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WHY IS THE EURO PUNCHING BELOW ITS WEIGHT?

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Abstract

On the twentieth anniversary of its inception, the euro has yet to expand its role as an international currency. We document this fact with a wide range of indicators including its role as an anchor or reference in exchange rate arrangements—which we argue is a portmanteau measure—and as a currency for the denomination of trade and assets. On all these dimensions, the euro comprises a far smaller share than that of the US dollar. Furthermore, that share has been roughly constant since 1999. By some measures, the euro plays no larger a role than the Deutschemark and French franc that it replaced. We explore the reasons for this underperformance. While the leading anchor currency may have a natural monopoly, a number of additional factors have limited the euro's reach, including lack of financial center, limited geopolitical reach, and US and Chinese dominance in technology research. Most important, in our view, is the comparatively scarce supply of (safe) euro-denominated assets, which we document. The European Central Bank' lack of policy clarity may have also played a role. We show that the euro era can be divided into a "Bundesbank-plus" period and a "Whatever it Takes" period. The first shows a smooth transition from the European Exchange Rate Mechanism with stable German inflation as its goal. The second period is characterised by an expanding ECB arsenal of credit facilities to European banks and sovereigns.

JEL: E5, F3, F4, N2

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I. Introduction

Although many arguments were advanced in support of the founding of the euro, surely one of the central goals was for Europe to have an international currency of the same stature as the dollar. In this paper, we document a broad range of measures of the euro's status as an international currency. These markers include trade invoicing, international public and private bond issuance, central bank reserve portfolios, and other measures. Our central metric is based on the currency central banks strive to either fix their exchange rate to, or to use as a reference in a managed float. By most of these measures, the euro comes up as a distant second to the dollar. These metrics show that the advent of euro did little more than consolidate the pre-existing franc and DM zones, both largely regional in nature.

We explore some of the possible reasons for the euro's stall. While the leading anchor currency arguably has a natural monopoly in peacetime, we contend that there are a number of structural factors that have limited the euro's international reach. Central to these is the fragmented nature of Eurozone debt markets compared to the deep unified market for US Treasuries.[1] The supply of truly safe euro-denominated government debt is limited, a fact that became evident as sovereign risk escalated in the Eurozone periphery and markets for periphery debt became increasingly thin. Put simply, a significant portion of Eurozone sovereign debt, not least that of Italy, cannot be regarded on par with safe German or US debt. More generally, the fact that Eurozone capital markets do not appear to be as integrated as in the United States may also an obstacle.[2]

We also highlight that from its inception until mid-2012, the European Central Bank's (ECB's) policy of trying to inherit the credibility of the German Bundesbank may have caused it to focus too much on German macroeconomic stability, and not enough on the rest.[3] This excessive focus on German macroeconomic conditions may been a contributing factor to macroeconomic instability elsewhere, instability that ultimately resulted in crisis and paralysis. Specifically, we show that ECB policy came very close to mimicking a Taylor rule for Germany, a rule that at many times may have been counterproductive for the Eurozone as a whole. Post mid-2012, the ECB looks to be following something

[1] Portes and Rey (1998) were early to suggest that capital market deepening and integration as a central determinant of the euro's international role.
[2] Coeuré (2019) also makes the point that the scarcity of safe assets in the Euro-area limits its internationalization. See Cimadomo et al's (2018) literature review on the comparison between US and Eurozone capital market integration.
[3] Feldstein (1997) predicted that converging macroeconomic objectives would lead to conflict among Eurozone members and may hamper the monetary union project. He particularly noted the divergence between Germany's and other member countries' opinion on monetary policy as a potential source of instability.

much closer to euro-wide Taylor rule, but only by treading into de facto fiscal policy and straining the limits of its mandate, a policy that may not be sustainable if another large economic shock were to hit or political consensus were to fray in the face of populist pressures.

Our findings are consistent with a growing body of work documenting the dollar's dominance in international trade and finance.[4] Our focus is on the role of the euro as a runner up to the dollar. We document its relative weight as an anchor currency using a variety of indicators. The stall of the euro has been emphasized previously in Ilzetzki, Reinhart and Rogoff (2017, 2019) and, more recently, by Maggiori, Neiman, and Schreger (2019, forthcoming); the latter particularly highlight dollar dominance in international private bond markets. The ECB's annual review of the international role of the euro has also documented the euro's runner-up status as an international currency.[5] The present paper aims to explore a broader range of evidence, but also to consider some possible reasons for the euro's limited reach. We highlight the possibility of a natural monopoly for the dominant currency and that the Eurozone crisis may have stalled the euro's emergence. But we further investigate deeper structural limitations to the euro's reach including the scarcity of truly safe euro assets and that the ECB's changing priorities over its first two decades might have slowed the euro's ascent.

We conclude by asking where the euro stands now in relation to ever-rising dollar dominance, and what it might take to overcome the challenges the euro has faced in its first 20 years. We caution that even though at present the euro is better regarded as a regional currency, this situation could change if China—perhaps in response to a sustained trade war—were to give the euro a larger weight in its currency basket on a sustained basis, and particularly if many other Asia countries were to follow suit. However, we caution that even if China were to permanently retain a much higher weight on the euro in its basket, the boost to the euro's international status would likely be short-lived. The emergence of the renminbi as an anchor currency could quickly usurp the euro's runner-up status in the international monetary system.

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[4] For broad reviews of the topic see Prasad (2015), Eichengreen (2011), and Eichengreen, Mehl, and Chițu (2017). Dooley, Folkerts-Landau and Garber were early to suggest that the dollar may have become the central anchor of the 21st century monetary system. Rey (2013) demonstrates the centrality of US monetary policy in international finance and Ilzetzki, Reinhart and Rogoff (2019) document the dollar's role as an anchor currency. The dollar's dominance has been documented in trade invoicing (Goldberg and Tille, 2008, Gopinath 2015, Faudot and Ponsot 2016) and debt denomination (Bruno and Shin 2015 and Maggiori, Nieman, and Schreger, forthcoming).

[5] Most recently, European Central Bank (2019) emphasized the recovery of the euro as an international currency following the crisis. We discuss the crisis in Section III.B below. The ECB stresses that internationalizing the euro isn't part of its official mandate. However, the European Commission has stated the internationalization of the euro as an objective, most recently in a December 2018 communique leading to the European Commission (2019) report.

II. The International Role of the Euro

This section documents the international role of the euro at its twentieth anniversary along a number of dimensions. A natural point of departure is the anchor currency classification of Ilzetzki, Reinhart and Rogoff (henceforth IRR, 2019). The IRR dataset assigns an "anchor" or "reference currency" to each country and territory in the world at a monthly frequency from 1945 to 2016. As we argue in IRR (2019), we view our anchor/reference classification as an encompassing portmanteau measure of the diverse forms of anchor currency dominance including invoice pricing, reserves, debt denomination, etc. Thus, in principle, the currency to which a central bank anchors its exchange rate summarizes the revealed preference of policymakers' aggregation across all these considerations. After documenting the euro's stalled rise as an anchor currency, we turn to specific aspects of the role of an international currency and document the euro's standing on each dimension.[6]

II.A The Euro as an Anchor Currency

The IRR classification is based on a set of algorithms that jointly classify a country's exchange rate arrangement (in terms of its flexibility) and anchor or reference currency. Details can be found in IRR (2019).[7] IRR document how the 21st century has seen a rise of managed floating (particularly the many flavors of inflation-targeting) regimes, especially in emerging markets. Although such currencies cannot be said to be within a fixed band relative to any anchor currency (or basket of anchor currencies), our classification algorithm nevertheless reveals that many can still be regarded as managed floating, with central banks explicitly (or implicitly) still placing a significant weight on exchange rate stabilization. To

[6] To be clear, we do not imply a causal chain beginning with anchor currency choice and leading to private sector decisions. The various dimensions of an international currency likely reinforce each other.

