Research & Social Science 8, 60-65.

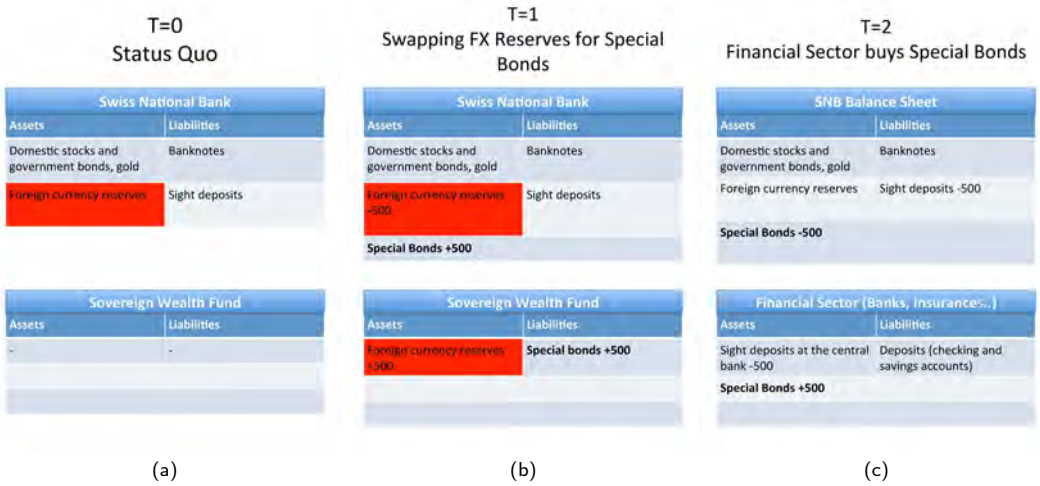

Fig. 10: Stylized balance sheets for the Swiss National Bank (SNB), the potential Swiss Sovereign Wealth Fund (SWF), and the Swiss financial sector. The SWF issues Special Bonds that are swapped with the foreign reserves of the SNB (figure (b)). Special Bonds can be sold to the financial sector, sterilizing sight deposits at the central bank (figure (c)).

such a fund could be set up.

Technically, a Swiss SWF could be set up in a similar fashion as the China Investment Corporation (CIC). Figure 10 (a) shows the stylized balance sheet of the SNB at the point of writing. A Swiss SWF would simply issue 'Special Bonds' and swap them with part of the foreign reserves of the SNB. Figure 10 (b) illustrates this swap exemplarily for CHF 500 billion. After the swap, the overall size of the SNB's balance sheet remains constant, but part of the foreign assets have been replaced with Special Bonds from the SWF.

As described in section 2.2, many countries use their SWFs to pool a variety of domestic funds. As indicated in figure 10 (c), implementing a Swiss SWF would allow the Swiss financial sector to use their excess sight deposits at the SNB in order to purchase Special Bonds, ultimately reducing the SNB's balance sheet[108]. Put differently, the SNB would finally sell Special Bonds to domestic banks or insurance companies, sterilizing sight deposits. A Swiss SWF would provide concentrated expertise and could be set up within a policy framework that leverages the Swiss Sovereign credit rating, making it particularly attractive to Swiss pension funds, who are looking for investment opportunities but lack access to attractive investments. Indeed, while Swiss pension funds have decreased their share of foreign investments in recent years, a Swiss SWF might well reverse this trend - in line with Switzerland's overall macroeconomic objective to increase foreign asset purchases[109].

[108] Note that even if Swiss residents, and in particular Swiss banks, decide to once again invest increasing amounts abroad, there is no immediate threat to the Swiss economy. The SNB can always issue repos (repurchasing agreements) and will, in addition, be left with a sufficient buffer of foreign reserves to smooth short-term fluctuations in the exchange rate. We also note that, in the (unlikely) depreciation of the Swiss franc, which is the usual argument of opponents of the a Swiss SWF who argue that the SNB should kept all its assets completely liquid and at hand, the foreign assets held by the fund would correspondingly appreciate, thus leading to an increase of the wealth of the Swiss SWF in Swiss francs, providing a natural counter-cyclical stabilisation.

[109] See section 3.3, which discussed the declining share in foreign investments of pension funds.

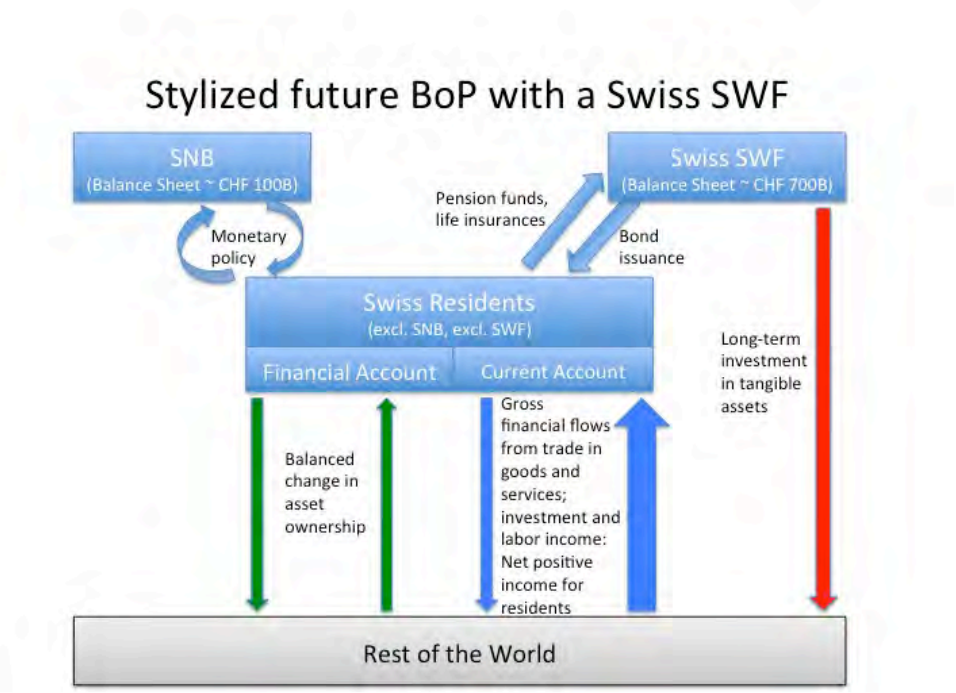

Fig. 11: Stylized balance of payments for Switzerland with the Swiss National bank (SNB), residents, non-residents and a potential Swiss Sovereign Wealth Fund (SWF). Net current account income is mirrored by net foreign asset acquisitions of the Swiss SWF. Private sector residents (e.g. pension funds) buy SWF bonds. The SWF channels these funds abroad into long-term investments in tangible assets. Note that the SNB's foreign assets have already been swapped with Special Bonds of the SWF, which, in turn, were bought by residents. As a consequence, the SNB's balance sheet has returned to its 'normal' size.

To increase foreign investments even further, in the future, the Swiss SWF could issue additional bonds (on top of those issued for the initial swap) to receive new funds and pool them for long-term investment abroad. Figure 11 illustrates the flows, i.e. the balance of payments, for such additional bond issuance[110]: As apparent in figure 11, the private sector is not sufficiently investing abroad, but the SWF pools private sector funds and channels them abroad[111]. In so doing, a Swiss SWF would act as a fund manager similar to Singapore's GIC, rather than as the owner of assets as in the case of Norway's Oil Fund[112].

Summing up, Switzerland is well advised to rethink its fiscal and monetary policies - both in its own national interest and from a global growth point of view. While room for re-balancing might be politically and economically limited in the near future, Switzerland has the opportunity

[110] Note that the balance sheets discussed previously document a swap of existing foreign assets. No additional foreign assets are purchased during the swap. Now, however, a scenario is described where the Swiss SWF issues new bonds in Swiss franc that are purchased by e.g. Swiss pensions funds. The SWF uses the additional funds to purchase additional foreign assets.
[111] However, if not a sufficient number of domestic funds are attracted overall, new policies can be implemented or the SNB will have to intervene on the foreign exchange market.
[112] See discussion in section 2.2: To be precise, Norway's Oil Fund is technically also set up as a fund manager. However, the aggregate public sector does own the assets that are generated from oil sales.

to create a Swiss SWF, which would optimize the purchase and management of its foreign assets.

5 Conclusion

We have presented the evidence demonstrating that the recent upward pressure on the Swiss franc cannot be explained by safe haven effects alone, but has been driven by a pronounced - and likely long-lasting - decline in Swiss residents' foreign investments. The decrease in foreign investments reflects both the end of the 'Swiss interest rate island' as well as Switzerland's subdued foreign wealth. Indeed, from a Swiss perspective, the foreign investment environment deteriorated already prior to 2008, and significantly worsened after 2008, partly driven by an unwinding of banks' foreign positions. Looking ahead, it is unlikely that Swiss residents will fully return to their pre-2008 investment and lending patterns - even if Europe and the rest of the world will experience a strong acceleration in growth and stability, thereby precluding further safe haven pressures. Accounting for possible future scenarios, we thus suggest that Switzerland has reason to consider the steady pressures on the Swiss franc and the associated central bank interventions as a 'new normal'. In other words, we argue that the SNB is unlikely to sell large parts of its foreign assets in the near future and will probably continue its interventions with a view to avoid a strong appreciation of the Swiss franc and to accommodate current account surpluses.

A comparison with other surplus countries highlights that the current situation in Switzerland is the norm, rather than the exception: central banks together with sovereign wealth funds (SWFs) typically hold a significant part of total net foreign assets. The latter can affect foreign asset holdings and purchases in various ways: SWFs can recycle natural resource income abroad or improve the management of foreign reserves. They can also pool a variety of domestic funds, mainly pensions funds, and channel them abroad. At the same time, we have seen that the rise of SWFs and foreign reserves have supported global current account imbalances. While surplus promoting policies benefit economic growth in some countries, including Switzerland, the simultaneous pursue of such policies by several countries leads to a 'race to the bottom'. Against this backdrop, official purchases of foreign assets are subject to a mercantilist critique, which is all the more pronounced if investments envision a short-term horizon that does not stimulate real economic activity.

Conceiving of Switzerland's current situation in terms of a 'new normal' encourages policy makers to rethink fiscal and monetary policies in a more long-term fashion. Given Switzerland's export-led economy, there will likely be no pronounced re-balancing in the near future. That being said, Switzerland has the opportunity to create a Swiss SWF to optimize the purchase and management of its foreign assets, while supporting global growth via long-term investments in tangible assets.

Appendix: A closer look at Swiss private sector's investment patterns before and after 2008

This Appendix documents the Swiss private sector's investment patterns. We are interested in the drivers of foreign investment prior to and after 2008. To what extent have pre-2008 investment patterns been unique? Are they likely to re-emerge in the near future? Without claim for completeness, this section aims at opening the discussion as well as motivating future research on these questions.

Components of the financial account

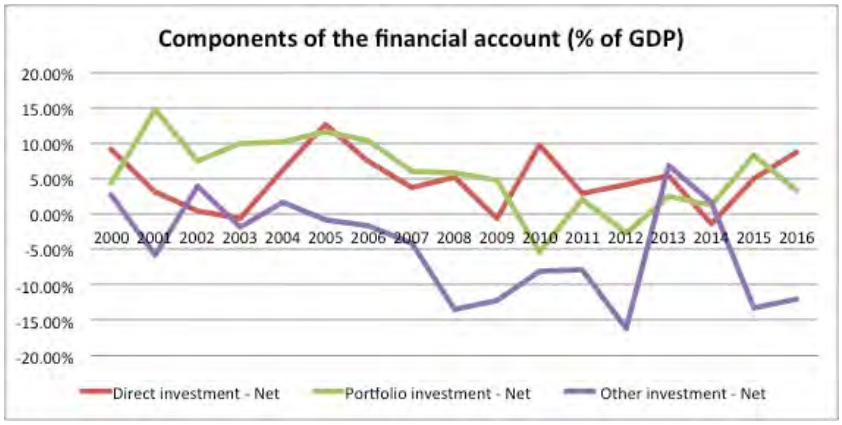

Fig. 12: Components of the financial account as a percentage of GDP, annual data. Source: SNB.

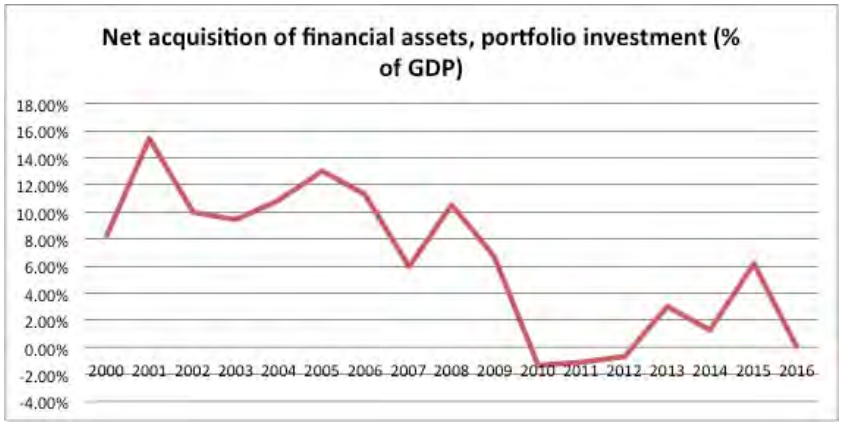

Fig. 13: Net acquisition of financial assets within portfolio investment, annual data, as a percentage of GDP. Source: SNB.

Figure 12 shows three sub-components of the net financial account: foreign direct investment (FDI), portfolio investment as well as other investment. While FDI is relatively volatile over the whole period, there is no significant decline after 2008. The component other investment, however,

experienced a clear decline after 2008. Similarly, portfolio investment decreased significantly after 2008, has since then recovered to some extent, but is still relatively low with around 5% of GDP in the last three years. Figure 13 shows the decline in net acquisitions of foreign portfolio investments by Swiss residents: The private sector has significantly reduced its net acquisitions since 2009.

Against this backdrop, the components of portfolio investment as well as other investment deserve closer attention. In the following, we will see that 'other investment' is almost exclusively driven by banks' investments. For the category 'portfolio investment', however, it is not straightforward to determined which agents in Switzerland are responsible for the decline in foreign investments. The role of Swiss pension funds' foreign investments is potentially important and will be discussed in more detail.

Banks dominate other investment

Figure 14 shows the net increase in commercial banks' loan, currency and deposit holdings - a position that is almost identical with total net acquisition of foreign assets. Put differently, the category other investment is dominated by commercial banks' foreign lending and deposit business, in line with the discussion in section 2. While banks' losses during the 2008 financial crisis, as well as new regulatory rules, make it unlikely that banks will return to their pre-2008 business model, more research is needed to assess the changes in regulation and bank governance in more detail.

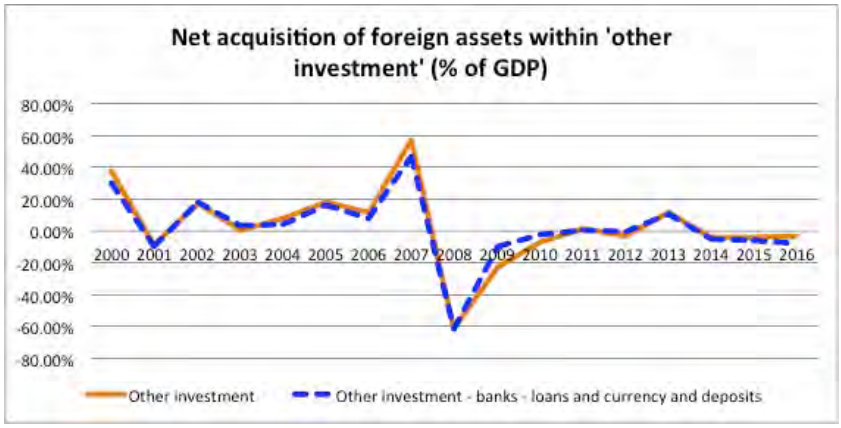

Fig. 14: Net acquisition of financial assets within other investment, annual data, as a percentage of GDP. Banks dominate other investment. Source: SNB.

The slowdown in portfolio investment: the role of Swiss pension funds and other sectors

The capital-based pension scheme in Switzerland, i.e. the so-called second pillar, might play a role in explaining the dynamics of foreign portfolio investment over time. The compulsory second pillar became effective in 1985, and built on pre-existing voluntary occupational plans. Figure 15 shows the size of the second pillar pension assets as a percentage of GDP. As expected, the amount of pension fund assets as a percentage of GDP grew steadily following the introduction

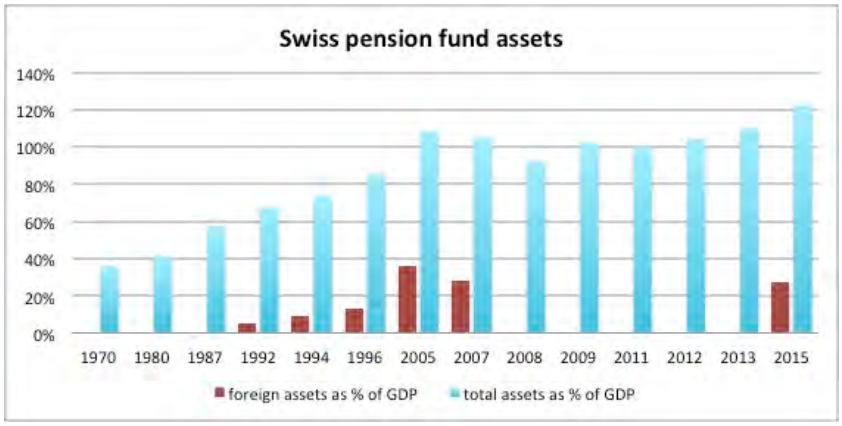

Fig. 15: Swiss pension assets, annual data, as a percentage of GDP. Source: Swiss statistical office, Vittas and Queisser (2000), Credit Suisse pension fund index.

of the compulsory pension plan. However, since around 2005, total assets lost momentum and plateaued.