[7] In IRR (2019), the exchange rate of 196 countries and territories is evaluated against eleven candidate anchor currencies: The candidate anchors are the US dollar, the Deutschmark, and French franc (replaced by the euro following 1999), the Japanese yen, the British pound, the Russian ruble, the Swiss franc, the Australian dollar, the South African rand, and the Brazilian real. The candidate anchors were chosen based on historical practice and currencies that are widely included in exchange rate baskets. In addition, currencies that are classified as freely floating themselves become candidate anchors in the relevant years: This adds the Canadian dollar and the Turkish lira in some years. The Chinese renminbi is not considered a candidate anchor currency as it has been strongly linked to the dollar itself and is not fully internationally convertible. Hence anchoring to the dollar and the renminbi is observationally equivalent. We therefore note the possibility that this classification may currently overstate the role of the dollar and warn the reader from simple extrapolations into the future. The algorithm also allows for de facto currency baskets as potential anchors. Baskets include a dollar-euro, dollar-yen, euro-yen, and dollar-euro-yen basket, with equal weights on the anchors in each basket. However, IRR (2019) demonstrates that only a small number of currencies have de facto pegs to baskets. Anchors are determined on the basis of 1, 2, and 5 percent exchange rate bands. Each country is assigned an anchor as that which the country's currency can be said to be within the narrowest band among the eleven anchors considered. Data is available at https://www.ilzetzki.com/irr-data and full chronologies of anchor currencies since 1945 can be found in Ilzetzki, Reinhart, and Rogoff (2017).

make this distinction, we refer to the dollar (or other anchor) as a "reference" currency rather than an "anchor" currency in these cases.[8] Appendix I gives a brief overview of the IRR classification algorithm. Further detail can be found in IRR (2019).

To what extent has the euro's role as anchor currency appreciably changed in the first two decades of its existence? The answer can be seen in Figure I, which shows the share of countries anchored to the euro since its inception in 1999. These data are spliced together with the share of countries previously anchored to the German DM or the French franc from 1975 to 1998. For comparison purposes, the figure also shows the share of countries anchored to the US dollar from 1975 to 2016. The top panel presents the share of countries anchored to the euro or dollar weighted by these countries' share of world GDP. This is the more relevant measure when thinking of the international reach of the euro. The lower panel shows the (unweighted) share of countries.[9]

The figure shows that to date the euro hasn't made inroads as a global anchor currency. In fact, the GDP-weighted measure suggests that the importance of the euro has declined in this period, with nearly 25 percent of world GDP anchored to the euro at its inception, compared to only 15 percent today. In large part, of course, this reflects a decade of poor growth post crisis that reduced the size of Europe's footprint on the world economy, especially relative to the faster growth of emerging markets. The thin line at the bottom of the figure shows the share of world GDP anchored to the euro, excluding the Eurozone itself. This line is perhaps the more relevant one in considering the euro's *international* role. It shows that the rise of dollar-anchored emerging markets is only part of the story. By this metric, the euro's role as an anchor currency is truly limited, with countries representing only 3.5 percent of non-Eurozone world GDP anchored to the euro. The biggest loss to the euro bloc in this period was the UK, which transitioned from a euro anchor to a freely floating regime. This loss is unlikely to be recovered in the foreseeable future, with the UK now in the process of exiting the European Union (EU). We note that the stall in the euro's significance would be virtually as large even if one ended the base period in the mid-1980s, long before the euro's conception.

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[8] The reference currency is assigned using additional criteria for managed floats. These include the currency composition of foreign trade invoicing, external debt denominated, and central bank foreign reserves, in addition to the central bank's historical practices. As noted in IRR (2019), the criteria point in the same direction in all cases so that a reference currency can be unambiguously assigned to all managed floating currencies. Finally, freely floating currencies are assigned to be anchored to themselves.

[9] Other exchange rate regimes classifications include Reinhart and Rogoff (2004), Shambaugh (2004), Levy-Yeyati and Sturzenegger, (2005, 2016) and Klein and Shambaugh (2010). They all implicitly classify anchor currency as well and would likely show similar patterns. Levy-Yeyati and Sturzenegger (2005) classify on the basis of reserve accumulation. We document the dollar's dominance on this dimension in the following section. The other classifications are similar in spirit to our own and would likely lead a similar preponderance of anchoring to the dollar.

The bottom panel of Figure I, which reflects the international popularity of the euro (irrespective of country size) also reveals stagnation after some modest gains in the early years of the new currency. In this panel, the share of countries unweighted by GDP has slightly risen from 26 to 28 percent. However, in a longer historical perspective, this increase is moderate relative to the gains of the DM-franc bloc post-Bretton Woods. This bloc grew from 17 percent in 1975 to 26 percent on the eve of euro adoption. We note that much of the increase in the share of countries anchored to the euro over this period consisted of new European Union members in Central and Eastern Europe, who are required to join the euro sooner or later according to EU rules.

The fate of the dollar in this period provides an interesting counterpoint. The top panel of Figure I illustrates that the US bloc has steadily and dramatically increased in its reach from the mid '80s (with 45 percent of world GDP anchored to the dollar) to today (nearly 70 percent). This is despite the similar decline of the US economy as a share of world GDP, even if recent performance has been better in the US than in the Eurozone (see Figure A.1 in the appendix). Even when excluding the US itself from the count, more than half of world GDP anchored to the dollar, compared to one third at the advent of the euro. Further, the bottom panel of Figure I shows that more countries (in unweighted terms) joined the dollar bloc than did the euro bloc since 1999.[10]

Figure II presents the evolution of these two blocs in two maps. The top map compares euro bloc in 2016 to the bloc in 1999. Countries in darker shades have anchored to the euro since its advent. Countries in lighter shades were anchored to the euro at its inception, but have since left the bloc. The reach of the euro is largely confined to the euro area itself, to non-euro EU members, and to former French colonies in Africa, most notably the members of the West-African CFR franc zone. Currencies that have anchored to the euro since 1999 are also largely confined to EU accession countries in Central and Eastern Europe. This period has also seen the (relatively larger) economies of the UK and Turkey de-anchor themselves from the euro.

The contrast with the dollar bloc, shown in the bottom map, is striking. The dollar's reach is truly global, with currencies in all world regions anchored to the dollar. A number of economies have

[10] Two factors account for most of the increase in dollar anchoring in the 1990s seen in Figure I. First, countries formerly in the Soviet bloc (with either multiple exchange rate markets or anchored to the Russian ruble) anchored to the dollar after the fall of the iron curtain. Interestingly, this included some current EU and Eurozone members (Poland, Baltic countries) who have since adopted a euro anchor (or the euro itself). This explains the increases in euro anchoring between 1995 and 200 seen in the bottom panel of Figure I. Second, hyperinflationary currencies (most prominently in Latin America) who were unanchored in the 1970s and 1980s, re-anchored to the dollar when global inflation stabilized in the 1990s.

decoupled their currencies from their link to the US dollar, most notably Canada and South Africa, in favor of freely floating regimes. A number of other economies (Brazil, Turkey) briefly flirted with freely floating regimes in the early 2000s, only to re-anchor to the dollar as the global financial crisis unfolded. But numerous countries ranging from Europe to Africa to Asia have moved to a dollar anchor in this period. In comparison to the dollar's global reach, the euro remains a regional currency.[11]

Two caveats are due. First, while the dollar bloc has expanded more rapidly in the past two decades than the (arguably shrinking) euro bloc, currencies in the euro bloc are more closely anchored to the euro than those in the dollar bloc are to the dollar, on average. The nineteen ECB member countries have abandoned national currencies altogether in favor of the euro, the CFA franc is pegged to the euro, and a number of Eastern European countries have crawling pegs to the euro. In comparison, several large members of the dollar bloc have managed floating currencies (e.g. Brazil, Turkey) or have wide bands around the dollar (e.g. India).[12]

Second, the Chinese role in the international monetary system is evolving steadily, in particular moving to a more fluid peg the last couple years, with the euro apparently receiving a larger weight. Of course, the Chinese government has long-term ambitions to make the renminbi itself an anchor currency (see Prasad, 2016). A more independent renminbi would be a substantial loss to the dollar bloc and would increase the international standing of the euro *relative* to the dollar, but less so in absolute terms. In fact, a freely floating renminbi could easily usurp the euro's role as the second major anchor currency nearly overnight.[13]

For the moment, with the renminbi widely unconvertible, a fully international role for the renminbi appears distant, despite China's rapidly growing role as an international lender. In the nearer future, China nevertheless remains a wildcard, as its anchor to the dollar is itself evolving. In late 2015, the People's Bank of China announced that it is replacing its US dollar band with a narrow band around a basket of currencies, including a greater weight to the euro. It is too soon to tell how this policy will play out in practice, but we note here that should such a policy come to fruition, the world's second largest economy may transfer some of the weight of its anchor toward the euro. Applying our algorithm to the brief two-

[11] Of course, the gap between the euro and other candidate anchors is also substantial. For example, no country currently anchors its currency to the British pound or the Japanese yen. The wildcard remains the renminbi, as we discuss below.

[12] Figure A.2 in the appendix shows an index that re-weighs countries anchored to the dollar and euro based on their exchange rate flexibility, putting a substantially higher weight on those countries that have a harder peg (details in the figure's footnote). Even by this index the dollar is nearly twice as important as the euro as an anchor currency.

[13] China's share of world GDP stands at 16 percent, already exceeding the share of world GDP anchored to the euro, standing at 15 percent, as shown in Figure I. This share would increase further if other countries, particularly in East-Asia, moved to a renminbi anchor. See Fratzscher and Mehl (2011) and IRR (2019) on the possibility of latent anchoring to the renminbi.

year period since this transition suggests that the China may have transitioned to a roughly equally weighted dollar-euro basket. We note that a two-year period is too short a timeframe to evaluate an exchange rate regime, particularly given that this has been a period of relative stability in the dollar-euro exchange rate. However, should this transition prove durable, it would increase the share of world GDP anchored to the euro from 15 to 23 percent and decrease the share anchored to the US dollar from 69 to 61 percent if Chinese GDP is allocated equally to the dollar and euro anchors. Should other countries in the Asian supply chain follow suit, China's change to a more diversified exchange rate basket would have an even larger effect.[14] (As noted earlier, a number of other major central banks currently in the dollar bloc have also shown increased flexibility, although they have shown no sign of viewing the euro as an alternative.)

II.B Markers of an Anchor Currency

Having documented the limited reach of the euro as an anchor currency, we now turn to narrower, but more specific markers, of an international currency and document how the euro fares on each dimension. Anchoring to a currency often requires central banks to hold a large stock of foreign exchange reserves, particularly in an era of increasing capital account openness. Figure III shows the share of world central bank reserves held in dollars and euros from 1995 to 2018 (or European Exchange Rate Mechanism, EERM, currencies prior to 1999).[15] The shares have held steady with roughly 20 percent of central bank reserves held in euro-denominated assets, compared to roughly 60 percent in dollars. The figure shows that the euro's share of central bank reserves is no higher than that of EERM currencies in 1995.[16] [17]

Admittedly, this stable *share* of central bank reserves should be viewed in the context of an unprecedented surge in reserve holdings. The dark line in Figure III shows that global central bank reserves have increased more than eight-fold from $1.2 trillion in 1999 to nearly $11 trillion today (both values in US dollars). This means that the *quantity* of euro-denominated assets held as central bank reserves has also increased by roughly the same proportion and currently stands at €2 trillion. The demand for central bank reserves in general has led to a dramatic increase in demand for euro-

[14] At such a point, however, one would need to consider whether these currencies constitute a separate renminbi bloc, as discussed in footnote 13 above.
[15] Data are from the IMF's *Currency Composition of Foreign Exchange Reserves* database, which gives the currency composition of official foreign exchange reserves for reporting countries. In 2018, these comprised 93 percent of all reserves.
[16] "Euro" reserves prior to 1999 are given by reserves denominated in Deutschemark, French franc, Dutch guilder and ERM, so they slightly understate the share of European currencies in international reserves prior to 1999.
[17] One shouldn't make too much of the higher frequency fluctuations in dollar and euro shares. Figure A.3 in the appendix zooms in on the euro share of central bank reserves alongside the dollar-euro exchange rate. The high-frequency changes in the euro share are largely driven by valuation effects.

denominated assets. These facts are consistent with central banks attempting to maintain a roughly constant euro exposure in their portfolios, but they show no signs of tilting towards the euro over time. In contrast, the share of central bank reserves held in currencies other than dollars or euros is steadily increasing and has nearly doubled (from 10 to 17 percent) since the global financial crisis.

Official foreign exchange holdings may provide a skewed view of the relative importance of the euro if governments put an undue weight on the dollar in their policy considerations. It is therefore useful to consider measures emanating from the private sector as well. Figure IV looks at the foreign exchange turnover for four major currencies from 1995 to 2016.[18] This measure comes from the Bank for International Settlement's survey of over one thousand of the largest currency dealers worldwide and gives a sense of the total demand for transactions in and liquidity of major currencies. This indicator gives the share of foreign exchange transactions in which the stated currency is on one side of the transaction. The total share of transactions therefore sums up to 200 percent, but the maximum possible share for any given currency is 100 percent.

The figure shows a strikingly similar pattern to that arising from official holdings. Close to 90 percent of transactions involved trades of US dollars for another currency, highlighting the centrality of the dollar as an international medium of exchange. The euro's share of foreign exchange turnover has held roughly constant throughout the period at around 35 percent and peaking just below 40 percent in 2010. By this measure the currency balance of the international monetary system has remained very stable during the euro's first two decades with no sign that this anchor currency has gained market share. The euro's share is slightly smaller than the combined share of the UK pound and the Japanese yen. Japanese and UK GDP combine to two thirds of that of the Eurozone and these two economies have an even smaller relative share of global international trade. The turnover statistics suggest that the euro is punching below its weight—and not only in comparison to the dominant US dollar.

The global financial crisis highlighted significant role of the US dollar not only in the global, but also in the European financial system. The scale of Federal Reserve's swap lines with the ECB and private European financial institutions was, of course, part of the policy response to meet this demand for dollars.[19] Figure A.4 in the appendix (adapted from Bahaj and Reis, 2019) illustrates the magnitude of the Fed's global dollar denominated liquidity provision during the crisis. While the crisis period was perhaps

[18] The euro is replaced by the Deutschemark prior to 1999. On one hand this understates the share of pre-1999 Eurozone transactions, because it excludes all Eurozone economies other than Germany. On the other hand it overstates this share because it counts trans-national intra-Eurozone transactions.

[19] See Bahaj and Reis (2019) for a detailed analysis of the role of central bank swap lines during the crisis and beyond.

an unusual period, if anything the narrow focus on swap lines understates the global demand for dollar liquidity that the Fed supplies. Figure V shows the total dollar-denominated liabilities of the Federal Reserve to non-US residents from 2000 to early 2019. The Fed provides over $5 trillion in direct liquidity to the rest of the world, a figure that has more than trebled since the beginning of the 21st century. A third of this liquidity is held in the EU illustrating the massive demand for dollar funding there. Half of this latter sum is held in the UK; the dotted line in the figure shows the Fed's liquidity provision to residents of the EU excluding the UK.[20] The figure also shows euro-denominated liabilities of the ECB to non-Eurozone residents. While these liabilities have increased 40-fold since the advent of the euro, ECB liquidity international liquidity is an order of magnitude smaller than that of the Fed. The figure illustrates that demand for Fed liquidity in Europe alone exceeds the demand for ECB liquidity elsewhere. In fact, the figure somewhat overstates the demand for ECB-issued liquidity overseas as almost the entirety of the large increases in euro denominated liabilities in 2008 and 2012 were held by the Federal Reserve as part of swap arrangements between these two central banks. The more recent rise in ECB overseas liabilities since 2016, including swap lines with People's Bank of China, could be a real phenomenon worth following in years to come.

Figure VI shows that demand for dollar-denominated assets is not restricted to the safe assets created by the Fed. It shows the composition of developing countries' public (and publicly guaranteed: PPG) foreign currency debt denominated in euros (or DM and French francs prior to 1999) and dollars from 1975 to 2017. This metric also shows a very stable international role for the euro with the share of developing country sovereign debt denominated in euros hovering around 10 percent. The euro has not become a currency of choice for external debt denomination with only 8 percent of PPG debt denominated in euros in 2017, exactly the share the euro held in 2000. If one goes back to the decade prior to euro adoption, we see that in fact the euro plays a smaller role today than did the German and French currencies it replaced, with the latter two holding a 13 percent share in 1990 and a similar share at the end of the Bretton Woods period. In comparison, the share of public debt denominated in US dollars in the developing world has increased dramatically. The dollar's share has steadily increased from 45 percent in the early 1990s to 75 percent today.[21] In fact, these data likely understate the increase in dollar dominance over this period because the World Bank data do not fully incorporate China's official lending to dozens of countries in the last decade, the lion's share of which is denominated in dollars, not

[20] Excluding other non-Eurozone EU members would have almost no visible effect on the figure.
[21] The past two decades have also seen a large increase in local-currency denominated external public debt, not included in this figure.

renminbi. Again should China re-calibrate its exchange rate policy—for example as an economic and political response to trade wars—this situation can change.