For our analysis, we are interested in how this capital-based pension scheme affects (foreign) investments of the private sector. Theoretically higher "forced savings" via capital-based pension schemes can either leave "voluntary savings" unaffected or (partially) compensate for and replace them. In general, the literature is not conclusive on how capital-based pension schemes affect household savings and investment patterns. Most studies, however, suggest that capital-based pension funds actually increase overall savings (see for example Murphy and Musalem (2004)).

For the Swiss case, Bütler et al (2007) document that the increasing amounts of forced savings have not been accompanied with a reduction, but rather an increase in voluntary private savings in Switzerland. We will thus assume that voluntary savings are not affected by the pension fund savings, so that we can look at foreign investments of pension funds in isolation. Vittas and Queisser (2000) estimate that the share of foreign asset allocation increased from 7.2% in 1992 to 15.6% in 1996. Over the same period, as indicated above, total assets under management increased as a percentage of GDP. Consequently, foreign investments of pension funds as a percentage of GDP increased over this period, and thereby contributed to the overall high foreign investments of the private sector.

Figure 15 combines estimates by Vittas and Queisser (2000) with more recent estimates of the Credit Suisse pension fund index to get a bigger picture of the long-term dynamics of foreign investments of Swiss pension funds. The overall picture now emerges that foreign assets as a percentage of GDP has increased from 1970 to 2005 [113]. Afterwards, however, foreign assets as a percentage of GDP have plateaued, and have recently been lower than in 2005.

Against this backdrop, it becomes clear that the Swiss capital-based pension scheme supported rising foreign investments until the early 2000s. In the future, it is unlikely that Swiss pension funds will again contribute to a rise in foreign investments for two reasons. First, there are no regulatory or market changes in sight that would favour foreign investments and enhance risk-

[113] For the 1970s and early 1980s, it is reasonable that the share of foreign investments was not larger than afterwards.

taking capacities in the pension fund industry. Second, the cash flow of the second pillar is already decreasing, and will turn negative in 2045, as a result of migratory movements of the previous decades [114].

How important are the magnitudes of pension funds' foreign assets compared to total foreign portfolio holdings of the Swiss private sector? Total foreign assets of pension funds only make up around CHF 170 billion of a total of around CHF 1200 billion foreign portfolio holdings in 2015. Pension funds are thus not negligible, but also fail to explain a major fraction of the overall change in portfolio investment. Besides pension funds, data on banks' portfolio holdings are available: Prior to 2008, banks increased their foreign portfolio holdings up to around CHF 100 billion in 2007. This level is similar to the one in 2015, so that banks also contributed to the slowdown in foreign asset acquisitions. Other sectors, i.e. all kinds of individuals and non-bank firms, massively increased their portfolio holdings prior to 2008, and ended up holding four times more foreign portfolio assets than banks and pension funds combined. Unfortunately, more disaggregated data on these other sectors are not easily available, leaving a large part of the portfolio investments unexplained.

Summing up this appendix, banks' investment patterns explain the reduction in 'other investments'. The slowdown in portfolio investment, however, cannot be attributed to a single sector. While banks and pension funds contributed to the slowdown, other, unknown sectors, did so even more. Future research should try to identify these sectors, as well as analyze banks' and pension funds' future foreign investment opportunities and possibilities in more detail.

[114] Cash flow restimates are taken from article in Die Volkswirtschaft, online available here, accessed May 5th

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4 Stock-Flow-Consistent Model

The research presented in this chapter moves beyond descriptive statistics and qualitative conceptual frameworks by building a Stock-Flow-Consistent (SFC) model.[1]

The model's design builds upon insights from the research on complex systems. Complex systems literature focuses on rare events of a system's dynamics in order to understand its structure. Naturally, the analysis of complex systems requires a long-term analysis because inherent instabilities might build up only gradually. Indeed, it is well known that a system that looks stable from the outside might be about to develop inherent instabilities, that are not yet visible to the observer. In material sciences, for example, the phenomenon of creepy risk is well studied: A rock is put under increasing pressure. For a while, nothing seems to happen on the macroscopic level. Suddenly, the rock cracks.

This approach of complex systems research stands in stark contrast to many mainstream economic models that exclude bubbles or crashes a priori, adopting a short-term horizon only. Yet, it is evident that such short-sighted modeling is not suitable for understanding the dynamics of capitalist systems. The great moderation, for example, has been accompanied by an illusionary belief of stability and control, seemingly justifying mainstream models. The 2008 financial crisis marked the sudden end of this period and took many economists and policy makers by surprise. The natural question that emerges is to know what explains the sudden end of the great moderation, and to understand the sluggish growth that has followed.

An SFC model provides a useful tool to answer this question and to analyze long-term growth trends in developed economies: It ensures that the economic analysis obeys accounting rules and enables the economist to keep track of non-linear feedbacks if the dynamics get complicated. Moreover, an SFC model is useful to conduct policy scenario simulations and analysis.

From a methodological perspective we should note that the model's key ingredients are interdisciplinary. On the one hand, financial assets and liabilities, both of which constitute conventional elements in SFC literature, are key components. On the other hand, the model builds on the premise that developed capitalist economies are complex systems and draws on insights from the respective literature, as mentioned above. In line with this, our model adopts a long-term perspective of economic growth, while at the same time accounting for the build-up of internal

[1] Compared to the version submitted to a peer-reviewed journal, the paper presented below includes several appendices, including a robustness analysis testing the sensitivities of the model's parameters.

instabilities, that eventually cause economic growth to collapse and result in a regime change.

Research Paper

(1) Senner, R. and Sornette, D. A simple model of financial crises: Household debt, inequality and housing wealth. *reptrint submitted to the Cambdirge Journal of Economics*, 2018b

A Simple Model of Financial Crises: Household Debt, Inequality and Housing Wealth

Richard Senner and Didier Sornette*◇

Abstract

In the aftermath of the 2008 financial crisis, the GDPs of the US and the eurozone have grown astonishing slowly and have not yet recovered their pre-crisis rates, as of 2016. Here, we argue that, in order to escape further sluggish growth, we need to diagnose the present ailments as rooted in the characteristics of growth regimes prior to the crisis. To do so, we use key stylized facts to develop a simple stock-flow-consistent (SFC) macroeconomic model that incorporates a financial and a real economic circuit, household credit and distributive dynamics. As such, it is able to trace stylized growth patterns over the last decades, taking non-linear dynamics into account. The model leads to three main findings. First, positive feedback between financialization and rising income inequality leads, over time, to credit-burdened growth (the Perpetual Money Machine regime). Second, households either consume or speculate with the newly created money giving rise to a bubble, which endogenously bursts in a financial crisis. The GDP collapses, asset prices fall, and the private sector deleverages. Third, in the after-crisis period, the government has room to stabilize GDP temporarily by acting as a borrower of last resort. In so doing, we find that recovering a solid growth requires the government to observe the golden wage rule, namely to re-couple wages and output.

Keywords: Financial Crises, collateral, credit creation, housing wealth
JEL codes: G01, E64, E51

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◇ This paper would not have been possible without the insights of, and discussions with Alexandro Izurieta, Andrea Terzi, Silvan Fischer, Sascha Bützer, Florian Böser and Marc Lavoie. We would also like to thank the participants of the 2017 FMM Summer School, the 2018 FINEXUS conference Zurich and the Rethinking Finance Conference 2018 Oslo. This paper also benefits from research conducted during an internship at UNCTAD and draws upon research conducted for a master thesis at ETH Zurich. All remaining errors are ours.

1 Introduction

The uncomfortable truth is this: The reason we don't really know why recessions happen, or how to fight them, is that we don't have the tools to study them properly. The fact is, there are just some big problems that mankind doesn't know how to solve yet. (Noah Smith, 2014[1])

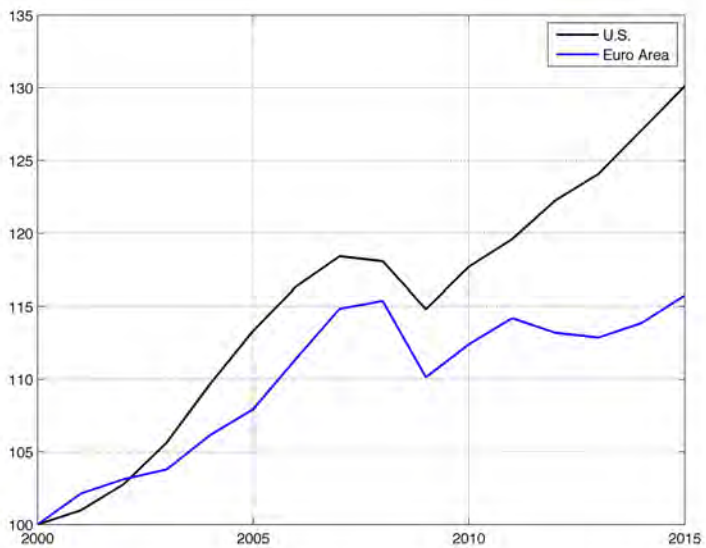

Fig. 1: Real GDP in the United States and the euro area; Index (2000 Q1 =100). While both economies recover similarly until 2011, growth remains particularly subdued in the euro area after 2011. Source: Ameco, authors' calculations.

Since 2008, GDP growth is subdued compared to the pre-crisis years in most advanced economies, including the US and the euro area. This challenges common conceptions of post-crisis recovery, according to which global GDP should have been long back to the pre-crisis trend. In 2008, the IMF for example predicted growth in the US and in particular the euro area to be only a few percentage points below the pre-crisis trend.[2] These growth forecasts, however, have since been (continuously) corrected downwards: In its recent World Economic Outlook[3], the IMF expects the global economy to grow by 3.2 percent in 2016, 0.2 percentage points down compared to the January forecast, 0.4 percentage points lower than the estimate from October 2015 and 0.6 percent points lower than its forecast from July 2015. Similarly, in May 2016, the GDP of the euro area is predicted to grow at 1.5 percent, a downward correction from 1.7 percent in January 2016.

[1] Assistant professor of finance at Stony Brook University, quote from an article on Bloomberg View.
[2] See for example IMF World Economic Outlook Oct. 2013, Fig. 1.13, Real GDP projections: Past and Current.
[3] World Economic Outlook, International Monetary Fund (IMF), April 2016

In the same spirit, the FED continuously revises growth forecasts downwards[4]. Moreover, the OECD announced in 2009[5] that "a recovery is in sight but damages from the crisis are likely to be long-lasting" (OECD (2009)).
However, as Figure 1 shows, real GDP in 2015 in the euro area is barely back to its 2007 level and yet there is no recovery in sight. Indeed, even unconventional monetary policy tools, such as Outright Monetary Transactions (OMTs), have not been able to revive the eurozone, let alone implement the inflation target. The situation is likely to persist as renowned economists warn.[6]
The pattern in the US appears only slightly more favourable with growth estimations for real GDP of merely 0.8% annualized based on the first quarter 2016.[7] However, in contrast to stagnating growth in the eurozone, growth in the US continued to recover slowly after 2011 (see Figure 1).

Why has growth in both economies not gained momentum? What explains the particularly unfavourable situation in the eurozone? The preceding discussion suggests that what happened in 2008 cannot be seen as a 'short-term shock' or an exclusively 'cyclical' phenomenon that will recover automatically. Instead, this situation appears to be the result of a fundamental change in the underlying economic growth regime. In order to escape sluggish growth, we need to take a step back in time and understand the characteristics of growth regimes before the 1980s, between the 1980s and 2008, and in the post-crisis period.
Conventional macroeconomic models in the spirit of the Ramsey Model fall short in capturing major characteristics of these different growth regimes. We take a different modelling approach that builds on the seminal work of Godley and Lavoie (2007) and exploits the only known invariance in economics, namely the stock-flow consistency (SFC). In addition, the analysis builds on i) stylized facts including financialization, income inequality and household debt and ii) a proper understanding of the feedbacks and associated endogenous risks between credit creation and asset prices. Particular attention is paid to potentially non-linear interplays between the financial and the real circuit of a monetary economy. The ultimate objective of this paper is to incorporate these concepts into a new coherent macro-financial model.
This model focuses on the dynamics that lead to a crisis while also addressing the question of optimal post-crisis policy. To this end, different government interventions are simulated and their effects on other economic sectors, as well as on overall growth, are analysed. Based on insights from these simulations, we then discuss the policy measures taken so far and look at optimal future policies to foster growth.

The paper is structured as follows: Section 2 discusses the conceptual and empirical literature. Section 3 presents descriptive statistics for the US and the euro area. Section 4 introduces the model, relates it to the relevant literature and presents the model's simulations. Section 5 critically discusses the model and its policy implications in light of the stylized facts. Section 6 concludes.

[4] Compare the 'Economic Projections of Federal Reserve Board Members and Federal Reserve Bank Presidents'. In January 2012, real GDP was expected to grow between 3.3% and 4% per cent in 2014, while actual real GDP growth in 2014 was 2.4%. Directly after the crash the projections were even worse: In November 2009, real GDP growth was expected to be 3.4-4.5% in 2011 (actual growth rate: 1.6%) and 3.5-4.8% in 2012 (actual growth rate: 2.2%).
[5] Organization for Economic Cooperation and Development (OECD) Economic Outlook 2009
[6] Baldwin et al (2015)
[7] Source: U.S. Department of commerce

2 Literature

"The macroeconomics that dominates serious thinking, certainly in our elite universities and in many central banks and other influential policy circles seems to have absolutely nothing to say about the problem. One single combination worker-owner-consumer-everything else simplified economy has nothing useful to say about anti-recession policy because it has built into its essentially implausible assumptions the conclusion that there is nothing for macroeconomic policy to do". Solow, when the octogenarian gave evidence to the US Congress on the state of mainstream economics in July 2010.

This section discusses the conceptual and empirical literature that focuses on macroeconomic characteristics of advanced economies over the last decades. The literature centers around the following four points: i) financialization, ii) income inequality and debt, iii) credit, and iv) risks and feedbacks in monetary economies. Existing models related to the one presented in this paper are discussed in section 4.

2.1 Financialization

Financialization describes the process by which financial firms, institutions and markets increase in influence and size relative to the non-financial economy. Philippon and Reshef (2012) document the strong increase in wages in the financial industry relative to wages in other sectors: "Workers in finance earn the same education-adjusted wages as other workers until 1990, but by 2006 the premium is 50% on average" (ibidem). Another common indicator to measure financialization is to look at the share of financial profits in overall profits. van Treeck (2009) documents that this share has increased since the 1980s in the US. He further shows that this was accompanied by shareholder value orientation (high dividend-payout ratio) and reluctance to invest in real physical capital. Similarly, Davis (2013) finds econometrically that "[s]hareholder value norms inhibit fixed investment by inducing a shift in managerial priorities towards financial targets." In the same spirit, Sornette and Cauwels (2014) document empirical evidence that the 1980s represent a regime shift away from a productive regime towards what the authors call a "perpetual money machine", where economic growth increasingly relies on financial innovation rather than real productivity. The authors document that, due to a climate of deregulation and strong growth in financial derivatives[8], the growth of the financial sector decoupled from real economic activity - a process inherently unsustainable in the long run. According to these authors, this financial instability is aggravated by incentive structures that turn funding away from the real economy, that is from research and development and the acquisition of new machineries, into financial instruments and financial acquisitions.

[8] The belief that derivatives would spread and diversify risk globally and enhance control was too optimistic: While small risks can be reduced through diversification, non-linear feedback effects between a large number of different risks can give rise to an increase in extreme risks. The recent Financial Crisis is one witness of their existence.

2.2 Demand Patterns: Wages, Profits and Debt

Financialization was coupled with, amongst other factors, rising income inequality. In order to discuss the literature on changing compositions and patterns of aggregate demand over the last decades, we build on the conceptual framework of so-called wage- and profit-led growth regimes of economies (see Lavoie and Stockhammer (2012) for an overview).

In a nutshell, a country is said to be in a wage-led regime if a higher wage share leads to higher economic growth. This is opposed to a country being in a profit-led regime, where a lower wage-share, i.e. a higher profit share, leads to higher economic growth. If a country is in a profit-led growth regime, this does not imply that 'profits are driving growth' but rather that, given the current conditions of the economy, a change in the income distribution in favour of profit recipients boosts economic growth. Given the fact that propensities to consume are higher for wage recipients than for profit recipients[9] and given that firms' investments depend on sales and expected profitability, "a higher real wage increases consumption but reduces investment, in so far as investment depends on the profit margin" (Bhaduri and Marglin, 1990)). Put differently, in theory, an increase in the wage share can lead to both a rise or a fall in national income.[10] Lavoie and Stockhammer (2012) survey the empirical literature on this topic and find that some countries are in a wage-led regime while others are in a profit-led regime. In particular, two studies find that the euro area is in a wage-led regime and five out of eight other studies find that the US is also in a wage-led regime.[11] In this context, it is worth mentioning Naastepad and Storm (2012) who provide an extensive discussion of the different regimes and argue in particular that the world economy at its current stage is in a wage-led regime. These findings are in line with the previous discussion on financialization, where rising profits crowd out fixed investment instead of boosting it.

Following this analysis, growth in the US and in the euro area can be expected to slow down once wage shares fall. According to the ILO (2015) report, wage shares in most countries actually have fallen since the 1980s. In particular, the wage share in the US has continuously declined since the 1980s, as well as in the euro area since its formation (see next section's Figure 2 and Figure 3). However, opposing the slow-growth hypothesis due to falling wage shares, the world experienced growth rates around 3 percent. Moreover, the US and the euro area did not grow particularly slowly in the period between 2000 and 2007, as shown in Fig.1.

This raises the question of how a wage-led economy can grow at such rates while wage shares are declining. Several authors, including van Treeck (2009) and Zezza (2011), propose an explanation to solve this 'puzzle': Private-sector borrowing kicks in and replaces the lack of demand from wage income. In line with this diagnostic, already in 1999, Godley (1999) identified unstable processes developing in the US, putting particular emphasis on the dynamics of household credit. A necessary condition for such household-credit-driven growth is 'easy access to credit' provided by banks. Indeed, the above mentioned authors argue that, due to financial deregulation, securitization and political support for a new 'debt culture', households' access to credit has been increasingly simplified. Stagnating wage income of many households could thus potentially be compensated by

[9] See for example Bowles and Boyer (1995)

[10] Net exports and government spending also affect the outcome, see again Lavoie and Stockhammer (2012) for further reference and a detailed analysis, which lies beyond the scope of this paper.

[11] See table 10 in Lavoie and Stockhammer (2012).

debt.[12]

The question remains, however: why households in actual fact chose to take advantage of these conditions in order to borrow more? One of the answers is that demand for credit increased because households wanted to keep up with their past living standard and/or with the consumption level of households surrounding them. Concretely, van Treeck (2009) argues that the new debt culture was indeed fueled by the so-called 'Relative Income Hypothesis', that is by upward-looking households, who determine their preferred consumption path by comparing themselves to higher income classes. Zezza (2011) documents that these higher income classes gained profound income raises. The macroeconomic implication is that lower income groups dis-save and become net borrowers. In line with this assessment, Bezemer and Zhang (2014) documents that, since the 1990s, domestic bank credit has been reallocated away from lending to non-financial businesses towards lending to households. An expanding literature discusses negative effects on growth and stability of this change in credit allocation. Jorda et al (2014), for example, find that non-mortgage lending plays a minor role in financial crises. In order to understand why household-credit-driven growth has potentially negative effects, we will in the next section discuss another stream of the literature that emphasizes the role of asset prices, money creation backed by collateral, and feedbacks between those variables.

2.3 Credit Creation backed by Collateral

Where does money come from and does it matter? Various schools of thought including monetarism consider money as being 'neutral' in the sense that it does not affect economic activity (in the long run). Cripps and Godley (1984) respond to monetarism and the old system of national accounts in arguing that financial flows and stocks are inherently important for economic theory and economic policy. Along these lines, Schumpeter (1954) and Tobin (1963) emphasize that a large part of the money stock in a modern economy is created by individual commercial banks through credit creation, opposing the money multiplier theory. The Bank of England (see McLeay et al (2014)) supports and Werner (2014) empirically shows that money is indeed created in bank accounts whenever a commercial bank gives a loan, and destroyed whenever the loan is paid back. Von der Becke and Sornette (2014) review monetary theories in detail and stress that money is not literally created 'out of nothing' because it is (usually) backed up by some sort of collateral of the borrower.[13] At the same time, money creation by banks can be limited due to capital and other balance sheet constraints.[14]

Given these insights on money creation, what are the implications for macroeconomic activity? Borio and Disyatat (2015) argue that it is important to take financing seriously, that is to make a proper distinction between real resources needed for production and the means by which goods are traded. This is since, after all, goods are not exchanged for goods as in Ramsey-style mod-

[12] The discussion of two other important aspects that allowed households to compensate the decreasing real wages lie beyond the scope of this article, namely female labour participation and increasing working hours.

[13] "Market-based finance creates money-like securities, which serve as collateral for more credit creation through the hierarchical money loop. From this perspective, most money creation is done by apparent non-money issuance of securities of all types, which acts as money and as the basis for the next level of credit creation [...] Within the hierarchy of money, potentially any asset can be and is generally used as a form of money as well as the collateral for credit. The use of assets, securities, and even derivatives, to create credit is the channel through which capital is used (rather than stored idle) for future innovations and growth." (von der Becke and Sornette, 2014)

[14] See "Where does money come from" by Greenham et al (2012) for an extensive discussion of banks' money creation. See Lipton (2016) for how banks become naturally interconnected in the process of lending.

els, but for claims on goods, i.e. for money. If the economy is expanding, additional purchasing power is needed, which can be created by commercial banks, in addition to the existing one. Put differently: If the resource/production constraint on economic growth is not binding, that is if the economy does not run at full capacity, credit creation and allocation by commercial banks allows the economy to expand its output.[15] Banks can thus fill the "ex-ante wedge between current aggregate income and planned expenditure" (Bernardo and Campiglio, 2013). If, however, no additional credit is created although the economy does not run at full capacity, then the financing constraint is binding and limits output. Such a limitation to output might indeed occur if for example the private sector is deleveraging, meaning if it is using its income to pay back debt instead of demanding goods and services.

The role of banks in creating money in the process of lending, as opposed to lending out pre-existing savings, is also important in the context of savings and investment. In this regard, it is worth quoting Terzi (2016): "The sum of all financial savings of the (resident) private sector can be seen as the total private stock of financial savings that is being matched by the net outstanding liabilities of private residents, the government, and non-residents. [...] This breaks the narrative of financial savings as a source of funds available for investment. In a real-exchange economy, a stored amount of output for consumption can fund the production of a real asset. In a monetary economy, financial savings do not fund production: they need to be validated by debt. A portion of the stock of private financial savings is typically stored in pension funds or private portfolios. Another portion is effectively 'in circulation,' that is, it is frequently transferred as producers (that is, workers and firms) compete for financial assets by selling their labor and their output, and as economic agents swap different financial assets when modifying their portfolio composition. The total existing stock of financial assets is validated by the willingness of other private entities, or the government, or non-resident entities to stay in debt with the domestic private sector. The stock is augmented when new liabilities are issued and diminishes when liabilities are paid off and not renewed."

Given the importance of the dynamics of the financial stock for economic activity, it is crucial to know the variables that determine the augmentation or reduction of financial assets, and credit in particular. Von der Becke and Sornette (2014) extensively discuss why first the amount of assets accepted as collateral, second the leverage, i.e. the amount of debt outstanding divided by the price of existing assets, and third trust or confidence are the three key variables along which credit creation evolves. We will see that the dynamics of these variables is driven by feedbacks between each other, and feedbacks between further economic factors that eventually give rise to an understanding of the financial crisis, opening solutions for growth recovery.

2.4 Feedbacks and Consecutive Risks between the Financial and the Productive Circuit

On a year-to-year basis, various factors can considerably change and affect economic performance including fiscal policy, monetary policy, natural disasters and other shocks, such as oil price shocks. Other variables like the slowly decreasing wage share that we discussed earlier do not visibly im-

[15] Additional purchasing power can also be created by a dis-saving of economic agents. However, this is only true if the dis-saved money is used to buy goods and services rather than to repay debt. Both mechanisms that create additional purchasing power, namely money creation and dis-saving, will be discussed in more detail in section 5.

pact the economy in the short run. Instead, their effect plays out in the long run. Similar to the frog that does not jump out of the water that is slowly being heated up, policy makers and economists frequently underestimate the impact of accumulated small changes that eventually lead to fundamental transformations and regime changes like financial crises.

This phenomenon can be related to the general process of creep in material sciences that precedes and prepares the incipient rupture (Sornette and Cauwels, 2015). It is inherent to many social and natural systems, where a stable phase accompanied by increasing creep can persist for many years or centuries before reaching a critical point that leads to a regime change. In this context, it is important not to get trapped in linear Granger-causality thinking or purely static analysis. The economy is a complex system that does not have room for arguments like 'financialization leads to financial crises'. Instead, typically, an initial instability is aggravated by complex non-linear feedbacks that put the system further away from stability or' equilibrium'. It is verbally challenging to describe, understand, and keep track of all the key dependencies in a monetary economy, which is why economists tend to develop coherent economic models like the one presented in section 4. Yet, several stylized feedbacks have been emphasized in the literature that will be discussed in the following.

Ideas of inherent financial instability go back to Minsky (1975, 1982), who argues that, in boom times, optimism leads to an extension of debt and leverage, which, triggered by the 'Minsky moment' (or tipping point) eventually comes to an end and contracts the economy due to low confidence, falling asset prices and deleveraging. This pro-cyclicality between asset prices and credit growth is also confirmed by Hofman et al (2015), who use historical data to show that significant changes in asset prices are linked to increased financial instability.

In the light of the previous discussion on credit creation backed by collateral, these results can be explained along the following lines. Once new credit is (partially) used for the acquisition of assets that qualify as collateral and are fixed in the short run, the credit creation process drives up collateral prices, thereby enabling more borrowing. Indeed, Greiber and Setzer (2007) argue that assets like houses are typically restricted in supply so that an extension in credit eventually leads to an increase in house prices, leaving consumer prices unaffected.[16] Similarly, if lending is backed by certain assets and channeled to financial vehicles and investors, these asset prices tend to increase. Iceland is a popular example, where credit creation expanded strongly in the 1990s and even more so in the 2000s. Consumer prices, however, were not affected because far-reaching financial deregulation inflated the financial sector, as documented in Sigurjonsson (2005). These findings are in line with Werner (2012), who stresses the importance of money creation as well as the effects of money allocation on economic growth.

Returning to financialization, Corsi and Sornette (2014) argue that the increased reliance on financial returns drives financial prices further up, which, as discussed before, increases collateral and bank lending capacity. As a consequence, a growing share of new credit will be channelled to financial investments. Moreover, Lin and Tomaskovic-Deve (2011), van Treeck (2009) and the ILO (2015) report emphasize that a marginalization of the role of the real economy and institutional deregulation are coupled with significant income inequality. As discussed before, income

[16] If housing collateral is used for productive investment of SMEs (Adelino et al (2015)), house prices might not increase. Ultimately the macroeconomic impact of credit creation backed by houses depends on the allocation of the newly created money. As we will see later, households do not directly invest in productive capacities but use mortgages to fund consumption or to purchase speculative assets like existing housing.

inequality and the relative income hypothesis, in turn, fuel credit demand while financialization and regulatory changes fuel credit supply. The resulting overall credit expansion along with rising asset prices and further financialization sustain the "perpetual money machine" (Corsi and Sornette, 2014). They do so, however, only temporarily because asset prices and debt-to-income ratios cannot grow forever.

Summing up the conceptual discussion, we have seen that the literature on wage- versus profit-led growth indicates that rising income inequality can slow down economic growth. This slowdown, however, can be weakened once excessive household debt kicks in and compensates for the lack of demand. Household debt, in turn, can lead to a bubble in the financial circuit because households' opportunities for productive investment are limited since households either consume or purchase speculative assets. Firms' borrowing for investment in innovative production capacities decreases as a share of overall borrowing. If households increase their leverage, only a fraction of household credit will enter the real economy via consumption - the other fraction will eventually enter the financial circuit. Speculative assets like houses, in turn, are used as collateral for households' borrowing, so that positive feedback eventually leads to an asset price bubble that bursts in finite time. Once the bubble bursts, households deleverage and consumption collapses, thereby contracting real investment and total GDP.
While considerable empirical and conceptual evidence exists to back up this narrative, a simple macroeconomic model that captures the key dynamics and allows one to test and discuss different hypotheses is still missing. This paper proposes a new model to narrow this gap. Before introducing the model, the next section presents empirical facts that support the stylized narrative outlined so far and that will be used to evaluate our model in section 5.

3 Key Empirics: Wage Share, Debt-to-Income and Sectoral Analysis

This section documents empirical evidence supporting the narrative developed in section 2. While there are numerous variables that are potentially relevant for the analysis, we will focus here on a few that we consider indispensable in the context of the US and the eurozone: i) the wage share, ii) households' debt-to-income ratio, and iii) sectoral balances.

The wage share is defined as the ratio between nominal compensation of employees and nominal GDP. Several studies have documented its decline in many advanced economies since the 1980s.[17] Figure 2 shows the wage share in the United States from 1960 to 2015. As we can see, the wage share in the US declined from roughly 62% before 1980 to 57% today. The wage share fell particularly strongly in the early 2000s. After 2008, a small rebound occurred, followed by a another period of decline.
Data for the euro area only go back to 1995. Since then, the wage share has decreased continuously until the global financial crisis hit in 2008 as seen from figure 3. The overall wage share fell from 58% in 1995 to 54% in 2007. Afterwards, a strong rebound can be observed that was followed by a small decline. Since 2010, the wage share has been roughly stable around 56%. Note, however, that considerable heterogeneity exists within the euro area: In Germany, the wage share

[17] See for example the ILO (2015) report

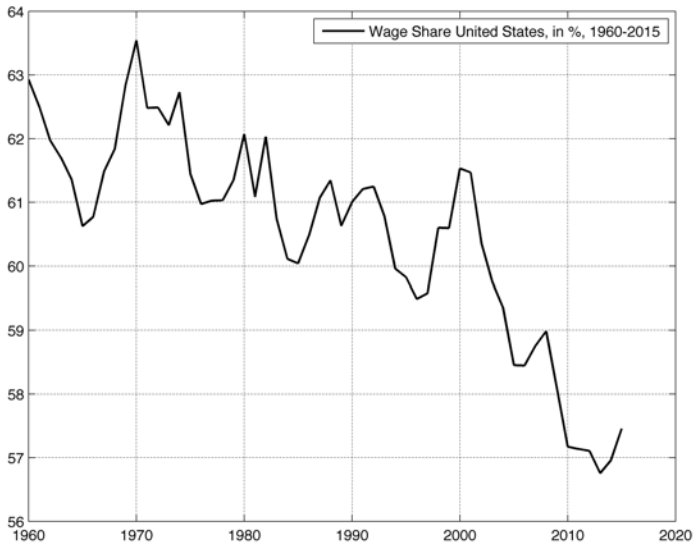

Fig. 2: Wage share in the US defined as employees compensation divided by GDP, as a percentage. The wage share declines continuously since the 1980s with an accelerated decline in the early 2000s. Source: Ameco

Fig. 3: Wage share in the euro area defined as employees compensation divided by GDP, as a percentage. The wage share falls continuously from 1995 before rebounding after 2008. Source: Ameco

decreased from 59% in 2000 to 54 % in 2008 while the wage share stayed constant or increased slightly between 2000 and 2008 in southern Europe.[18]

Fig. 4: US Household debt outstanding as a percentage of household disposable income, 1969-2015. The ratio rises continuously until 2008 and falls afterwards. Source: Flow of Funds and NIPA.

Motivated by the discussion in section 2, we are also interested in the magnitude of household borrowing. Figure 4 shows households' outstanding debt as a percentage of disposable income in the US. The ratio rose from slightly above 60% in the 1970s to over 130% in 2007. Note that the rise in the debt-to-income ratio was particularly strong between 2000 and 2007. Since then, the ratio has decreased but remained above 100% in 2015.

Concerning the euro area, household debt and income data are only available for the period after 2003. We can see in figure 5 that the ratio increased from 80% in 2003 to 97% in 2010, followed by a decrease to around 93% in 2015. Similar to the previous discussion on wage shares, debt-to-income dynamics vary considerably among the individual countries in the euro area. In Spain, for example, household debt-to-income increased from 60% to 130% over the mentioned period. In Germany, in contrast, the ratio continuously declined from 105% in 2001 to 80% in 2015.[19]
Finally, let us consider the sectoral balances of the two economies. Figure 6 shows the net financial balances, i.e. the net lending or borrowing of each economic sector in the United States between 1960 and 2015 as a percentage of GDP.[20] Note that corporations mostly ran an annual deficit

[18] For the purpose of this paper, Southern Europe is defined to consist of Spain, Italy and Greece. Source: Ameco.
[19] Source: Eurostat.
[20] The sum of all net financial balances is always zero for a country (taking the rest of the world into account). Clearly, this is not to be confused with *material* assets that usually do not sum up to zero.