In an important recent paper, Maggiori, Neiman and Schreger (forthcoming) find a huge chasm between the dollar and euro when it comes to privately issued debt. In fact, in most regions of the world, when private borrowers want to sell bonds abroad, they end up denominating debt either in the lender's currency or in the US dollar. Europe, even Germany, is no exception. This constraint is particularly important when it comes to small and medium size businesses, who generally have very little international capital market access, in part due to fixed costs to entering the market. US small and medium size firms stand as a striking exception, a factor that Maggiori, Neiman and Schreger conjecture may quantitatively be even more important for growth than the traditional "exorbitant privilege" that the US government has in borrowing abroad.

Table I summarizes these and other measures and compares the roles of the US dollar and the euro as international currencies as the latter comes to its twentieth anniversary. The US economy is 50 percent larger than the Eurozone economy but the dollar dominates by a larger margin on nearly all dimensions. Twice as many countries have anchored their currencies to the US dollar as compared to the euro. The share of world GDP represented by the euro-anchored economies is even smaller. Developing countries prefer denominating their external debt in dollars relative to the euro by a factor of nearly ten to one. Almost all foreign exchange transactions have the dollar on one side of the exchange. The European banking system has been showing increased home bias over time, but European banks still hold only 71 percent of their assets and denominate 59 of their liabilities in euros. This compares to 85 and 76 percent in the US, respectively.

The table includes an additional indicator for which a snapshot is available in 2015: the currency of choice for trade invoicing. We report here a "trade invoicing index", which we have constructed using the data of Gopinath (2015). It averages the percent of countries invoicing *any* trade in euros (or dollars) with the *share* of trade invoiced in this currency. The euro fares far better on this indicator than on any other anchor currency metric with an index of 56 compared to 69 for the US. However, these numbers need to be taken in context of EU dominance in international trade. One quarter of the world's exports originates in the Eurozone, compared to only 9 percent from the US (the figure for China is 12 percent). The gap is

only slightly smaller for imports. One might have expected a larger role for the euro given that the EU is the largest global hub for international trade in goods and services by a large margin.[22] [23]

In summary, our data on anchor currencies suggest that the euro lags by a substantial margin relative to the dollar as an anchor currency. This margin existed at the advent of the euro and has held stable over the two decades of the euro's existence. Specific roles of an international currency—trade and debt denomination and foreign exchange reserves—all show similar patterns. This is to be expected. The various roles of an anchor currency are complements and dominance of an anchor in each dimension is likely to reinforce its dominance in the others. The following section discusses these complementary roles as one explanation for the still fledging role of the euro as an anchor.

III. Why is the Euro Punching below Its Weight?

Why has the euro still remained a largely regional currency for Europe, its periphery, and some of its former African colonies? The simplest answer is that there is only room for one major anchor currency and that the dollar already plays this role. There are a number of mutually-reinforcing factors that would lead to a natural monopoly for a single global medium of exchange, store of value, and unit of account. Swoboda (1969) pointed to the convenience yield of invoicing trade in a common currency. Global oil and other primary commodity markets are based on the US dollar. The rise of global supply chains will have reinforced the strategic complementarities in firms' invoicing decisions (Bacchetta and Wincoop, 2005; Goldberg and Tille, 2008). Similar complementarities exist in the currency denomination of assets (Hassan, Mertens, and Zhang, 2016; He, Krishnamurthy,and Milbradt. 2019). Finally, currency denomination in goods and financial assets may also be complementary, as suggested in recent work by Gopinath and Stein (2018).

History would appear to support these theories. The British pound played a similarly outsized role in the 19th and early 20th century. There is perhaps an analogy to the relatively limited reach of the Latin Monetary Union, with France in its center, to that of the euro today. History also suggests persistence in

[22] Both the trade figure and Gopinath data include intra-Eurozone trade. A rough estimate of the Eurozone's exports to the rest of the world is still close to a fifth of total world trade. The euros's trade invoicing index would be smaller, and the dollar's higher, if adjusted to exclude intra-Eurozone trade. If all intra-Eurozone trade is invoiced in euros, the dollar index would come to roughly 75 and the euro index would decline to below 50 under this adjustment.

[23] The dollar is also an important currency for *intra*-national trade in dollarized economies. On de facto dollarization see Calvo and Vegh (1999); Reinhart, Rogoff, and Savastano (2014); and Ize and Levy Yeyati (2003).

the global anchor currency of choice. The UK pound dominated well after the US economy surpassed it in size. Earlier, Spanish silver dollar persisted as a global currency long after Spain's empire declined. That the US dollar rose in global status only in the aftermath of World War I and the unravelling of the British Empire suggests that large seismic shifts may be necessary for the main anchor currency to fall from grace.[24]

The natural monopoly in anchor currencies is not a universally held view. Eichengreen (2011) predicts a not-so-distant future where the dollar, euro, and the renminbi share the stage in a tripartite international monetary oligopoly.[25] [26] Our evidence from the previous section shows that the euro has shown no sign of emerging to more than a secondary role in the monetary order of the 21st century to date. This section points to a number of factors that may have inhibited the euro's rise. These factors are also ones to look at in considering its potential to increase its international position in the future.

While denomination of goods and assets are complements, much of the discussion that follows focusses on financial rather than goods markets. The reason for this was highlighted in Table I. The euro is already a major invoicing currency, almost at par with the dollar. Further, the Eurozone is not punching below its weight in volume of trade, being both the source and destination of more than a quarter of world trade. It is particularly in the financial arena that dollar dominance looms large.

We begin our discussion with the availability of safe assets, which we view as central to the euro's limited international reach. Next, we reflect on some other structural weaknesses that may challenge the euro's international status in the foreseeable future. We then turn to the Eurozone crisis. While the crisis may have stalled the euro's emergence as an international currency, it also exposed its structural deficiencies, so that the crisis may have been as much a result as a cause of the euro's weaknesses. In the following section, we turn to ECB policy, which may have been an additional hindrance to the euro's expansion.

III.A Asset Availability

We begin our discussion with a search for high-quality euro denominated assets. The core supply of euro-denominated assets will necessarily originate in Europe and central to these are high-grade sovereign

[24] Eichengreen, Mehl, and Chiţu (2017) have a different interpretation of the historical record where there were important periods where several international currencies shared the stage.
[25] As we note in the concluding section, the sheer size of East-Asian economies implies that the euro would likely be a distant third in such a tripartite system. China's (growing) share of world GDP alone exceeds the total share of world GDP currently anchored to the euro.
[26] Bergsten (1997) predicted a dollar-euro duopoly with the dollar and euro each comprising 40% of central bank reserves.

bonds. The large and increasing demand for safe assets has been widely studied (see Caballero, Farhi, and Gourinchas 2017).[27] Whether they are accumulated as a safe asset or for exchange rate stabilization (IRR, 2019), central bank reserves are largely held in bonds of a relatively select number of issuers. We documented in Figure III that the lion's share of these reserve holdings are held in US dollar denominated assets. The left-hand panel of Figure VII puts this demand in the context of the supply of euro and dollar safe assets. The figure shows that the supply of marketable US government debt, at over $14 trillion in 2018, dwarfs the combined availability of German and French marketable government debt, at just over $3 trillion. Even if one includes the debt of other non-crisis Eurozone economies, the marketable debt of Eurozone sovereigns amounts to only $4 trillion.[28] In the context of $10 trillion central bank foreign exchange reserves, safe euro denominated assets are in short supply.