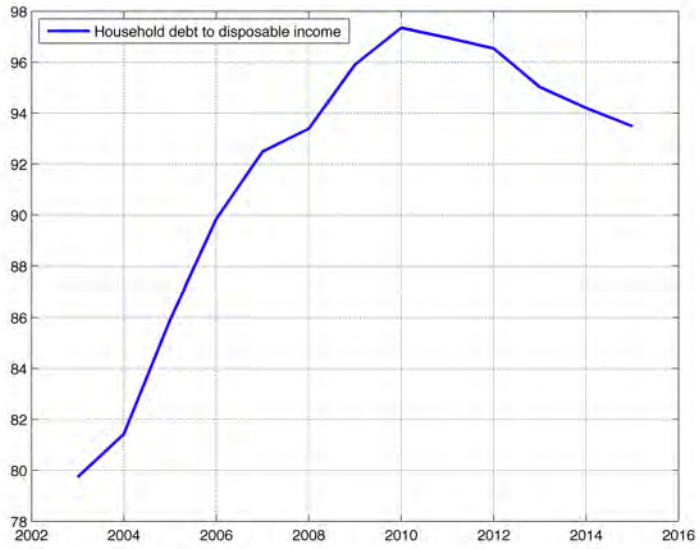

Fig. 5: Household debt outstanding to disposable income in the euro area, as a percentage. The ratio increases over time and peaks in 2010 followed by a slow debt reduction relative to income. Source: Eurostat

before 2000 but became net savers afterwards. Households were typically net savers although the magnitude of savings as a percentage of GDP has been decreasing continuously until 2008, when households became net borrowers. However, after the crisis, households quickly became net lenders again. Since all sectoral balances have to sum up to zero and households and firms became relatively large net lenders after 2008, some sector(s) must have increased their net borrowing. Indeed, the increasing savings of the private sector in the aftermath of the crisis were offset by a government deficit corresponding to 12% of GDP in 2009. The government deficit has since been reduced and was below 5% in 2015. This reduction was mirrored by a reduction in net savings of both the private sector and the rest of the world. The net lending position of the latter has been increasing since 1980 and reached its peak in 2008.

Figure 7 shows the net financial balances for the euro area from 1999 to 2015. The decrease in households' net lending has not been as strong as in the US prior to the crisis but is still visible. Immediately after 2008, households increased their net savings and firms did so even more strongly relative to their previous position. While households' net lending in 2015 was roughly back to its pre-crisis level, firms were still relatively high net savers. Once again, the remaining question is thus who mirrored the relatively high net savings of the private sector after 2008. Immediately after the crisis, the government sector ran a deficit of up to 6%. In the following years, however, the government deficit decreased until it reached 2% in 2015. This reduction in government spending since 2010 has been compensated by an increasing deficit run by the rest of the world.

Summing up the empirical evidence presented in this section, the emerging picture is a falling wage share that was partly offset by household debt. This offset was unsustainable once the debt burden became too large relative to wage income. After the crash, a deleveraging process started. The private sector suddenly became a relatively large net lender and the government (and the rest of the world) mirrored this net lending by increasing net borrowing. Overall this picture is less pronounced for the euro area due to the heterogeneity among its member countries. Consider Germany, the largest economy in the eurozone, where prior to the crisis the wage share as well as household debt-to-income decreased but the current account surplus increased. In Spain, on the other hand, the wage share did not decrease, households' debt-to-income increased more than in the US and the net lending of the rest of the world increased. In section 5, we will discuss in more detail the question of how to interpret the heterogeneity in the eurozone, using insights from the model's simulations.

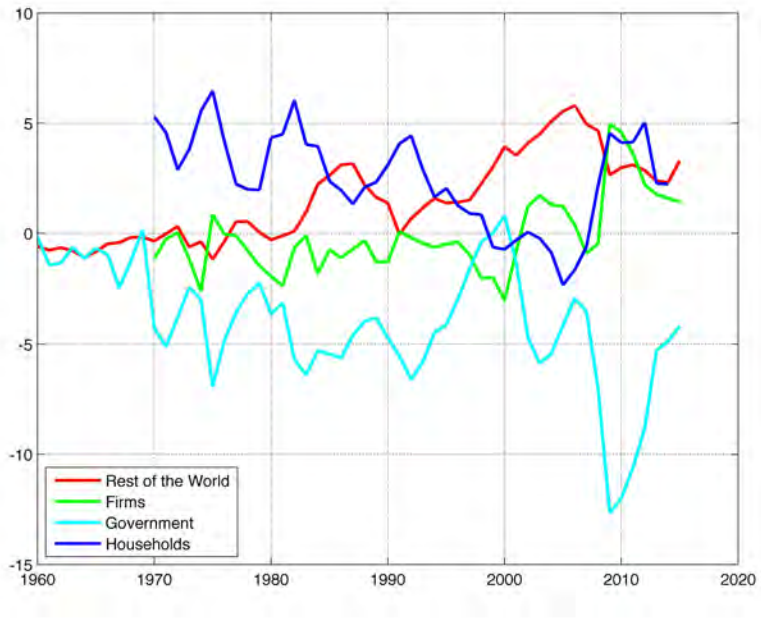

Fig. 6: Sectoral (net) balances of the US as a % of GDP. Increasing government deficit after the crisis mirrors increasing private-sector savings. Source: Ameco

4 The Model

"The fact that money stocks and flows must satisfy accounting identities in individual budgets and in an economy as a whole provides a fundamental law of macroeconomics analogous to the principle of conservation of energy in physics". (Cripps and Godley, 1984)

Motivated by the stylized facts in the last section, the aim of this section is to develop a consistent

Fig. 7: Sectoral (net) balances for the euro area as a % of GDP. Rest of the world and government deficit mirrors increasing private savings after the crisis. Source: Ameco

analytical framework to test whether feedbacks between financialization, income distribution as well as asset prices are able to track major trends and economic regime shifts in a monetary economy like the US over the last decades. Non-linear feedbacks like the ones between asset prices, collateral and credit are taken into account to allow for criticalities like financial crises. We will see that our model uses only 7 behavioural equations to incorporate these ideas. Moreover, we will see that a crisis does not have to be triggered by exogenous shocks but can be endogenous to our model economy. In addition, and in line with the discussion on the importance of money in section 2, the model economy cannot be a pure exchange economy. Instead, the role of credit creation is incorporated and nominal variables are used. Against this backdrop the model focuses on distributional and compositional determinants of aggregate demand, not on supply-side factors.

4.1 In Search of a Holistic Modelling Framework: Key Model Ingredients and the Importance of Stock-Flow Consistency (SFC)

An interdisciplinary method that has proven useful in order to find a suitable modeling framework for a variety of systems is to look for a symmetry or invariance of the system. The system to be analysed in this paper is a modern macro-economy populated by various agents. The latter ones are typically classified into different sectors, namely households, firms, the government and the rest of the world. In this context, we have seen the importance of finance for economic analysis. Indeed, the only known invariance in economics builds on a trivial, and yet fundamental

insight about finance: every financial flow and every financial stock of one economic sector has a counterpart somewhere else in the economy. Using the words of Godley and Lavoie (2007), who formalized this invariance into so called stock-flow consistent (SFC) models, this can be put as follows: "Everything comes from somewhere and everything goes somewhere". Every purchase or sale by one sector implies another sale or purchase in another sector. And every financial asset in the economy has a corresponding liability somewhere else.[21] The stock-flow-consistency simply exploits double-entry bookkeeping for economic agents, sectors and countries.

In mathematical terms, the sum over all financial assets and liabilities is always zero. Let S_i be the net financial stock of sector i. We can then formulate the stock-consistency by requiring that the sum of all financial assets is zero at any given point in time

$$\sum_i S_i = 0$$

In the case of a closed economy, total household savings plus total firm liabilities plus total government liabilities are equal to zero.

Taking the derivative (or applying the discrete difference operator) with respect to time leads us to the mathematical formulation of the flow-consistency, i.e. of the law that every payment or reception of a financial asset in the economy has a counterpart somewhere else in the economy:

$$\sum_i \partial_t S_i = 0$$

In the context of a closed economy, equation (1) states that the sum of net household lending, net firm lending, and net government borrowing equals zero.[22] In line with this logic, the financial savings of the whole world also add up to zero. Note that if financial balances of all except one sector are known, the financial balance of the remaining sector is also known due to the stock-flow-consistency (the system is 'overdetermined').

The idea to use the described invariance as a basic framework for economic reasoning and modelling is connected to at least two streams in the literature. Economists at Cambridge around Keynes, Kalecki, Cripps, Kaldor and Godley laid the foundations in the anglo-saxon area, whose ground breaking state-of-the-art generalization can be found in Godley and Lavoie (2007). More recently, Bezemer (2009) argues that accounting for macroeconomics, that is incorporating the balance sheets of all sectors, is crucial for an understanding of the economy. Modern monetary circuit is a terminology adopted by a branch in the literature that largely overlaps with the stock-flow-consistent approach (see for example Lipton (2016)). Similar ideas have been developed by German economists in the early 20th century. The theory of bank credit by Hahn (1930) is extended by Lautenbach (1952) who extensively discusses the interplay of credit and production respecting aggregate consistencies. Stützel (1978) further developed the theory that is summarized in his seminal book "Saldenmechanik" ("Balances Mechanics", translation by the authors). Stützel's title suggests a similarity with mechanics in physics and emphasizes that his theory is not per se about

[21] As mentioned earlier, this does not hold true for "real" assets. The whole world has zero net financial wealth but positive real wealth.

[22] While households are typically net lending and the government and firms net borrowing, this pattern can vary over time and has important macroeconomic implications. Indeed, as we have already seen in Section 3, households and firms became net lenders in the post-crisis period.

behavioural economic relationships but also about fundamental and logic consistencies. Indeed, Stützel's work can be seen as the German counterpart of the anglo-saxon stock-flow-consistency.
Acknowledging the value of this literature, Bezemer (2009, 2011) identifies four common features of models that predicted the recent crisis: i) having room for two kinds of assets, ii) taking credit flows, i.e. money creation into account, iii) tracing the debt stock, and iv) obeying accounting identities.[23] Most of these factors are traditionally found in SFC models. As we will see later, our model incorporates all of them.
Our model relates to several recent contributions to the SFC literature including Dos Santos and Zezza (2006), who discuss growth and the distribution of income. Similar to our model, wage earners have a higher propensity to consume out of income than firm owners. Dos Santos and Zezza (2008) provide a modern benchmark SFC growth model putting particular emphasis on the financial sector modelling. Van Treeck (2007) focuses on share-holder value orientation and financialization more generally. Similar to our approach, the model is able to trace feedbacks between a real and a financial (stock market) circuit. Lavoie (2008) also studies financialization and the propensity of households to take new loans. The propensity to take new loans for consumption or speculation is also part of our model and depends upon collateral, leverage, wage income and the relative income hypothesis. Finally, as we will see, one of our policy implications is very close to Zezza (2011), who uses a SFC model to emphasize the importance of a re-distribution towards median income households in order to get to a sustainable growth path.
While the stock-flow consistency provides a suitable modelling framework for our investigation, several elements that are not per se associated with the SFC literature are also important. Our model builds on Corsi and Sornette (2014), who propose a reduced form model for the joint dynamics of liquidity and asset prices. Non-linear feedbacks produce explosive dynamics that eventually result in a market crash.
More specifically, our model extends a model of Rozendaal et al (2016) by introducing two assets and by embedding their model into a stylized macroeconomic framework with endogenous GDP and different economic sectors, i.e. households, firms and a public sector. Rozendaal et al (2016) emphasize the importance of credit and in particular of asset prices, leverage and trust, the latter variable determining the fraction of assets that can be used as collateral. As we will see in the next section, introducing behavioural equations for consumption and investment will allow us to trace the inter-connectedness between the real and the financial circuit as well as to follow up on various key economic indicators like GDP, income distribution and sectoral financial flows.

[23] While standard neoclassical models can also be called SFC in some sense, the definition of stock-flow-consistency in the 'Godley' sense that we are using is more specific and does not apply to DSGE models. Zezza (2011) mentions the following crucial features of SFC models: "1. The model is dynamic, and the position of the system in a given period is crucially affected by its previous historical path; 2. The model is consistent, in that every monetary flow is recorded as a payment for one sector and a receipt for another sector. In addition to flow consistency, every relevant stock - of real or financial assets - is linked to a corresponding flow. For instance, the net stock of assets for the household sector changes its value in a given period through household saving and capital gains; 3. The banking system is explicitly represented; 4. Prices do not necessarily clear markets. At any moment in time, the stock of an asset may differ from its "desired" level. Quantity adjustments towards "desired" or "equilibrium" levels for model variables require some buffers; 5. The accounting structure of models adhere to the principles laid down in the System of National Accounts (SNA) for flows, flow of funds and stocks accounting, helping to move from theoretical models to applied models."

4.2 The matrices of our model economy

As usual with the SFC modeling approach, we start out by presenting the stock and flow matrices of our economy. We have a closed economy model with four sectors, namely households, banks, firms and a public sector. As indicated in the balance sheet matrix in table 1, households and firms both can hold deposits M at banks. Moreover, households take loans D^{HH} from banks to finance consumption and to purchase speculative assets from other households. The speculative asset A is owned by households and we assume that it consists of a fixed amount of housing. [24] Firms finance investment out of their cash flow. [25] The commercial banking sector does not make any profits since interest rates are assumed to be zero. There are no bonds or cash in our economy. The only financial asset are deposits. The public sector's role is limited to the ability to bail out households (i.e. to take over their debt), or, interpreted differently, to transfer newly created liquidity to households (see more below).

Table 1: The stock matrix

	Private Sector			Public Sector	Σ
	Households	Banks	Firms		
Deposits	M^{HH}	$-M^{bank}$	M^{firm}		0
Loans	$-D^{HH}$	$+D$		$-D^{GG}$	0
Speculative Asset	A				$+A$
Net Worth (Balance)	$-V^{HH}$	0	$-V^{firm}$	$-V^{GG}$	$-A$
Σ	0	0	0	0	0

Table 2 shows all the transactions that occur between sectors in any given period of time Δt. All sources of funds appear with a plus sign, and all uses of funds have a minus sign. As usual, the first block of lines (first four lines) describes all the flows associated with the national income and product accounts. The subsequent two lines trace the change in stocks of financial assets and liabilities. Consistency is ensured because all columns and rows sum to zero. Firms produce whatever is demanded by households and there are no inventories. Finally, we have to describe the capital and current account of firms. Following Godley and Lavoie (2007, p.220): "Firms sell the fixed capital goods they produce, and this appears with a plus sign in the current account column, since this is a source of income. But they also acquire these fixed capital goods - their investment - and these appear with a minus sign in the capital account column, since these investment goods purchases are a use of fund."

[24] Note that the speculative asset could consist of a variety of assets, like for example tulips, IT companies or crypto coins. The speculative asset has the characteristics that its supply does not move much compared to the overall market capitalization, or that its supply increase is not very GDP-relevant (think of creating new crypto coins with a few mouse clicks that have no intrinsic value).

[25] Note that credit-financed investment can easily be included but does not change the important dynamics as will become clear later.

Table 2: Transactions-flow matrix

	Households	Banks	Firms		Public Sector	Σ
			Current	Capital		
Consumption	$-C$		$+C$			0
Wage income	$+W$		$-W$			0
Investment			$+I$	$-I$		0
Public Transfers	$+G$				$-G$	0
Δ deposits	$-\Delta M^{HH}$	$+\Delta M^{bank}$		$-\Delta M^{firm}$		0
Δ loans	ΔD^{HH}	$-\Delta D$			ΔD^{GG}	0
Σ	0	0	0		0	0
			(Profit + Fin. Assets)			

4.3 The Model - Equations

Time is discrete and indicated by subscript t. The following notation for the difference operator is used: $\Delta D = D_t - D_{t-1}$. We use $:=$ and $=$ to distinguish definitions from behavioural equations. We start with the usual income-demand identity: Nominal GDP is defined as consumption plus investment in a closed economy with no government (A government sector will be introduced in section 4.5 as an extension.):

$$Y_t := C_t + I_t \tag{1}$$

4.3.1 Household Sector

As we have just seen, households own housing. [26] Households can use their housing wealth as collateral to borrow money for consumption and to borrow for financial speculation. [27] Consumption plans are made prior to the realization of household income. Desired consumption is determined by the Relative Income Hypothesis, which states that the utility or satisfaction that individuals derive from a certain consumption level depends on the consumption level in relation to a weighted average of the consumption patterns of other people in the economy - and not solely on the absolute level of consumption. The Relative Income Hypothesis goes back to Duesenberry (1949). [28] Due to a boom in the literature on the economics of happiness and a growing body of empirical evidence (see for example Oswald (1997) and more recently Clark et al (2008)), interest in the Relative Income Hypothesis has increased over the last 20 years. Dijk et al (2010) build on Duesenberry and develop a theory of expenditure cascades, where context and evaluation affects consumption decisions. Along these lines, Bertrand and Morse (2016) create a trickle down consumption theory and Christen and Morgan (2005) show that desired consumption is such as to "keep up with the Joneses"(ibda). The Relative Income Hypothesis is modeled by assuming that households desire to consume a constant fraction $\bar{\lambda}$ of what the expected national income would be. Expected national income is a simple extrapolation from previous GDP growth. Put simply, if the overall economy recently grew by 5%, households desire to increase their consumption in a

[26] In the following we will use both terms, housing and speculative asset, in a substitutable way.

[27] Passarella (2011, 2014) follows a different approach and splits firms into two different sectors. Only one sector is allowed to invest in financial markets. Similar to our model, production and asset price evolution can be analysed simultaneously.

[28] "The strength of any individual's desire to increase his consumption expenditure is a function of the ratio of his expenditure to some weighted average of the expenditures of others with whom he comes into contact" (ibda)

proportional way. Desired consumption is thus

$$C_t^e \coloneqq \bar{\lambda} \cdot (1 + g_{t-1}) \cdot Y_{t-1} \tag{2}$$

where $g = \frac{\Delta Y}{Y}$ is the growth rate of the economy. The feasibility of this consumption path is determined by households' available funds. In our model, households receive wage income in return for their labour, are able to borrow additional money from banks, and can use their savings (existing deposits). Potentially, there is an ex ante gap between current income and planned expenditure, similar to the dynamics of the model of Bernardo and Campiglio (2013).[29] If the financing constraint of households is binding, the actual realized consumption will be lower than desired consumption: [30]

$$C_t = \min\{C_t^e, W_t + \Delta D_t^{HH} + M_{t-1}^{HH}\} \tag{3}$$

where W_t is the wage bill determined by a bargaining process between workers and employers (see later),ΔD is the net increase in household debt, and M_t^{HH} is the amount of household deposits. We will see later that an increase in household deposits reflects speculation in the financial circuit, i.e. purchasing of houses from other households, driving up house prices. [31]
Since deposits are the only financial asset in our economy, households' financial balance is equal to net borrowing or lending (flow). Net borrowing or lending is

$$F_t^{HH} \coloneqq W_t - C_t \tag{4}$$

and the net stock of financial assets of the household sector is the sum over all past flows:

$$S_t^{HH} \coloneqq \sum_{i \leq t} F_i^{HH} \tag{5}$$

Note that the net stock of financial assets is not equal to D^{HH} because households also hold deposits for the purpose of speculating in the housing market.

4.3.2 Leverage, Debt and Trust

Household leverage is defined as

$$L_t^{HH} \coloneqq \frac{D_t^{HH}}{A_t} \tag{6}$$

where D_t is the gross debt stock of households and A_t is housing wealth (or the price of the speculative asset more generally).

[29] The ex ante gap is also in line with Zezza's key ingredients for a 'crisis model': "At any moment in time, the stock of an asset may differ from its "desired" level." (Zezza, 2011)
[30] It is important to note that this budget constraint is a monetary one in line with the discussion on money in section 2, and more precisely in line with the call of Eeghen (2014) to prioritize the money budget equation over the real resource constraint. DSGE models, in contrast, primarily focus on the resource constraint.
[31] Withdrawal of money from the financial circuit is equivalent to a sale of houses. We will see later that such a withdrawal reduces the price of the speculative asset.

Household's credit expansion is limited by households' collateral. Collateral is equal to a fraction of housing wealth and we call this fraction trust T. High trust and high housing prices, for example, do allow for high levels of debt:

$$D_t^{HH} \leq T_t \cdot A_t \tag{7}$$

Building upon Rozendaal et al (2016), we introduce the dynamics for debt and trust. We assume that trust increases when it is above leverage. On the other hand, trust is expected to decrease if leverage is above trust:

$$T_t = T_{t-1} + k \cdot T_{t-1}(T_{t-1} - L_{t-1})(1 - T_{t-1}) \tag{8}$$

where k is a positive constant. This expression has the form of a discrete logistic equation (most common S-shaped function), whose fixed points are at $T = 0$, $T = L$ (for a constant L) and $T = 1$, thereby making sure that Trust stays within the range of 0 and 1. Similarly, debt tends to increase if collateral is larger than debt and vice versa:

$$D_t^{HH} = D_{t-1}^{HH} + a \cdot (T_{t-1} \cdot A_{t-1} - D_{t-1}^{HH}) \tag{9}$$

where a is a constant. Households are optimistic and willing to borrow more, that is increase leverage, if trust and/or asset prices are very high compared to the existing debt stock. [32] Note that the evolution of household debt (eq. (9)) incorporates the key concept that banks' loan supply is limited by collateral as described in eq. (7).
While demand and supply for debt could be modeled in more detail, the chosen functional form reflects stylized facts as discussed in section 3 and, at the same time, ensures traceability of the model.

4.3.3 Financial Circuit

As we have seen before, the economy is divided into households, banks and productive firms (and a public sector later on). What we call 'financial circuit' is part of the household sector and describes the dynamics of housing wealth. We assume that households use deposits within this financial circuit to buy and sell existing housing from other households. Given the debt dynamics D_t (eq.9), the consumption patterns of households C_t (eq.) as well as the wage bill W_t (will be determined later on), we can determine the net increase or decrease of households' deposits in

[32] Rozendaal et al (2016) also propose an alternative debt equation that takes the trend of assets and trust into account:

$$D^{HH} = D_{-1}^{HH} + a \cdot (T_{-1} \cdot A_{-1} - D_{-1}^{HH}) \cdot \Delta t + \Delta(TA) \tag{10}$$

The additional term $\Delta(TA)$ can boost or slow down the change in debt. Preliminary analysis shows that this additional term results in the same major outcome of the model, that is the economy enters the long-run growth regime or the financial crash regime. The intuition behind this similarity will become clear in section 4.3, where we discuss the simulation results of the model. Given that, in the SFC modelling spirit, most behavioural equations of our model take only previous flows and stocks into account, we follow this spirit and do not include the additional trend term. Future research, however, could focus on a more fundamental, behavioural justification for the functional form of the debt equation.

each period:

$$B_t^* \coloneqq \Delta D^{HH} - (C_t - W_t) \tag{11}$$

If, by simple accounting, households borrow more than they need to fulfill the desired consumption path, gross deposits of the households sector increases by B^*. If, however, households' desired consumption cannot be satisfied by wage income and new debt, households can use existing deposits to finance consumption expenditures. The stock of households' deposits is thus given by:

$$M_t^{HH} \coloneqq M_{t-1}^{HH} + B_t^* \tag{12}$$

4.3.4 Households portfolio choice

The higher households' deposits, the more funds chase a fixed amount of housing, thereby driving up the house price. Vice versa, a withdrawal of deposits from the financial circuit (caused by a need of funds for consumption) causes a reduction in the house price.
Housing wealth is

$$A_t = P_t \cdot e_t \tag{13}$$

where P_t is the price and e_t the number of housing. We assume the latter to be fixed, leaving GDP unaffected. GDP is only indirectly affected because asset prices influence households' consumption and firms' investment decisions. We build on Godley and Lavoie (2007) to determine households portfolio optimization. Housing wealth as a share of overall gross wealth is constant:

$$\frac{A_t}{A_t + M_t^{HH}} = \beta \tag{14}$$

or:

$$A_t = \frac{\beta}{1-\beta} \cdot M_t^{HH} \tag{15}$$

where M^{HH} is determined in equation (12), and β is a constant. [33]
The return r_t^A on the speculative asset is defined as

$$r_t^A \coloneqq \frac{\Delta A_t}{A_t} \tag{16}$$

Decreasing interest rates played an important role in maintaining an increasing debt stock in the US and the euozone. [34] For simplicity, however, we assume zero interest rates. [35]

[33] Following Fisher (1911) and the Quantity Theory of Credit by Werner (2012), $\frac{\beta}{1-\beta}$ can also be seen as the velocity of money in the financial circuit, which we assume to be stable. See also Senner (2018) for a detailed discussion of the empirical estimation of the equation of exchange.

[34] Borio and Disyatat (2015) show in a voxeu.org article from 2014 that interest rates declined since the 1980s. At the same time the debt stock increased - the latter probably not being possible without the former. The authors also discuss how policy intervention keeps rates low in booms and lowers them after a crash, resulting in an overall downward bias of interest rates in the long run.

[35] We will see later, however, that this simplifying assumption is supporting one regime with long-run growth and ever increasing debt.

4.3.5 Firm Sector

The real production side of the economy has to be modeled in order to keep track of the spill-overs and feedback loops from the financial sector.
Firms (or business owners) form a group distinct from households. Firms can make profits and they invest in machinery and equipment according to aggregate demand and profit incentives. Motivated by the fact that the propensity to save out of profits is considerably higher than the propensity to save out of wages,[36]
we assume that firms do not consume at all but invest and eventually save retained earnings. Retained earnings cannot be invested in the speculative asset and are held in cash.[37] The financing of firms is not directly modeled, meaning it is not modeled how firms borrow money (limited by their capital stock, which serves as collateral). We assume that firms' financing constraint is never binding so that all desired investment plans are financially feasible.[38] Firms take investment decisions according to:

$$I_t = I_{t-1} + \alpha \cdot I_{t-1} \cdot g_{t-1} \tag{17}$$

While more sophisticated versions of an investment function are possible, [39] they do not add much value since we are interested in extracting the key interactions between collateral, household debt and housing. We thus take the most simple functional form for the investment function, where firms are backward looking on past GDP growth. In each period, the firms' profit bill equals:

$$\Pi_t \coloneqq Y_t - W_t \tag{18}$$

Firms' net financial position (flow) is equal to the profit bill minus investment

$$F_t^{firm} \coloneqq \Pi_t - I_t \tag{19}$$

Note that the flow-consistency of the model can be seen along the following lines. Plugging $\Pi_t = Y_t - W_t$ in the last equation and replacing Y_t with $C_t + I_t$, the net lending or borrowing of the firm sector becomes $C_t - W_t$, which is equal to the negative net borrowing or lending of the household sector. Unsurprisingly, the sum of the flows is equal to zero.

[36] Bowles and Boyer (1995) for example find that in several countries the propensities to save out of profits are 0.4 higher than out of wages.

[37] If the investment induced by demand incentives is smaller than income, firms will retain profits in cash and become net savers. While cash holdings of firms increased in the US (see for example research by the St. Louis FED), they still only make up a fraction of total non-financial firms' financial assets. By restricting firms to exclusively hold cash, we ignore the increasing financialization of real firms, i.e. the fact that non-financial firms also increasingly relied on financial profits over the last decades. Motivated by the literature discussion in section 2, however, we focus on the overall more important behaviour of private households (including speculators and financial firms).

[38] While firms' leverage increased in the US, it did not increase as much as household leverage. Firms' leverage is therefore ignored in order to focus on household debt.

[39] A more sophisticated version of the investment function could take into account that investment growth depends positively on the change in the profit share, and negatively on the return of the speculative asset: $I_t = I_{t-1} + \alpha_1 \cdot \Delta\tau \cdot I_{t-1} + \alpha_2 \cdot I_{t-1} \cdot g_{t-1} - \alpha_3 \cdot I_{t-1} \cdot r^A_{t-1}$ or formulated in growth rates: $g_I = \frac{\Delta I}{I} = \alpha_1 \Delta\tau + \alpha_2 g_{-1} - \alpha_3 r_{F,-1}$. The negative effect of the rise of the speculative asset on the investment decisions incorporates the idea of a human capital flight to the financial sector as well as a crowding out of real investment due to financialization more generally, in line with the discussion in section 2. However, this more complex investment function does not fundamentally change the dynamics of our model economy.

The net stock of claims or obligations towards the other sector in the economy is:

$$S_t^{firm} \coloneqq \sum_{i \leq t} F_i^{firm} \tag{20}$$

Note more generally that a stable price level of the real economy is implicitly assumed so that GDP, for example, is a measure of real output of the economy and not subject to inflationary or deflationary distortions. The rationale behind this is best explained in Hofman et al. (2015). The authors argue that the CPI (Consumer Price Index) is not the main problem after a financial crash, but rather asset price deflators and in particular housing price deflators. In line with our model, the authors find that "the most damaging interaction appears to be between property price deflations and private debt" (Hofman et al., 2015). Constructing a model for advanced economies, where high levels of GDP inflation or deflation were rare over the last decades, this assumption does not appear to be very restrictive but simplifies the model a lot.
As a consequence, if households increase their borrowing to spend more on consumption, real GDP increases directly. This implies that the economy is not running under full capacity, i.e. we assume that the economy is not constrained with respect to production. If, however, households borrow for financial speculation, then asset prices are inflated immediately.

4.3.6 Collective Bargaining determines Income Distribution

Following Taylor (2010), the wage share is determined by historical forces and policy intervention - as opposed to the marginal productivity of labour on the 'perfect labour market'. Apel (2015) discusses income inequality promoting policies in the US and their connection to the decreasing bargaining power of workers and financialization. The author calls for the inclusion of such dynamics into macroeconomic models. We attempt to do this by modelling institutional, political, economic and lobbyistic forces through a wage share that depends a priori negatively on the financial savings of firms (or firm owners), and thereby reflects the relationship between financialization (characterised by a net saving firm sector) and income inequality. Workers (households) and firms bargain over the potential output of the next period and the workers receive ex ante a share λ^e:

$$\lambda_t^e = \lambda_{t-1} - \max(\sigma \cdot \frac{S_{t-1}^{firm}}{Y_{t-1}}, 0) \tag{21}$$

where σ is a non-negative constant. The max operator incorporates the asymmetry of financialization. This means that if firms are net borrowers, there is no increase in workers' bargaining power.
Based on this bargaining, the following wage bill is determined in the beginning of the period:

$$W_t \coloneqq \lambda_t^e \cdot Y_{t-1} \cdot (1 + g_{t-1}) \ . \tag{22}$$

Put differently, based on a linear extrapolation of past GDP, workers and firms make a contract determining the wage bill for the coming period. The wage is thus determined in the beginning of the period and before GDP actually realizes.[40] Note, however, that for comparability with true

[40] In advanced economies, relatively few people work in the informal economy without a working contract. As a consequence, wages are sticky and pre-determined.

wage share data later on, it is important to consider the ex post wage share:

$$\lambda_t := \frac{W_t}{Y_t} \tag{23}$$

The actually realized wage share λ_t might differ from the ex ante wage share. The latter is the result of the bargaining process in equation 21. Equation 22 then determines the wage for the coming period before consumption and investment decisions are made. As a consequence, the actual wage share that realizes over the period can differ as households could suddenly deleverage and use all their income to repay debt. This, in turn, would contract consumption as well as the denominator of the wage share, i.e. GDP. As a consequence, the actual wage share would be higher than the initial bargaining outcome of firms and workers.
On a more general note, observe that the individual firm is always maximizing profits and tries to lower labour costs. For the individual firm, the wage is solely a cost and not a source of income. For the whole economy, however, wages are both, costs and sources of income. Equation 21 states that financialization gives the individual firm more power to pursue its profit maximization, while workers receive less power to argue for more spending power.[41]

[41] This argument reflects the basic idea of the popular 'Paradox of Thrift'. Note furthermore that Stützel's 'economic sentences', where one particular sentence for the individual firm might not be translated into a sentence for the whole economy.

4.4 Simulation Exercises

In this section, we feed the model developed in the previous section with concrete parameters to simulate the dynamic evolution of our economy. The economy has two different regimes: in the first case, a long-run growth regime occurs with ever increasing asset prices and debt levels; in the second case, a financial crisis with a total crash of the economy occurs. Our model economy can be in two different regimes depending on the parameter values. [42] These two regimes will be discussed in the following.

4.4.1 Regime 'Infinite Perpetual Money Machine'

For one set set of parameters the economy grows forever, with ever rising debt levels and household prices. Figure 8 shows such a scenario that we call the 'infinite Perpetual Money Machine'. [43] GDP, investment and consumption all grow steadily. At the same time, the decreasing wage share (Fig. 8 (f)) is compensated by growing household debt relative to income (Fig.8 (e)). This increasing debt is enabled by trust converging to its maximal value (Fig.8 (f)) and ever growing housing prices (Fig.8 (h)). As a consequence, households cumulate a growing deficit position vis-à-vis the firm sector. The return on housing wealth increases and remains considerably higher than GDP growth (Fig.8 (g)). Note furthermore that firms invest out of the cash flow. Their aggregate income is thus larger than their expenditures so that they become net savers.
How should the scenario 'Infinite Perpetual Money Machine' be interpreted? Within the modelling assumptions and for certain parameter constellations, no crisis occurs and real growth is stable. In reality, however, it is questionable whether ever rising income inequality along with high debt to income ratios are stable once, for example, (even small) interest rates are taken into account. Moreover, it is likely that the instability may come from channels not modeled here, such as unrest, insurrection, revolt, revolutions and political regime changes, as suggested from the historical record (Graeber, 2011).

4.4.2 Regime 'Financial Crisis'

If we increase sigma gradually we will enter a new regime where the ecoomy crashes after a finite time, see figure 9. [44] A financial crash occurs and the economy collapses. The wage bill falls back behind consumption (Fig. 9 (b)) and is, as in the previous scenario, compensated by growing household debt (Fig. 9 (e)). Household debt to income (Fig. 9 (e)) rises and reaches its peak *before* the crash.[45]
As opposed to the previous simulation the economy crashes. What is the underlying mechanism that creates this crash? Note that the crash is not caused by an exogenous shock to one of the parameters or variables. Rather, the crash is the outcome of a multidimensional interplay of different dynamics. The basic drivers can be understood along the following lines. Debt cannot grow at the desired speed to allow for the desired consumption. At some point, households are forced

[42] The model's matlab code, a documentation of the implementation and a sensitivity analysis is available from the authors upon request.
[43] A terminology adopted from Corsi and Sornette (2014) and Sornette and Cauwels (2014).
[44] A variety of different input parameters can lead to a crash. In the example shown, the only difference to the previous scenario is a higher sigma.
[45] This modeling result indicates that a close observation of the debt-to-income dynamics could potentially predict a crash.