This is not to say that European sovereigns are insufficiently indebted. Quite to the contrary, all but four euro-area governments currently meet the Maastricht criterion of a debt to GDP ratio under 60 percent. France's debt to GDP ratio is inching towards 100 percent, and Italy's debt well exceeds the size of its economy. Instead, it is the absence of a Eurozone-wide safe asset that doesn't allow the area to mobilize its combined fiscal capacity. With volatile spreads throughout the crisis, the debts of Italy, Spain, Portugal, and Greece can hardly be said to be safe and have not been widely included in reserve portfolios outside the Eurozone. The illiquidity of these debt markets becomes particularly manifest in times of economic or political turmoil. (More on this in Section III.C below.)

The foreign demand for US debt can hardly be taken for granted. As Figure VIII shows, the share of US marketable debt held overseas has gradually declined since 2008. Central bank reserve holdings of US bonds has even been declining in absolute terms since 2015. But as the figure illustrates, this hasn't reflected a transition to euro-based assets, whose share of foreign ownership has similarly declined.[29]

US dominance as a supplier of corporate bonds is equally striking. As the right-hand panel of Figure VII shows, the total stock of US non-financial corporate debt securities outstanding is almost five times as large (at 39 percent of US GDP) as the stock of Eurozone corporate issues (at 11 percent of GDP) [30]. A foreign investor seeking a diversified international corporate bond portfolio will by necessity bias her holdings to dollar-denominated assets. The vast gap is significantly explained by the reliance on bank,

[27] Chahrour and Valchev (2018) provide a theory that links the availability of safe assets to anchor currency choice.
[28] This includes all original Eurozone members excluding Ireland, Italy, Portugal, and Spain.
[29] A substantial portion of these declines are due to an increase in Federal Reserve and ECB holdings of these assets.
[30] The gap is larger in practice because 20% of Eurozone corporate bonds are denominated in foreign currency. There is also a growing share of US corporations issuing euro-denominated bonds (so called "reverse yankee" bonds), but this is a smaller phenomenon at around 2% of outstanding US marketable corporate debt.

rather than bond financing in the Eurozone, with the stock of outstanding corporate bank loans twice as large as in the US. Close to 80 percent of Eurozone corporate debt is held as unmarketable assets on bank balance sheets (compared to less than 30 percent in the US), making them unavailable as assets for foreign holders. If anything, this figure likely *overstates* the supply of marketable euro denominated debt. As Maggiori, Neiman and Schreger (forthcoming) show, US corporate debt is universally denominated in dollars, but issuance in foreign currency is more common elsewhere.

Turning from bonds to stocks, Table II shows the market capitalization of major equity markets. The US dominates in this category as well with the total valuation of stocks on the New York Stock Exchange and NASDAQ each double the market capitalization of the largest ex-US competitor (the Japan Exchange Group).[31] US equity markets exceed the combined market capitalization of equity markets in all other regions considered here (Eurozone, China, UK, and Japan) and comprise nearly half of the world's equity market capitalization. This too is yet another huge factor pointing to dollar dominance. Even though the US accounts for only 20% of GDP, it has a far superior capacity for securitizing assets given its relatively reliable legal and regulatory system.

Although a number of national exchanges united under the Euronext umbrella, Eurozone equity markets remain very fragmented, with Euronext only halfway between the London Stock Exchange and the Japan Exchange Group in total market capitalization. Combining all Eurozone exchanges from the Euronext down to the Malta Stock Exchange gives a total market capitalization that is still five times smaller than the two US stock exchanges. Trade volumes are even smaller in comparison, with monthly equity turnover in US markets more than seven times that of European markets, reflecting higher liquidity of US-issued stocks. While Chinese stock markets are still somewhat opaque and closed to foreign investors, and while market capitalizations obviously fluctuate with market valuations, Chinese stock exchanges (including Hong Kong) have by now surpassed their European counterparts in terms of market capitalization. The depth of the US equity market coupled with the comparatively low returns in fixed income assets helps explain why some of the world's largest sovereign wealth funds have pivoted to US equity markets.

Interestingly, the relative market capitalizations of US and Eurozone stock exchanges are of strikingly similar magnitudes to the relative role of the dollar and the euro on other dimensions (see Figures III to VI and Table I). World demand for US equities may indeed be an important source for US dollar demand. The inclusion of equities in this discussion may appear disconnected from the safe-asset discussion that

[31] Based on December 2018 valuations.

initiated this section, but US equities may be in fact safer than locally available fixed-income assets in many developing countries, certainly when one considers taxation and the risk of outright expropriation.

Importantly, Eurozone capital markets remain much less integrated than in the United States, with regulatory and informational barriers leading to a much larger home bias than across US States. The illiquidity of markets for many Eurozone governments' debt is partly due to the significant home bias that has arisen after the Eurozone crisis, but the problem extends to capital markets more broadly. Cimadomo, et al (2018) survey the literature and find that income shocks across US states appear to be shared to a much greater extent than across Eurozone countries. Although one might expect the difference to have become less after the formation of the euro, the results in the literature even on that score are mixed. One possible reason is the growing importance of private equity, particularly in the United States. In Europe, venture capital remains extremely balkanized due in part to regulatory barriers, greatly limiting its impact in general, and certainly in sharing risk. (See Raposo and Lehmann 2019 for a discussion of barriers to venture capital market integration in Europe).

In summary, whether considering government bonds, corporate bonds, and equities (not to speak of more exotic instruments like securitized products or ETFs), dollar-denominated and US-originated assets dominate the international marketplace. Europe is under-producing assets even relative to the size of its economy.

III.B Other Long-Term Structural Impediments to the Euro's International Role

The correlation between stock market capitalization and anchor currency status is no coincidence. There is a long history of a single country hosting both the anchor currency and the largest financial center, and usually being a dominant military power.[32] Europe does not seem likely to fulfill these criteria anytime soon. Following its victory in the Napoleonic Wars, London emerged as the dominant global financial center, a role it occupied until World War I, even after the US economy surpassed the UK in size.[33] In the 17th and 18th century, the Netherlands' role as a major financial center lead to an important international role for the Dutch guilder.[34] The strong international role of the Spanish escudo in the 16th

[32] Eichengreen, Mehl, and Chiţu (forthcoming) document empirically the historical importance of security alliances in predicting reserve holdings. See also Strange (1971) for a historical account of the geopolitics of Sterling's decline and the US dollar's emergence.
[33] Ahamed (2009) emphasizes how the UK's dominance in banking and trade finance continued to reinforce the centrality of the pound up until World War I long after the US had vastly surpassed the UK in economic size, with US bankers remaining mainly domestically focused until after the First World War when the UK banks' capacity to raise capital had been sharply diminished.
[34] Denzel (2010)

century coincided with Spanish imperial expansion and political and military dominance in Europe. (See Schmelzing 2019 for a timeline of the dominant safe assets from the 13th century to today.)

Causation, of course, goes both ways. Demand for US stocks and bonds firms-up demand for US dollars. And conversely, attractive and liquid US financial markets provide firms worldwide with dollar financing. Nearly one-thousand foreign firms are listed on the NYSE and NASDAQ and many others borrow in dollar terms on US bond markets.

Aside from aggregate asset measures, dollar dominance in transactions the United States huge regulatory control of the "rails" of the international financial system which are used to clear global transactions. More than 50% of SWIFT messages are for dollar transactions (see Cook and Soramki, 2015, annual SWIFT updates). At present, all dollar transactions have to go through banks and clearing houses that are regulated by the United States authorities, who in turn can rely on a well-established regulatory and legal infrastructure.

The Eurozone faces many challenges in establishing a global financial center in continental Europe to compete with London, New York, and Singapore. Of course, London is the de facto financial center for the Eurozone, but it is the UK has not joined the euro, and Brexit is unfolding as we write. Although some of London's back office business may go to Paris and Frankfurt, the reasons why it will be difficult for Germany and France to establish a financial center are well known. First, there is the matter of high taxation which makes it less desirable to headquarter in those locations. Second, there is a strong case to be made that German and especially French legal structures are not as conducive to sophisticated financial market development as Anglo-Saxon law, as La Porta, Lopez-de-Silanes and Shleifer (1998) have argued in an influential body of research. Third, and perhaps most important going forward, the future of finance lies in technology (see, for example, Rogoff, 2016). Europe badly trails both the US and China in technology research (OECD, 2018), with little prospect of catchup. (The leading European artificial intelligence firm DeepMind, is located in London.)