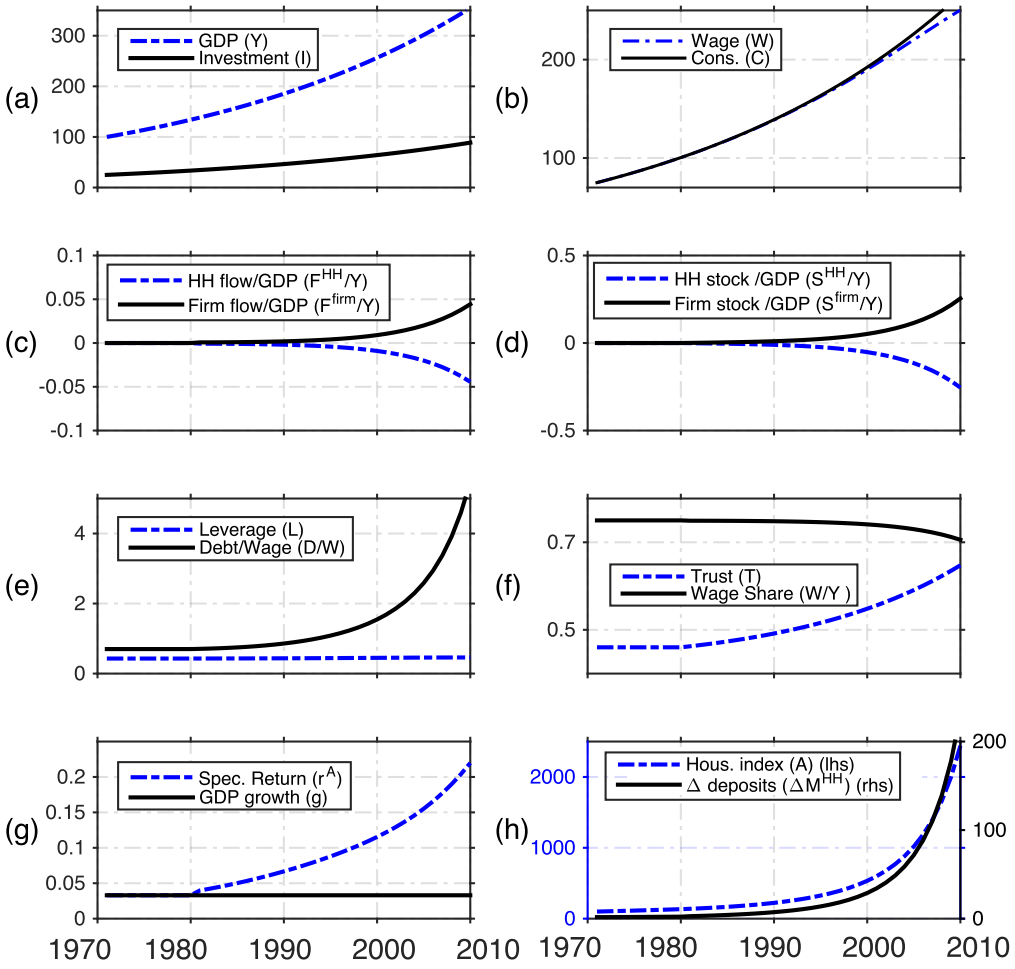

Fig. 8: Scenario 'Infinite Perpetual Money Machine' with long-run growth, ever increasing household debt and rising asset prices. Input Parameters: k=0.3, a=0.6, $\sigma = 0.03$, $T_0 = 0.5$

to use money from the financial circuit for their consumption expenditures. They thus withdraw money from the financial circuit, which can be seen by shrinking households' deposits (Fig. 9 (h)). As a consequence, the asset price falls and households are forced to withdraw even more money as the collateral shrinks. This means that households' leverage sky-rockets (Fig. 9 (e)). In order to decrease leverage, households use their labour income to repay debt, which contracts consumption expenditures (Fig. 9 (b)). Firms' income suddenly drops while they continue having to pay contractually pre-determined wages.[46] Firms react to lower demand by decreasing investment (Fig.

[46] Recap that the wage was determined in the beginning of the period, see section 4.2.

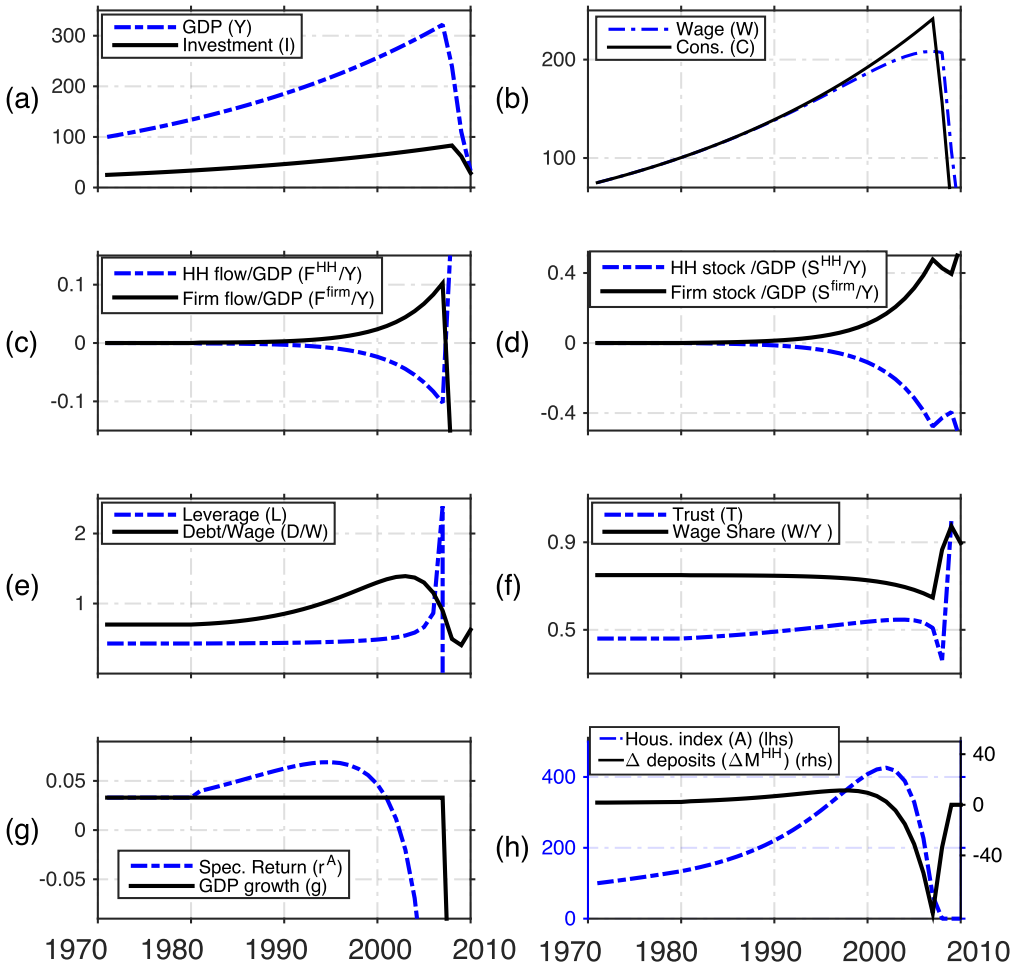

Fig. 9: Scenario: endogenous crash. Input Parameters: k=0.3, a=0.6, $\sigma = 0.05$, $T_0 = 0.5$

9 (a)). These factors ultimately force firms to become net borrowers (Fig. 9 (c)). The interplay of all these factors results in a total collapse of the economy.

From a households' perspective, there are two important forces at play. We know that the net increase or decrease of households' deposits in each period is $B^* = \Delta D - (C - W)$. If B^* turns negative, this means that the first component, namely increasing debt, cannot compensate for the second term, the wage-consumption gap. The first term (ΔD) can increase if asset prices and trust are supportive. At some point, however, the latter factors are not supportive enough so that ΔD becomes too small relative to the second term ($C - W$). Indeed, the wage-consumption gap continues to grow as wages are further and further depressed relative to GDP. Once collateral,

consisting of trust and the speculative asset price, is no longer high enough to allow for a sufficient debt increase, households withdraw money from the financial circuit and thereby trigger a downwards spiral.
To put it yet another way, the purchasing power shortage in the real sector forces households to withdraw their money from the financial circuit. This action lowers the value of the speculative asset, which, in turn, lowers the collateral. This offsets a deflationary spiral because income is used to repay debt. The immediate contraction of GDP is contagious and followed by further contraction due to firms' investment decisions.
Before discussing these simulations in more detail in section 5, we will extend the model and introduce a public sector.

4.5 Extension: Introducing a Public Sector

So far, the model economy either grew forever in what we called an Infinite Perpetual Money Machine regime, or the economy ended in a financial crash. We will now focus on the latter scenario and consider the following question: What are the assumptions that hinder our model economy from exhibiting a (moderate) rebound after the crash? A total collapse of an economy rarely happens in the real world. The natural stabilizer in times of crisis is the government and the monetary authority, who serve as a spender and borrower/lender/dealer of last resort - both institutions have so far been ignored.
In this section, a very simple authority, consisting of a government and/or a central bank is introduced that intervenes as soon as consumption drops. [47] The public authority channels newly created liquidity to the financial circuit, which corresponds to the money withdrawn by households:

$$G_t = max(-B_t^*, 0) \tag{24}$$

As a consequence, compared to the model without an authority, the amount of funds in the financial circuit available to the household sector increases by G_t:

$$M_t^{HH} = M_{t-1}^{HH} + B_t^* + G_t \tag{25}$$

The economic rationale is that the central bank and the government buy the collapsing assets from households. A different interpretation of this modeling approach would be that households default on part of their debt and the authority takes over those liabilities, i.e. bails out households/banks. Note that this kind of authority intervention is not related to any direct purchase of goods or services and accordingly does not, by definition, directly affect GDP. Still, national income will indirectly be affected because the government takes over households' debt and thereby relaxes households' budget constraint (equation 4.3.3). The relaxed budget constraint will allow households to consume more during the deleveraging process compared to the scenario without a public authority.

[47] Both actors are modeled as one authority and the terms government and central bank or monetary authority are used interchangeably from now on.

Net financial borrowing or lending of the government sector (GG) is:

$$F_t^{GG} \coloneqq -G_t \tag{26}$$

and the net stock of financial assets of the public sector is the sum over all past flows:

$$S_t^{GG} \coloneqq \sum_{i \leq t} F_i^{GG} \tag{27}$$

The next section presents new simulations with the public authority.

4.6 Simulation Exercises with Public authority

4.6.1 Public sector bailout

Incorporating a government sector into the model requires no new initial parameters since the government's reaction, as defined above, is completely determined by the other economic agents' collective outcome. We use the same set of parameters as in the crash scenario above.

In (Fig. 10), the government starts intervening after the crash and bails out households. This policy allows households to deleverage, that is to repay debt and use wage income again for consumption expenditures (Fig. 10 (d) and (b)). At the same time, this policy results in a high public debt to GDP ratio (Fig. 10 (d)). Such a bailout is able to postpone the crash, but not able to avoid it. The reason is that firms' profits continue to increase after the crisis, and so does firms' bargaining power. As a consequence, the wage share falls dramatically. Wage income, and therefore demand, collapsed.

4.6.2 Adding Wage Policy to the Public Sector Bailout

Against this backdrop, we finally introduce a more powerful public authority in the sense that it is able to re-set the wage share to an earlier level as well as to set σ to zero. Fig. 11 shows the scenario that we call the 'golden wage rule scenario'. [48] In this scenario government intervention allows the private sector to become a net saver: while firms are net borrowers shortly after the crash due to sticky wages, they become net savers shortly afterwards like households (Fig. 11 (c)). The public sector takes the counter position for these savings and runs a deficit. The implementation of the golden rule allows the government to decrease deficit spending relative to GDP over time: households now receive a constant wage share out of the cash flow of firms, which is sufficient to achieve the desired consumption path. Government intervention allows households to repay their debt quickly and to use their income for consumption expenditures, which prevents consumption demand from collapse. Note furthermore that public debt-to-GDP decreases over time (Fig.11 (d)) because it is diluted by growing GDP ((Fig. 11 (a)). [49] On the other hand, firms dis-save due to the implementation of the golden rule, which decreases their savings ((Fig.11 (d)). Trust and asset prices are stabilized (Fig.11 (f) and (h)). Finally, as discussed earlier, the (ex-post) wage

[48] Following the German terminology of a golden wage rule ("goldene Lohnregel") where national wages increase with productivity (plus the desired inflation rate). The terminology is also used in a more recent article by Watt (2010) (see also (Watt, 2007)).

[49] Public sector debt is not repaid, but, rather, the economy 'grows out of debt'.

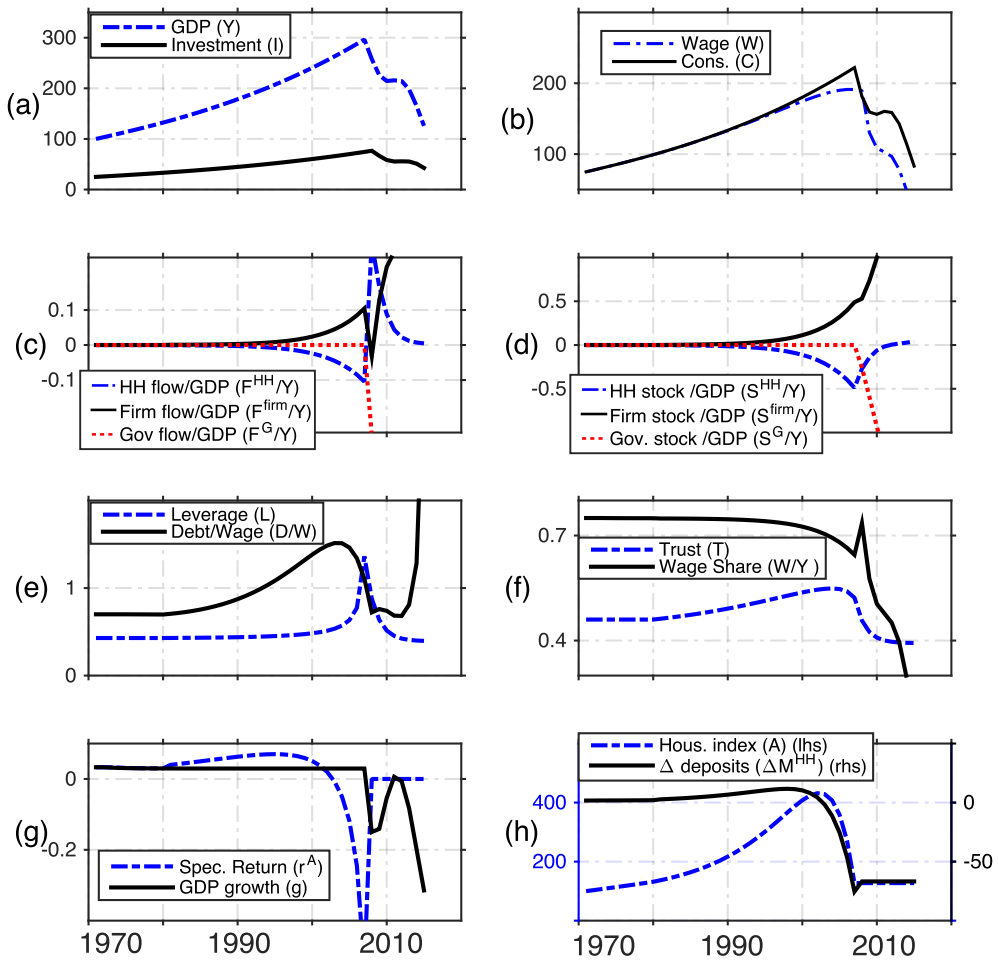

Fig. 10: Public Sector intervenes and bails out households. The collapse of the economy is postponed, but not prevented.

share increases immediately after the crash, and is afterwards stabilized via the golden wage rule. The next section discusses the simulations more generally, and puts them in context of empirical evidence.

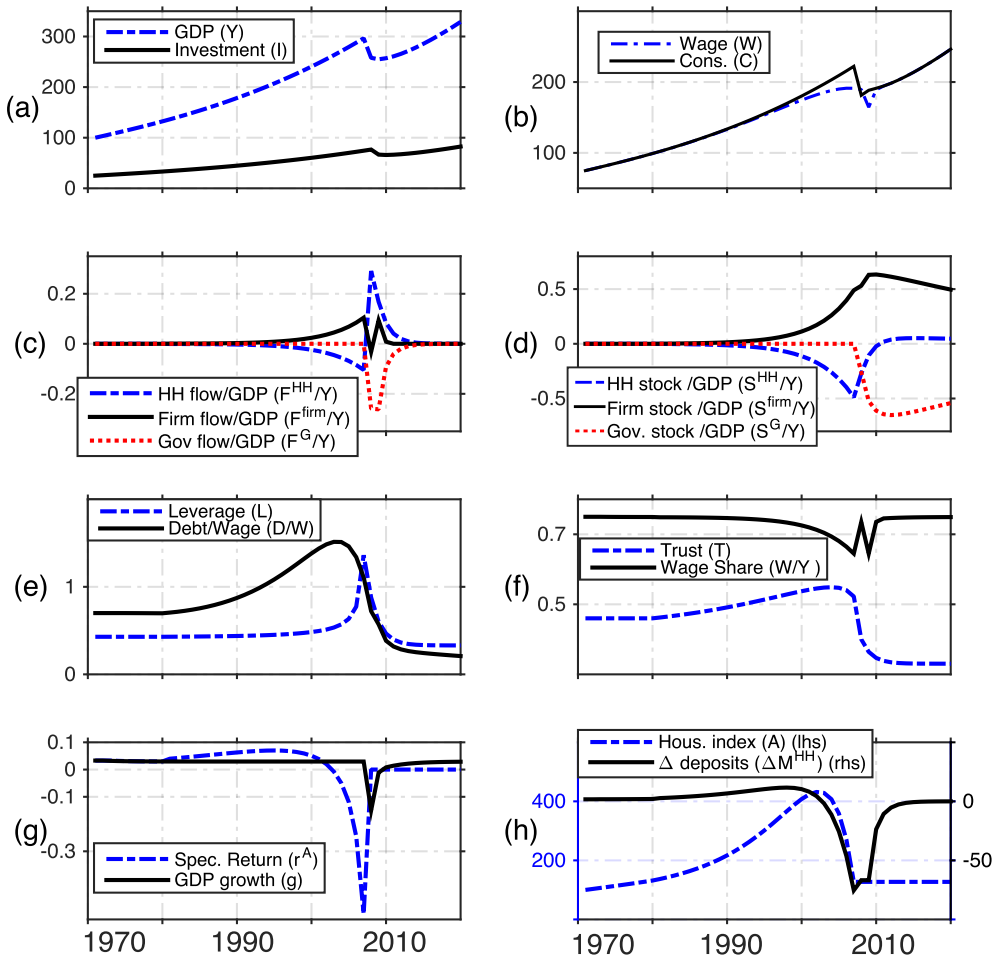

Fig. 11: Public sector bailout combined with the implementation of the golden wage rule after the crisis. The economy recovers and continues to grow. Government debt to GDP decreases over time and households' wage is sufficient for the desired consumption path.