Coeuré (2019) lists another obstacle to the rise of the euro is the fact that the Eurozone does not "speak with one voice" in international economic affairs. That is certainly true, but perhaps equally important is that Europe is not a leading military power, and is extremely reliant on the United States for its security. Although it is possible to be a dominant financial center without being dominant militarily (Schmelzing 2019 gives the example of Venice in the 14th century which had great financial power with relatively limited military power), the intervening centuries have largely favored dominant military powers as best able to produce "safe assets," and to enforce financial contracts.

In sum, although individual Eurozone countries enjoy a plethora of admirable governance features, there are at present serious obstacles to rise of the euro as an international currency, including lack of a continental financial center, Europe's weak position in technology research and lack of independent military strength. All these features predate the 2010 Eurozone debt crisis, which we turn next.

III.C The Eurozone Crisis

The stagnating international role of the euro is evaluated in a particularly challenging period for the euro area. The region was particularly affected by the global financial crisis. Extensive narratives of the European debt crisis have been outlined elsewhere (see Blustein 2016 and Mody 2018, for example), including the possibility that the currency union itself exacerbated its depth (see Feldstein 2012, for example). Here we narrow in on the extent to which the limited role of the euro as an international currency was a cause or an effect of the crisis.[35]

Figure IX shows the spreads of ten-year sovereign bonds for four of the European crisis countries over the interest rate on ten-year German bunds (shown in solid lines, left-hand axis). The advent of the euro dramatically and rapidly compressed these spreads. Most notably, Greek spreads declined by 700 basis points from 1997 to 1999. By the time Greece joined the euro in 2001, the Greek government could borrow for ten years at the same rate as the German federal government. This suggests that by the time the euro was adopted, investors treated the debts of all European sovereigns as nearly perfect substitutes.[36] Even in this period, however, much of the foreign demand for the bonds of Southern European sovereigns was confined to Europe itself (particularly European banks).[37]

This insatiable demand for the debt of peripheral European sovereign bonds is also apparent in the share of these bonds held by foreigners, shown in dashed lines in Figure IX (right-hand axis). The share of debt held by foreign nationals doubled from 1997 to 2008. At the onset of the crisis, the foreign share was as high as that in Germany or France. The spike in the sovereign spreads of the crisis countries in 2010 to 2012 is well known. The figure shows that this was accompanied by a sharp decline in the share of marketable debt of these governments held by foreigners.[38] We have seen that home bias increased elsewhere in Figure VIII. But the magnitude of the drop in foreign holdings was larger and more

[35] Of course the crisis originated in the US and could have affected the US economy as well. The fact that the demand for dollar liquidity overseas increased during the crisis (see Figure V) while the Euro's future came in to question suggests that the euro's weaknesses may have been structural rather than cyclical.
[36] At times Southern European governments could borrow more cheaply than could the German government.
[37] This may have been partly driven by ECB policy giving all Eurozone bonds common treatment as collateral.
[38] Battistini, Pagano, and Simonelli (2014) have documented the increase in home bias in European sovereign debt during the Eurozone crisis.

precipitous in the crisis countries. Further, the foreign holdings of crisis country bonds declined in absolute terms, not only as a share of their total outstanding debt.

The drop in the relative bond prices together with a decline in the shares in foreign portfolios indicates a substantial decline in foreign demand. Figure IX suggests that investors ceased treating European sovereign bonds as perfect substitutes as early as 2007. Spreads range from 150 to 550 basis points (and are rising) at the time of writing, more than a decade later. While spreads have declined, they are showing no sign of converging—this despite massive ECB interventions. (The ECB held around 20 percent of all Italian, Spanish, and Portuguese debt in 2018.)

The crisis may have been exacerbated by the internationalization of the euro, but it also revealed the euro's deficiencies as an international currency. Investor over-optimism about the equivalent quality of all Euro-area sovereign debt in the euro's first decade (or their reliance on an implicit ECB guarantee) gave some sovereigns (e.g. Greece and Portugal) an illusion of fiscal space that narrowed as the crisis unfolded. Even when south-European sovereigns were at peak demand, much of this demand was within Europe rather than broad-based. The crisis brought to the fore the varying quality of European sovereign debt. This has highlighted the short supply of euro-based "safe assets" discussed above and may limit the euro's role as an anchor currency for years to come. Of course, to the extent efforts towards significantly greater Eurozone fiscal, banking and ultimately political integration bear fruit, the trends of the past two decades may reverse.

IV. A Central Bank Finding Its Footing

We now turn to new analysis and a brief account of the short monetary history of the euro's first two decades. For most of history, anchor currencies (the US dollar, UK pound, Dutch guilder, or Spanish peseta) achieved credibility as an anchor by themselves being backed by commodities (silver or gold). Since the end of the Bretton Woods system, anchor currencies have instead been backed by the fiscal capacity of the issuing governments and the credibility of the central banks managing their supply.

The ECB's de jure inflation targeting mandate provides a framework for a potentially credible anchor currency. While inflation has been low and stable in the Eurozone (as in most advanced economies), the ECB's de facto monetary framework can still be said to be a work in progress. The ECB's first twenty years can be divided into to two roughly equal phases. We argue that the first decade (under the Duisenberg and Trichet presidencies) can be characterised as a "Bundesbank-plus" period, where the ECB provided more continuity with, rather than a break from, the Deutschemark-centric European

Exchange Rate Mechanism (which again we abbreviate as EERM). A regime change occurred in its second decade (under the Draghi presidency) as the Bank took increasingly aggressive measures in attempt to aide recovery, particularly in the economies of its southern members. Of course, with an expanding policy toolkit of numerous asset purchase programs, this "whatever it takes" period may have come with new uncertainties about the nature and credibility of the euro anchor.[39]

Our analysis is based on estimating Taylor rules for all Eurozone members and for the Eurozone as a whole, while assessing the extent to which the ECB has responded to inflation (or unemployment) in specific member countries or the zone as a whole. We begin by describing the approach adopted and results obtained from estimating an individual Taylor rule for the countries that make up the Eurozone. We consider the possibility that the ECB's policy interest rate implicitly follows a Taylor-type rule with respect to the inflation and unemployment of a given country or region *n*. If i_t^* is ECB's target policy interest rate, the rule takes take the following form:

$$i_t^* = i_0 + \beta_n\left(E_t\pi_{n,t+1} - \bar{\pi}\right) + \gamma_n E_t y_{n,t+1}, \qquad (1)$$

where $\pi_{t,n}$ is year-on-year inflation for country *n* and $\bar{\pi}$ is the inflation target. As a proxy for the output gap $y_{t,n}$, we use the difference between average unemployment in country *n* over 1992-2007 and unemployment in month *t*.[40] E_t is the expectations operator. i_0 is the steady state interest rate, typically given by the (real) natural rate of interest plus the inflation target. The Taylor principle (ensuring that the *real*, not only *nominal*, interest rate responds to inflation) is satisfied for country *n* when $\beta_n > 1$. Given the definition of the output gap, countercyclical policy implies $\gamma_n > 1$.

We allow for the possibility of policy inertia, so that the ECB's actual policy rate i_t follows

$$i_t = \rho_n i_{t-1} + (1-\rho_n) i_t^*, \qquad (2)$$

[39] With normal monetary policy constrained by the lower bound on interest rates (until such day as the Eurozone takes the legal and regulatory changes necessary to make unconstrained negative interest rate policy fully effective, see Rogoff, 2016), the ECB has been limited in its actions to various forms of quasi-fiscal policy that is difficult to assess, particularly as it takes place alongside the fiscal policy actions of the Eurozone's individual governments,.

[40] We use year on year inflation to smooth out transient fluctuations to inflation at monthly frequency, which the ECB might choose to ignore. Estimating the policy rules with annualized month-on-month inflation leads to similar results, but with larger standard errors as could be expected when using noisier data.

where ρ_n is the degree of policy inertia.[41] Together, (1) and (2) give the following estimating equation

$$i_t = \alpha_n + \rho_n i_{t-1} + (1-\rho_n)\left(\beta_n E_t \pi_{n,t+1} + \gamma_n E_t y_{n,t+1}\right) + \varepsilon_{t,n}, \quad (3)$$

where the error term $\varepsilon_{t,n}$ gives the ECB's deviation from country *n*'s Taylor rule in month *t* and $\alpha_n = (1-\rho_n)(i_0 - \beta_n \bar{\pi})$.