5 Discussion

5.1 Discussion of the Model Simulations

Since one unit's liability is another unit's asset, changes in leverage represent no more than a redistribution for one group (debtors) to another (creditors)... and should have no significant macroeconomic effects. Bernanke (2000)

Which insights can be gained from the model's simulations? Incorporating financialization, distributive dynamics, as well as a real and a financial circuit with collateral-backed credit creation into the model gives endogenously rise to a financial crisis. The crisis finds its origin in the fact that, with the goal of achieving its desired consumption level, the household sector builds up massive debt levels to finance consumption and to speculate. Once this bubble bursts, households stop borrowing because falling asset prices force households to deleverage. This kind of financial crisis [50]has been labelled a "balance sheet crisis" by Koo (2011) who emphasizes that financing, not supply-side shocks or resource scarcity, is limiting growth. If the economy is in a balance sheet recession, this does not mean that certain supply side or structural adjustments are useless. It simply means that the by far largest obstacle to economic growth is financing and demand more generally.[51]
Note, however, that while it is important to understand that agents who repair their balance sheets contribute to the economic collapse, it is also crucial to understand the dynamics that led to the crisis. In this regard, attention should be paid to distributive dynamics prior to the crisis. Rising income inequality is compensated by household debt. The insight is that this compensation cannot last forever and is inherently unstable. [52] Indeed, as discussed earlier, small persistent changes can ultimately lead to a significant break down of the whole system. The wage share for example drops by only 5 percentage points over several years (not annualized). This risk, which slowly creeps upward, ultimately reaches a critical point: when the financial crash occurs, GDP collapses by 10-15% in just one year. It is important to take this asymmetry between the time scale of the build up of the bubble and the time scale of the crash into account in order to design effective economic policy.

Once the financial crash occurred, what can be done to put the economy back on a growth path? How can the financing constraint that is limiting growth be loosened so that growth becomes possible again? In a broader context, we know that, while certain natural resources are finite, the resource for purchasing power, namely money or credit, is not naturally limited. It is therefore up to a proper political and institutional management to prevent major shortcomings with respect to financing.
In the scenarios with a government sector, it became evident that a purely reacting authority, which restricts its actions to bailing our the private sector, but does not implement the golden rule (Fig.10), is not able to deal with the balance sheet crisis. Such a government cannot prevent

[50] A financial crisis is to be distinguished from a 'real' or 'Schumpeterian' creative destructionist 'crisis'.
[51] Note, however, that several economists argue that capitalistic economies are characterized by constant excess supply, i.e. the economy is most of the time constrained from the demand side (Keen, 2011).
[52] At this stage, we do not discuss the Infinite Perpetual Money Machine scenario of our model, but focus on the crash scenarios.

a collapse. [53] The economy in the last scenario, where public authorities recouple wages and growth (Fig.11), does not crash. Note that overall debt levels are reduced, in line with Sornette and Cauwels (2014) who argue that "we need to go back to a financial system and debt levels that are in balance with the real economy".[54] While Terzi (2016) argues that new debt is (in the aftermath of a financial crisis) necessary, we argue that this is only true as long as the private sector is deleveraging.[55] In the long run, the implementation of the golden rule forces firms to channel their savings back into the economic circuit, which allows the public authority to step back. Put differently, this last scenario solves the so-called twin peak crisis, where i) agents with high savings do not spend their money and ii) other agents have high levels of debt but cannot repay it because they lack access to the other agents' savings. Indeed the golden rule is one mechanism that helps to channel money to consumers - followed by lower overall debt levels and economic growth.[56] This reasoning is very much in line with Zezza (2011), who argues that a shift in the income distribution is needed to regain a sustainable growth path.

Summing up, the simulations show that monetary economies give naturally rise to regime changes. Initially the growth regime is 'productive' with an efficient distribution of income and low overall debt. Inherent instabilities in the feedback between the financial and the productive circuit give rise to a growth regime that is increasingly debt-burdened with inflated asset prices and high debt levels. Part of the growth of this new regime is not sustainable and finds its sudden end with the burst of the bubble. Afterwards, a new growth regime is needed that builds on both, fiscal and wage policy.

6 Concluding Remarks

This paper reviewed a number of stylized facts together with micro- and macroeconomic behavioural insights and incorporated them into a new stock-flow consistent model of modern monetary economies. The model's key assumptions are i) financial savings of business owners decrease the bargaining power of workers, and thereby raise the profit share in the economy, ii) the relative income hypothesis determines the desired consumption plan of households, and iii) households' borrowing depends on credit creation, which is backed by collateral.
The simulations exemplified the effect of non-linear feedbacks and we discussed their effect on the real economy as well as on the financial circuit. With only seven behavioural equations our model

[53] In this scenario the government enables households to freely use their wage income for consumption. But the government does not compensate for the loss in debt-financed consumption. Future research could focus on fiscal stimulus that goes beyond the bail out that we modeled.

[54] The idea that one agent's liability is another agent's asset with the consequence that overall debt levels do not matter for economic performance is fundamentally flawed. See also Keen (2011) for further discussion. Moreover, note that increasing gross debt to GDP is not necessarily a bad indicator for economic stability because a growing economy that relies increasingly on the division of labour might well need more liquidity in relative terms. An increase in banks' assets to GDP can indicate inflated asset prices or excessive speculation, but it can also go hand in hand with a more productive and innovative economy. A single focus on world gross debt thus does not provide much insight, unless analysed together with the structural changes of the economy.

[55] "This means that an increase in spending can only be obtained with greater private borrowing, greater government debt, or greater net exports." (Terzi 2016). But Terzi might be well aware of the effect of a dis-saving of firms because the author also writes that "savings reduce spending unless offset by new debt" - and of course the opposite is also true: financial dis-saving of one sector increases spending unless used to pay back debt (that would destroy the financial savings). Terzi furthermore writes that "[p]olicies that aim at fostering private spending can [...] try to pull private saving desires lower" which is exactly what the golden rule achieves for the firm sector.

[56] Note that higher economic growth also includes higher absolute profits for the firm sector.

remains very traceable while at the same time providing important insights. For a large set of parameters, we find that our model economy is inherently unstable and eventually produces an endogenous financial crisis. The crash indicates the end of a debt-burdened growth period that was unsustainable. We further find that a public authority can prevent the total collapse of the economy. However, one key insight is that, in order to avoid (another) period of debt-burdened growth, the public authority should not only provide initial stimulus but also implement the golden wage rule, that is re-establish the link between productivity and employee's compensation. A successful implementation of this rule results in long-run growth without excessive private and public debt. Put differently, public stimulus in the aftermath of a financial crisis is necessary but not in itself sufficient for long-term growth - unless complemented by a re-coupling of wages and productivity. Finally, one important finding is that, in our model economy, neither debt nor inequality, nor finance on its own 'caused' the crisis. Instead, spill-overs, feedbacks and 'creeping risks' appear to have played a role, suggesting that policies based on mono-causal thinking may be misleading.

How serious should the model's implications be taken? Our simulation results are overall consistent with many stylized facts in the US and the euro area. In the latter, however, further analysis is needed to properly take the huge heterogeneity amongst member countries into account. We have argued that in these economies the credit-driven growth came to an end in 2008. Since then, growth has been weak, motivating the search for a new growth regime. Our analysis suggests that demand is still limiting growth in both economic areas.

The important question is thus: Which sector of the economy should increase its demand in what proportions and how should this demand be funded? We argued that public stimulus of the real economy, not the financial one, remains necessary and needs to be complemented by a re-coupling of wages and productivity. Alternatives, including a long-time recession or another period of debt-burdened growth, carry a high risk - both economically and politically. Another alternative, namely export-driven growth, is subject to the fallacy of composition and therefore not a useful strategy for larger economic areas, let alone the world.

Against this backdrop, it appears vital to further develop the approach sketched in this paper. A next step could be to build a two-country or multi-country model to better analyse the interplay of growth strategies in different countries.In a wider context, this paper emphasized the importance of 'traditional' economic policy tools like public investment, labour policies and international economic cooperation - as opposed to an illusionary belief that the central banks can solve problems that lie beyond their means. [57]

[57] Having that said, further unconventional monetary policies like negative interest rates in combination with central bank digital currency can clearly increase the effectiveness of monetary policy transmission mechanisms, and should therefore carefully be studied (see Grasselli and Lipton (2017)).

Appendix A Summary of the Model Equations with Public Sector

$$Y_t \coloneqq C_t + I_t \quad \text{(National Income)} \tag{1}$$

Households

$$C_t^e \coloneqq \bar{\lambda} \cdot (1 + g_{t-1}) \cdot Y_{t-1} \quad \text{(Desired Consumption, } g \coloneqq \frac{\Delta Y}{Y}\text{)} \tag{2}$$

$$C_t = \min\{C_t^e, W_t + \Delta D_t^{HH} + M_{t-1}^{HH}\} \quad \text{(Actual Consumption)} \tag{3}$$

$$F_t^{HH} \coloneqq W_t - C_t + G_t \quad \text{(Net Borrowing flow)} \tag{4}$$

$$S_t^{HH} \coloneqq \sum_{i \leq t} F_i^{HH} \quad \text{(Net Financial Stock)} \tag{5}$$

Leverage, Debt and Trust

$$L_t^{HH} \coloneqq \frac{D_t^{HH}}{A_t} \quad \text{(HH Leverage)} \tag{6}$$

$$T_t = T_{t-1} + k \cdot T_{t-1}(T_{t-1} - L_{t-1})(1 - T_{t-1}) \quad \text{(Trust)} \tag{7}$$

$$D_t^{HH} = D_{t-1}^{HH} + a \cdot (T_{t-1} \cdot A_{t-1} - D_{t-1}^{HH}) \quad \text{(Debt)} \tag{8}$$

Financial Circuit

$$B_t^* \coloneqq \Delta D^{HH} - (C_t - W_t) \quad \text{(Net change in HH deposits)} \tag{9}$$

$$M_t^{HH} \coloneqq M_{t-1}^{HH} + B_t^* + G_t \quad \text{(Money stock)} \tag{10}$$

$$A_t = \frac{\beta}{1 - \beta} \cdot M_t^{HH} \quad \text{(Speculative Asset)} \tag{11}$$

$$r_t^A \coloneqq \frac{\Delta A_t}{A_t} \quad \text{(Speculative Return)} \tag{12}$$

Firm Sector

$$I_t = I_{t-1} + \alpha \cdot I_{t-1} \cdot g_{t-1} \quad \text{(Investment)} \tag{13}$$

$$\Pi_t \coloneqq Y_t - W_t \quad \text{(Profit Bill)} \tag{14}$$

$$F_t^{firm} \coloneqq \Pi_t - I_t \quad \text{(Net Borrowing)} \tag{15}$$

$$S_t^{firm} \coloneqq \sum_{i \leq t} F_i^{firm} \quad \text{(Net Financial Stock)} \tag{16}$$

Wage Bargaining

$$\lambda_t^e = \lambda_{t-1} - \max(\sigma \cdot \frac{S_{t-1}^{firm}}{Y_{t-1}}, 0) \quad \text{(Ex ante Wage Share)} \tag{17}$$

$$W_t \coloneqq \lambda^e \cdot (Y_{t-1} \cdot (1 + g_{t-1})) \quad \text{(Wage Bill)} \tag{18}$$

$$\lambda_t \coloneqq \frac{W_t}{Y_t} \quad \text{(Actual Wage Share)} \tag{19}$$

Government

$$G_t = max(-B_t^*, 0) \quad \text{(Public spending)} \tag{20}$$

$$F_t^{GG} \coloneqq -G_t \quad \text{(Net lending)} \tag{21}$$

$$S_t^{GG} \coloneqq \sum_{i \leq t} F_i^{GG} \quad \text{(Net Fin. Stock)} \tag{22}$$

Appendix B Implementation of the Model

To implement the model, initial values for all level variables as well as all parameters are fed to the model's simulation. Given the simplicity of the model, a conventional empirical estimation of the model is not possible. For example, net imports in the US increased a lot over the last decades. Since our model does not incorporate an external sector, these dynamics cannot easily be matched to our model economy. Nevertheless, we use stylized facts to feed the model's simulation. Throughout all simulations, the following initial values are used:

$g_1 = 0.03;\ \beta = 2.3;\ Y_1 = 100;\ Y_2 = g_0 \cdot Y_1;\ C_1 = 75;\ Y_2 = g_0 \cdot C_1;$
$W_1 = 75;\ W_2 = g_0 \cdot W_1;\ C_1^e = 100;\ C_2^e = g_0 \cdot C_1^e;\ D_1 = 0.7 \cdot W_1;$

The other variables are determined by accounting identities. The initial money stock, for example, is determined by the initial debt stock. Initial values are taken from US data over the period from 1970 to 2000. For example, initial GDP growth g_1 is assumed to be 3.3 percent, in line with worldbank data. Similarly, the value for beta β is estimated using data from FRED data. Along these lines, initial debt (and deposits) is assumed to be 70 percent of the wage bill. In the first ten years, the model economy is in a steady growth path. At $t = 11$, lambda is shocked lambda negatively by 0.01 percent which initiates the different feedback loops described in section 5.
Parameters a, k, α, T_0 and σ are subject to variations along different simulations. The model's sensitivity to these parameters is tested in appendix C.
A matlab file with all computations is available upon request to the authors. Future research could build a consistent dataset that matches, and potentially adapts our model economy.

Appendix C Robustness Analysis

In this appendix, the model's sensitivity to changes in parameters is analysed in order to assess the robustness of the simulation results. The time it takes until a crisis occurs or whether no crisis at all occurs will be the target variable of interest. The key parameters to be analysed are:

- σ (bargaining parameter)
- T_0 (initial trust)
- k (convergence speed of trust)
- a (convergence speed of debt)
- α (investment parameter on GDP)
- β (household portfolio parameter)

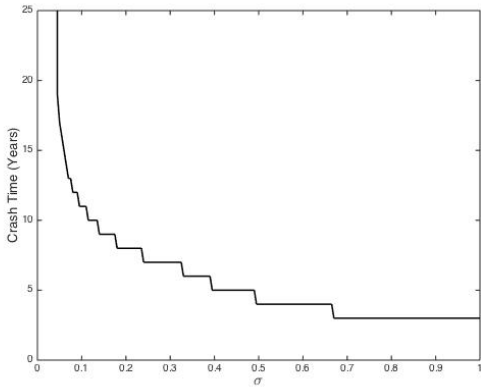

Fig. 12: Time to crash as a function of sigma (σ). The curve is truncated at small values of σ but is diverging as $\sigma \to 0$, as indicated in log-log plot. Input parameters: k=0.3, a=0.3, α=1, $\beta = 0.7$, $T_0 = 0.4$

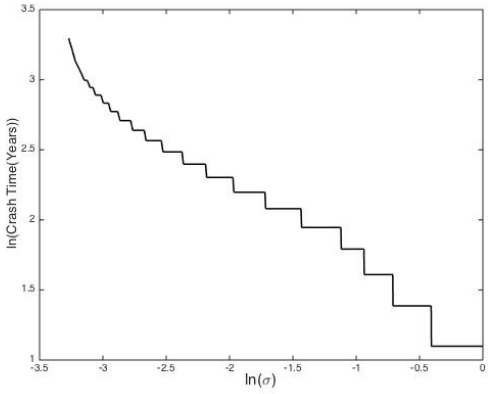

Fig. 13: Log-log scale of sigma and time to crash. Relationship is approximately linear, indicating power law relationship between both variables. Input parameters: k=0.3, a=0.3, α=1, $\beta = 0.7$, $T_0 = 0.4$

The parameter σ determines the wage share via a bargaining process as described in section 4.3.6. What is the influence of σ on the dynamics and the regime? Figure 12 plots the time until a crisis occurs as a function of σ. The higher σ, the faster the wage share gets reduced, the larger the gap between desired consumption and income, and the sooner a financial crash occurs. The stepped shape occurs because the variable time on the y-Axis is discrete (in years) throughout the model and

its simulations. Within the limits of discrete computational possibilities, the result shows that even for very small values of sigma, a crisis occurs - although at a relatively late stage. Figure 13 shows that the logarithm of the time to crash versus the logarithm of sigma is approximately linear, indicating a power law relationship between both variables. This result can be understood in light of non-linear feedbacks that are inherent to the model so that even small disruptions build up and destabilize the economy. More generally, such a phenomenon is called a singular perturbation: a small parameter within a model cannot be approximated by setting the parameter to zero (see Sornette (2006)). If sigma is approximating zero but still unequal to zero, a (late) crash will occur. If sigma is exactly zero ($\sigma = 0$) no crash occurs. This has important policy implications since any attempt to lower sigma will not be very successful unless sigma is strictly set equal to zero. The idea of putting sigma to zero to achieve a sustainable growth path is related to 'the golden wage rule' and is discussed in section 5 in more detail.