Following Clarida, Galí, and Gertler (2000) and a large literature that follows, we estimate (3) using GMM. The data are monthly and span from January 1999, when the euro was adopted, to September 2014 when the ECB set interest rates at zero and the connection to a simple Taylor rule loses meaning (variants that incorporate quantitative easing are not explored here).[42] We substitute realized inflation and output gaps for their expectations in (3) and employ six lags of these variables as instruments (or forecasting tools) in the GMM estimation.[43]

Figure X shows in bars the coefficients on inflation (β_n) for all original Eurozone members, Greece, and the Eurozone as a whole. The whiskers depict 95 percent confidence intervals. The contrast between the coefficient estimates for Germany and other members is striking. The estimated coefficient on the inflation rate for Germany is above one; Germany is the only Eurozone economy for which the estimated Taylor rule satisfies the Taylor principle (although there are three other countries for which the 95% confidence intervals include the possibility of stabilizing monetary policy).[44]

The coefficient for the Eurozone as a whole is of also of note. The point estimate is well below one; we can reject that the ECB's coefficient on Eurozone inflation was above one (that is, satisfies the Taylor principle) or above that of Germany, within standard confidence intervals. In other words, one cannot reject the hypothesis that the ECB's practice has been to stabilize inflation in Germany, but not for the currency area as a whole. On the surface, at least, these estimates indicate that in the first decade and a

[41] The *n* subscripts on the autocorrelation coefficient ρ reflect the fact that the estimated degree of policy persistence may differ when estimating a given country's Taylor rule.

[42] Data source: Eurostat. We use the Main Refinancing Facility Rate as the policy rate as this is the facility that provides the bulk of liquidity to the banking system and is more analogous to the Fed Funds rate. Results are similar when considering the deposit facility.

[43] We use the average quarterly lagged interest rate in estimating (3), as the interest rate shows little variability at the monthly frequency.

[44] Coibion and Gorodnichenko (2011) show (in the context of a New Keynesian Model) that the critical value of β_n required for stabilization is one only when trend inflation is zero. The critical parameter is increasing in trend inflation. Given that average inflation was higher in the European periphery than in Germany during this period, our estimates may if anything overstate how appropriate ECB policies were for countries of Southern Europe.

half of its existence, the ECB may have placed a de facto greater emphasis on stabilizing inflation in Germany than elsewhere. This result is anticipated in Smant (2002), who concludes that, after an initial period of lower than expected interest rates, since mid-2000 the ECB has set the policy interest rate consistent with the Bundesbank's old policy rule.[45] [46]

We explore this hypothesis further by estimating a "horse-race" type regression, where we allow the ECB to follow a rule that incorporates inflation and unemployment for both Germany and the bloc as a whole. In other words, we modify (1) to read

$$i_t^* = i_0 + \beta_{DE}\left(E_t\pi_{DE,t+1} - \bar{\pi}\right) + \gamma_{DE}E_t y_{n,t+1} + \beta_{EU}\left(E_t\pi_{EU,t+1} - \bar{\pi}\right) + \gamma_{EU}E_t y_{EU,t+1}, \quad (4)$$

where superscripts DE and EU represent Germany and the Eurozone, respectively. The resulting coefficients on inflation β_{DE} and β_{EU} are shown in Figure XI. Once we control for German inflation and unemployment, the estimated coefficient on Eurozone inflation is negative and not statistically significant from zero. In this specification, we cannot reject the hypothesis that the ECB put zero weight on Euro-wide inflation innovations that were orthogonal to German inflation. The coefficient on German inflation also declines in this horse-race regression, but we still cannot reject the hypotheses that the Taylor principle was satisfied for Germany or that the ECB put a higher weight on German inflation than on Eurozone inflation.

Certainly, the ECB has not officially adopted a Taylor rule when setting the course of its policies. But there is broad agreement and clear theoretical foundations for the notion that a central banks' interest rate policy ought to respond actively to inflation, albeit the ECB's official mandate is targeting inflation for the Eurozone as a whole. Nevertheless, our findings for ECB policy prior to November 2011 are more consistent with a central bank responding to German inflation than Eurozone inflation as a whole. To be

[45] The coefficients on the output gap (γ_n) are shown in Figure A.5 in the appendix. They paint a somewhat different picture, as they are positive for all Eurozone members other than Finland and Germany with the interpretation that the ECB does conduct countercyclical monetary policy for most Eurozone members. There is less agreement as to the necessity that the central bank responds to unemployment, nor on the value that the coefficient on unemployment should take. Given that the ECB's dominant mandate is achieving and maintaining price stability, one cannot rule out that the countercyclical nature of its policy is indeed secondary.

[46] The value of ρ_n for a number of countries (France, Greece, the Netherlands) approaches one, leading to convergence problems when estimating (3). The estimated coefficients for these countries displayed in Figure X impose the estimated autocorrelation coefficient from the Eurozone Taylor rule estimation ($\rho_{EU} = 0.42$) in estimating (3). The estimated autocorrelation coefficient in the German Taylor rule is very similar ($\rho_{DE} = 0.44$). We show later in Figure A.7 in the appendix that results are very similar when we impose a single value of ρ for all countries in the sample.

absolutely clear, our findings relate to the ECB's implicit reaction function, and do not demonstrate any explicit intent.

We conduct a number of robustness checks. First, we estimate the Taylor rule via for all countries in the sample using OLS rather than GMM. Figure A.6 in the appendix shows the coefficient on inflation for all countries. The OLS estimates are strikingly similar to those estimated via GMM. Second, estimates of policy persistence ρ_n may be biased if the ECB didn't follow a Taylor rule with respect to a country *n*, which is likely true for most individual countries in our sample. To address this, we estimated (3) imposing the autocorrelation coefficient estimated from the Eurozone's Taylor rule, i.e. $\rho_n = \rho_{EU}$ for all $n \neq EU$. Figure A.7 in the appendix shows results for all countries, with similar results again.

Coefficients for Germany' Taylor rule and that of the Eurozone as a whole are shown for a number of additional robustness checks in Figure A.8 in the appendix. Panel A of the figure shows estimates of (3) using GMM, but with current rather than expected inflation and output gaps. Panel B adds oil prices (as an additional forecasting variable) to the instrument list. In panel C, we add an additional control for ECB policy shocks. The shocks are taken from Jarocinski and Karadi (forthcoming) who use high frequency data on interest rate futures to isolate the new informational content of ECB monetary policy announcements about the path of interest rates.[47] Purging interest rates from their surprise component retains the more systematic variation in the ECB policy rate.[48] In all specifications, one cannot reject the hypothesis that the ECB was following the Taylor principle for Germany, but can reject that is doing so for the Eurozone as a whole, within standard confidence intervals. We can also reject that the weight on Eurozone inflation was higher than that on German inflation.

A different way to pose the same question is to re-construct what interest rate policy would have looked like using a Taylor rule for the Eurozone and for individual Eurozone members, and ask whether actual policy followed that path. Taylor's (1993) original rule, given by:

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[47] Jarocinski and Karadi write: "We have constructed a novel dataset of euro area high-frequency financial-market surprises along similar lines as the Gurkaynak, Sack and Swanson (2005b) data for the US. This dataset contains 284 ECB policy announcements from 1999 to 2016. Most of these announcements happen after the ECB Governing Council monetary policy meeting and consist of a press statement ECB at 13:45 followed by an hour-long press conference at 14:30. Analogously to the US, we use 30-minute windows around press statements and 90-minute windows around press conferences, both starting 10 minutes before and ending 20 minutes after the event. Whenever there is a press conference after a press statement our surprise measure is the sum of the responses in the two windows."

[48] Controlling for monetary policy surprises that are identified through financial market prices may constitute an over-control. If the ECB did in fact put an excess weight on stabilizing German inflation and this came as a surprise to market participants, these shocks would contain information about the systemic response of the ECB to German inflation.

$$i_t = \pi_t + .5y_t + .5(\pi_t - 2) + 2, \quad (5)$$

where i_t is the recommended policy rate, y_t is the output gap, and π_t is inflation. As in (1), the output gap is measured as the difference between average unemployment in the country in question and unemployment in month *t*.