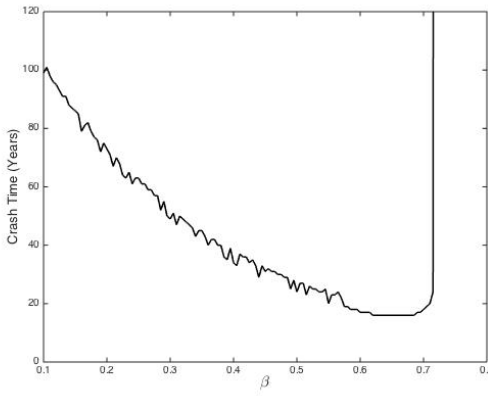

Fig. 14: Time to crash as a function of beta β. Bifurcation at the critical value $\beta = 0.72$. Input parameters: k=0.3, a=0.3, α=1, $T_0 = 0.4$, $\sigma = 0.04$

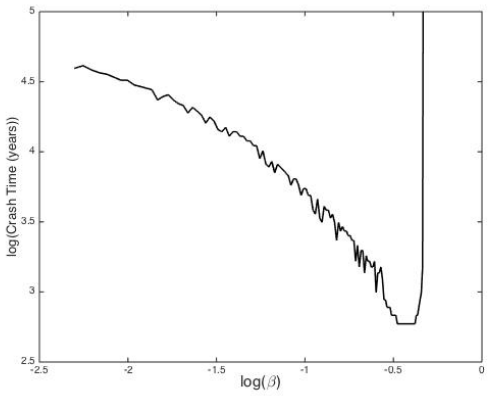

Fig. 15: Log-log scale of beta and time to crash. Two opposing forces at work, see text. Input parameters: k=0.3, a=0.3, α=1, $T_0 = 0.4$, $\sigma = 0.04$

Figure 14 plots the crash time as a function of β, i.e. the share of housing wealth in overall households' assets. As we can see, the relationship between both variables is not monotonous globally. This is because an increase in β has two opposing effects on the crash time: On the one hand, a higher beta drives up the return of the speculative assets, thereby reduces the wage share faster and ultimately favors an earlier crash (similar to the effect of σ). On the other hand, a higher beta causes housing wealth to rise faster, thereby increasing collateral value and allowing house-

holds for a longer period (potentially until infinity) to finance desired consumption expenditures with higher debt levels. As we can see in figure 14, for small but rising beta, the first effects dominates. However, once beta passes a critical value, the economy enters a no-crash regime. Put differently, at the critical value of beta (in the figure it is 0.72) a bifurcation occurs.
Figure 15 plot the logarithm of beta against the logarithm of the crash time: this time, there is no power law distribution, which is not surprising given two opposing forces. Let us now look at the parameter T_0, which determines the initial level

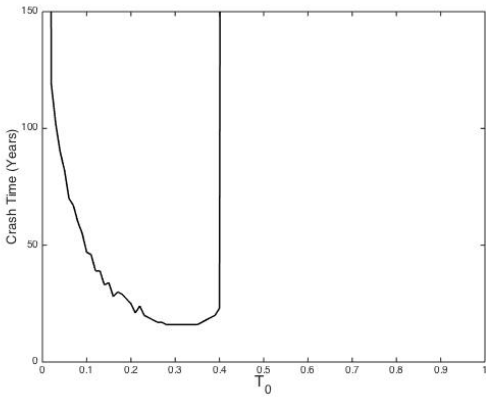

Fig. 16: Time to crash as a function of initial trust T_0. Input parameters: k=0.3, a=0.3, α=1, $\sigma = 0.04$

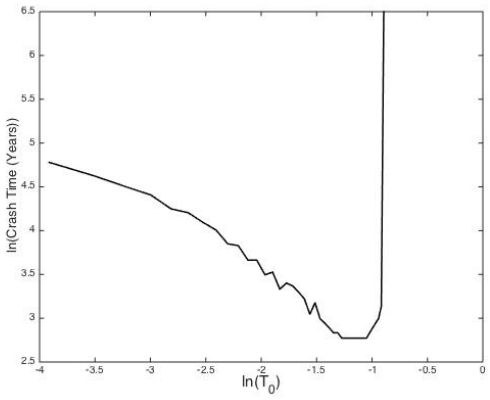

Fig. 17: Log time to crash versus log of initial trust. Input parameters: k=0.3, a=0.3, α=1, $\sigma = 0.04$

of trust in the economy, i.e. the fraction of housing wealth that can be used as collateral in the beginning. Figure 16 shows that the economy enters the infinite growth regime for high levels of initial trust, and the crash regime for low levels of trust. The intuition is that, for high values of initial trust, debt and collateral grow fast enough to make desired consumption always feasible. More precisely, figure 16 illustrates the existence of a bifurcation, in the mathematical sense of the term, which separates two qualitatively different regimes. Similar to the preceding discussion about beta, a change in initial trust has two opposing forces: On the one hand, higher initial trust allows for faster rise of household debt, making desired consumption plans feasible. On the other hand, higher initial trust also causes excess flushing of the housing market with new money, thereby increasing house prices, causing both, a lower wage share and an earlier crash.

Next, the sensitivity of the model to the parameter of the investment function α is analysed. In figure 18 we vary α around 1 and look at the influence on the crash time

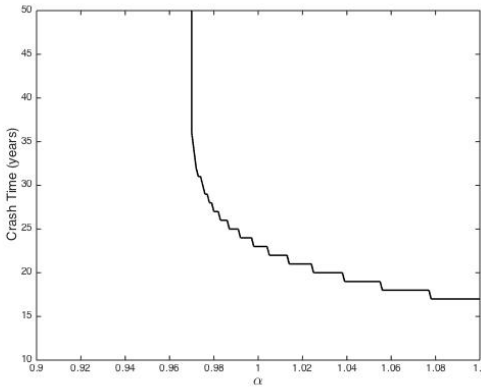

Fig. 18: Crash time versus parameter α of the investment function. Divergence as α approaches $\alpha_{crit} = 0.96$. Input parameters: k=0.3, a=0.3, $\beta = 0.7$, $\sigma = 0.04$, $T_0 = 0.4$.

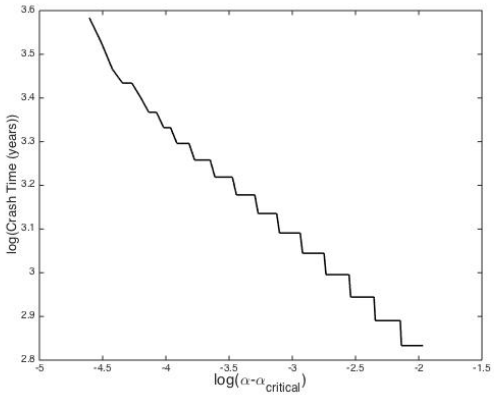

Fig. 19: Log(crash time) versus log(α minus α_{crit}). Linear shape indicates a power law functional relationship. Input parameters: k=0.3, a=0.3, $\beta = 0.7$, $\sigma = 0.04$, $T_0 = 0.4$.

(α=1 means that investment grows at a constant proportion of past GDP). Large values of α lead to an earlier crash because the economy, and thus households' debt demand grows faster than collateral value. For small values of α, the economy grows slower so that asset prices have more time to build up and sustain the relatively small gap between disposable income and desired consumption expenditure. Figure 19 plots the logarithm of the crash time versus logarithm of α minus critical alpha. Critical alpha α_{crit} is 0.97. The linear relationship indicated that the crash time follows a power law functional relationship. The parameter alpha thus controls the bifurcation: alphas above the critical value result in the crash regime, while alphas smaller than the critical value result in the infinite growth regime.

Let us finally turn to how a and k affect the model's simulations. The parameters a and k are rates of changes that control the dynamics of debt and trust in the economy. For large values of a and k, debt and trust converge quickly, resulting in the no-crash regime (see Figure 20). Indeed, the two domains (crash and no crash) are separated by a hyperbolic-like boundary, one in white and the other in variations of grey. The system thus exhibits bifurcations between the no crash infinite growth dynamics and the regime with a crisis occurring in finite time. The bifurcation is controlled similarly by both parameters a and k, i.e. the transition from no crash to the crisis regime can be obtained by decreasing either a or k from large values. More generally, both parameters appear to be substitutable to some extend with respect to their affect on the occurrence of a crisis: small values of k

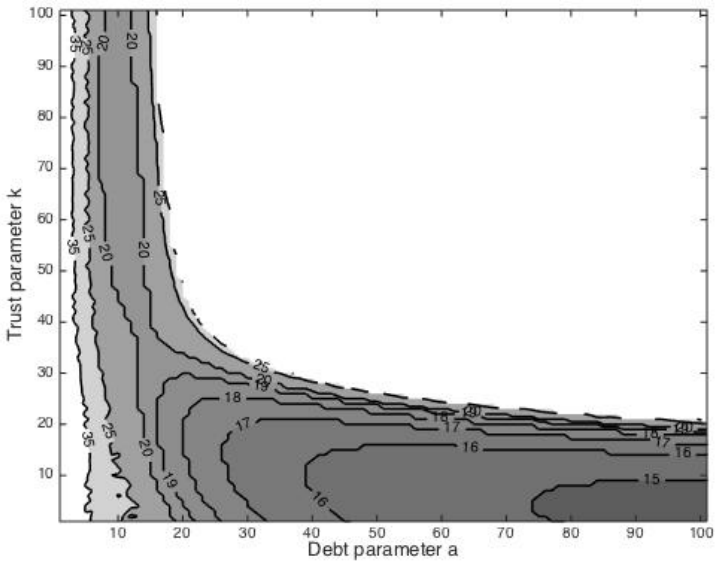

Fig. 20: Crash time contours as a function of debt parameter k and trust parameter a. The lighter the color of the hyperbolic-like areas, the later the crash occurs. 'White' indicates no crash. Other input parameters are fixed: $\sigma = 0.04$, α=1, $T_0 = 0.4$

can be compensated by large values of a and vice versa. It is furthermore interesting to see that, for a wide range of parameters corresponding to the crisis regime, the time until the crash occurs is quite similar (around 25 years) and does not vary significantly. While a and k are able to change the regime, within the crash regime, the simulation results are not very sensitive to both parameters. Note that the transition from crisis (finite time to crash) to no crisis (infinite time to crash) occurs abruptly at the hyperbolic-like boundary and not via a divergence of the time to the crash. This suggests an underlying sub-critical bifurcation rather than a continuous bifurcation.

Summing up the preceding analysis, most parameters can not only affect the time until a crisis occurs, but also change the regime of the economy, i.e. control the bifurcation separating the two regimes. Within each regime, changing the values of the parameters in general lead only to smooth continuous modifications of the dynamics. A more sophisticated robustness analysis would change several or all parameters simultaneously and analyze the behavior in the high-dimensional parameter space.

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5 Conclusion

This thesis uses accounting consistencies and insights from complex systems to add value to the literature of financial macroeconomics. The following section highlights the main contributions and some of the blank and blind spots of the conducted research and proposes directions for future research.

The first paper has looked at crypto currencies from the perspective of monetary theory. Our main contributions are:

- a comparison between theories underlying crypto currencies and state-of-the art research on theory of money and pricing
- a classification of stablecoins, a critique of crypto-monetarism and a forecast that crypto currencies do not threat fiat money in the absence of credit creation
- theoretical and empirical evidence that price (in)stability is primarily linked to changes unit labour costs

Our analysis is subject to the following limitations and challenges. First, the field of crypto currencies is rapidly changing. Our classification of stablecoins constitutes a snapshot of the stablecoin universe as of May 2018. New designs for stablecoins are proposed and existing ones are modified on a monthly basis. Basecoin, for example, has recently been re-branded to 'Basis', and its design has been modified slightly. A further weakness of the paper is that it does not provide concrete solutions on how to account for the importance of unit labour costs regarding price stability. How could the design of wage bargaining be changed in order to foster price stability? How could diverging unit labour costs between regions and countries be addressed? Is there any room for crypto currencies to provide new solutions to these challenges? Similarly, the paper has not discussed the international dimension of price stability and money theory. Yet, this dimension appears very important. As labour, commodity and foreign exchange markets are becoming more and more global, they affect currency areas beyond the influence of national policies, with important effects on price stability and the monetary architecture more generally. Future research should revive the debate about a global reserve currency and, more generally, a new global financial architecture. Regarding money theory, the paper motivates future research about the history of monetary economic thought from a philosophy of science perspective.

The second paper has discussed the upward pressure on the Swiss franc, including in light of global imbalances and the rise of sovereign wealth funds. Our main contributions are:

- the insight that the post-2008 upward pressure on the Swiss franc has not only been driven by safe haven inflows but also by the decline of Swiss residents' foreign investments
- empirical evidence that central banks together with sovereign wealth funds (SWFs) typically hold a significant part of surplus countries' total net foreign assets
- a mercantilist critique of official purchases of foreign assets, which is all the more pronounced if investments envision a short-term horizon that does not stimulate real economic activity
- a proposition to create a Swiss Sovereign Wealth Fund that distinguishes itself from existing Sovereign Wealth funds in other countries along several dimensions

The analysis has several limitations and shortcomings. While we are the first to show the role of sovereign wealth funds for global imbalances, our dataset is not complete with respect to publicly managed foreign assets. This is due to the fact that we have not included pension funds in our analysis. To be precise, the distinction of sovereign wealth funds (SWFs) and pension funds is not straight forward, and our paper only looks at funds that are conventionally classified as SWFs. Future research should build a global database that includes foreign investments of (semi-public and public) pension funds, and analyze their regulatory set-up. Along with research on long-run investments in infrastructure, education and other public goods, such a database could help change regulations in order to optimize the portfolio allocation of public funds to the benefit of global development. More generally, such an analysis would require more nuanced knowledge about country, ownership, resident and currency denomination of financial flows and stocks. Our research, for example, could not conclusively identify the Swiss actors that are responsible for the decline in foreign investments. Discussions with central banks and the Financial Stability Board indicate that this question might be difficult to answer given constraints in publicly available data. For example, very little is known about off-balance sheet foreign exchange hedging positions. Yet, monitoring the development of such foreign exchange derivatives might be important to avoid the mistakes of the 1990s, when over-the-counter derivatives were believed to be stabilized by market forces. We hope that central banks will take a closer look at these positions in the future.

The third paper has built an SFC model with a view to analyze growth trends in developed economies prior to 2008. Our main contributions are:

- a simple model that is able to incorporate non-linear feedbacks between the real economy and the financial circuit and whose simulations are consistent with stylized facts
- a critique of economic policies that are based on mono-causal thinking in light of spill-overs, feedbacks and 'creeping risks'

- a proposition to resurrect the golden wage rule, that is, to align wage and productivity growth on the national level

The model's simplicity and traceability naturally comes along with certain shortcomings. First, while the model relies on stylized facts, it is not empirically estimated. Future research could attempt to do so. In general, empirical estimation techniques of SFC models are still in their infancy. Once developed further, empirically estimated SFC models could prove useful for both practitioners and policy makers in order to forecast and conduct scenario analysis. Second, our model does not pay much attention to the supply-side of the economy. Depending on the research question, input-output matrices could be used to integrate supply-side dynamics. Moreover, agent-based models could shed light on distributional aspects of economic shocks or policies. Finally, insights from category theory could be used to simplify and generalize issues around aggregation and compositionality in economic modeling. For example, multi-country modeling could serve to extend our model in order to analyze the interplay of growth strategies in different countries.

To conclude, this thesis has contributed to a more systematic and holistic approach to financial macroeconomics. In so doing, it adds to the ongoing rethinking of economic science. The analysis of financial flows and stocks, in particular money and debt, has proven to be a crucial, indispensable and powerful tool to address a variety of economic questions. The algebraic modeling of this approach is still in its infancy but promises to be an exciting area for future research. In particular, integrating the supply side or modeling different aggregation levels in a consistent way, deserves closer attention. Such analysis requires an interdisciplinary approach and should, as emphasized in this thesis, draw upon insights from the literature on complex systems. Perhaps even more important, this thesis has revealed an urgent need in economic science to improve data knowledge and categorization, as well as to create new data surveys.

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"A Simple Model of Financial Crises: Household Debt, Inequality and Housing Wealth " (with D. Sornette), reprint submitted to the Cambridge Journal of Economics

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07/2017	Poster presentation: 6th International Summer School: Forum for Macroeconomics and Macroeconomic Policies (FMM), Berlin
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