Figure XII shows the evolution of the hypothetical policy rate associated with a Taylor rule for two Eurozone countries taken at a time: first Portugal and France; and then Germany and the Eurozone as a whole.[49] [50] Policy rates were far lower than the Taylor rule would have advocated for France, Portugal, and most other Euro-area economies, and indeed for the currency union as a whole until 2008. By contrast, from 1999 to the onset of the global financial crisis, the ECB followed Germany's "Taylor rule" with a remarkable degree of precision. This is most clearly demonstrated in late 2002 and early 2003, when the German economy faced a mild recession. The ECB lowered the deposit facility rate from 2.25 to 1 percent over the course of six months. (The MRO rate declined by a similar margin from 3.25 to 2 percent.) German inflation was indeed sluggish, with year on year inflation of 0.5 percent in May 2003 well below the ECB's target. But Eurozone inflation was higher, declining only to 1.8 percent and above the Bank's 2 percent target for most of this period. Greek, Spanish, and Portuguese inflation peaked at 4 percent, Italian inflation was just below 3 percent, and French inflation just at target.

As the crisis hit, the ECB became more willing to loosen policy due to conditions in the crisis countries, which in varying degrees included France, Greece, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain, as documented in Reinhart and Rogoff (2014). As a result, the policy rate followed the Eurozone Taylor rule more closely (Figure XII, last panel). By the time interest rates reached zero and went negative in 2013-2014, policy had converged to the Eurozone's estimated Taylor rule and departed substantially from Germany's.

One can plausibly argue that the break from Bundesbank-plus regime can be dated earlier, as the ECB's balance sheet nearly doubled in 2011 and the Bank created a number of lending facilities, particularly targeting the crisis countries. These included the Long Term Financing Operations (LTRO) starting in 2011, Outright Monetary Transactions starting in 2012, and Quantitative Easing, starting in 2014. While the first has provided liquidity to the banking system, the latter two allow for purchases of

[49] We report the results for France and Portugal, as these are representative of the remaining Eurozone countries (with the exception of Germany, as discussed). The Taylor rule for all the remaining Eurozone countries are not reported to economize on space but are available from the authors.

[50] Figure A.9 in the appendix shows that these hypothetical rules look very similar if we allow for policy persistence.

sovereign bonds. In 2017, the LTRO program expanded to allow banks collateralized borrowing in US dollars. That the ECB itself is providing liquidity in foreign currency is prima facie evidence of the euro's decline as an anchor currency.

Table III quantifies the visual impression arising from Figure XII. It shows the mean squared error between the ECB's policy interest rate and the counterfactual Taylor rule of a central bank following (5) for a given country *n*. The first column shows estimates from the original rule (5). The second column adapts the rule to allow interest rate persistence as in (2), with a coefficient $\rho = 0.9$. In both cases, ECB policy was far closer to Germany's counterfactual rule than that of any other Eurozone economy, including the entire Eurozone.

In summary, the Eurozone's monetary framework has evolved in two stages. The first can be characterised as a Bundesbank-plus era in roughly 1999-2011, in which the ECB provided continuity from the EERM and appears to have mimicked the policies that the Bundesbank would have conducted. The second period from 2011 to date reflect a "whatever it takes" era of zero and negative interest rates and an expanding ECB balance sheet providing financing to banks and less creditworthy sovereigns.

It is too soon to predict what the ECB's next phase will look like, with a transition in the ECB presidency this year. It is hard to imagine a return to a Bundesbank-plus model from the current juncture. The more pertinent question is whether the ECB can gain the credibility required to expand its international role. The absence of a European-wide safe asset limits the supply of euro-denominated reserves. German and Italian bonds are far from perfect substitutes: The Italian economy hasn't grown for 15 years, its banking system is teetering on the brink of collapse. With the implicit ECB guarantee to banks and sovereigns in southern Europe, the fear remains that the ECB devolves into a Banca d'Italia plus. The gap between an idealized optimal currency union and the reality of the Eurozone's economy and institutions is wide.

One can argue that eurozone monetary policy in recent years has come to do a much better job in patching up the massive holes in EU wide fiscal policy and this has likely helped stabilize the euro's position, even if it has not been nearly enough to help the euro fulfil its promise of challenging the dollar. Further progress will likely require, at a minimum, greater national political stability, and more likely entail a greater centralization of eurozone fiscal authority, which does not seem likely in the near term. Inter-central bank lending among ECB members (Target II balances) has to some extent provided a

backdoor Eurobond that has helped sustain financial stability. But this is not a long-term substitute for genuine Eurobond backed by a stronger Federal system.[51]

V. Conclusions

The euro is punching below its weight as an anchor currency and on a host of dimensions including trade invoicing, asset denomination, and central bank reserve accumulation. While there may well be a natural monopoly in anchor choice and currency denomination we suggest that there are a number of structural factors that limit the euro's appeal. At the present conjuncture, only partially a result of the Eurozone debt crisis, a central reason is the scarcity of high-quality marketable euro-denominated assets, and the general lack of liquidity compared to dollar debt markets. But we have also pointed to other deeper-seated factors. The fact the continent does not boast a financial center of the calibre of New York or London can be traced to taxation issues and, perhaps even more durably, advantages of the Anglo-Saxon legal system for finance that La Port, Lopez de Silanes and Shleifer (1998) have emphasized. Then there is the matter of the EU's limited geopolitical reach, which is in part due to its military dependence on the United States. Last but not least, with the future of finance intimately linked to technology, Europe's secondary role in technology research (behind the United States and China) is also a long-run limitation.

Interestingly, over the near term, the relative international role of the euro may be determined far from Europe itself, particularly in East Asia. In December 2015, the People's Bank of China announced that it is moving from a US dollar to anchor to a broader basket of currencies.[52] It is too early to determine how these exchange rate practices will evolve, but the euro's role may expand substantially by many of the metrics explored in this paper if China does indeed put a larger weight on the European currency. The share of world GDP anchored to the euro could increase to 21 percent and central bank reserves in euros may increase. It is less clear whether the private sector will follow suit in its denomination of trade and asset holdings. The shortage of safe euro-denominated assets that we document in this paper will pose a challenge to portfolio diversification aims of both private and official actors.

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[51] The role of Target II has and whether it been debated it past volumes of this journal. For example, Whelan (2017) writes that "there is also evidence that portfolio rebalancing by Spanish and Italian banks and investors (which has seen them sell domestic sovereign bonds to the Eurosystem and relocate their money into foreign assets) has also played an important role." See also Whelan (2012).

[52] This basket is less diverse in practice than in theory. Many of the currencies in the basket (e.g. the Hong Kong dollar and the Malaysian ringgit) are themselves anchored to the dollar, so that the dollar is still the largest currency in the basket by a substantial margin.

The move to greater renminbi flexibility is a double-edged sword for the international role of the euro. Chinese authorities are making efforts internationalize the renminbi. Given the size of the Chinese economy, a freely floating renminbi could overtake euro as the world's second anchor currency virtually overnight. If other currencies follow suit, or are already latently anchored to the renminbi, this bloc would substantially overshadow the euro bloc.

Closer to home, we have also highlighted the potential role of the ECB in providing clarity on the nature of the euro anchor. We suggest that early ECB monetary policy was an extension of the Bundesbank's pre-1999 policies. During the Eurozone crisis the very future of the currency was on the brink and the ECB became bolder and resorted to a wide range of policies to bolster the European economy. If the *Bundesbank-plus* regime was "one size fits one", the *Whatever it Takes* regime may be "one size fits none". This problem has no easy solution without significant institutional changes. Exacerbating these challenges is that Europe has increasingly come to rely on quasi-fiscal financing from the ECB through its quantitative easing policies (which in effect may be regarded as second-best substitute for a euro-bill) and its direct support for private sector bank lending (which again involves cross-national subsidies and directed lending choices that might ordinarily be the province of fiscal authorities) Given the lack of a European-wide fiscal authority, the ECB fulfils its mandate to the best of its ability, but its quasi fiscal tools are limited. The future prospects of the euro as an international (and even regional) currency depend on how European policymakers and the ECB rise to these challenges in the euro's third decade.

References

Ahamed, Liaquat, Lords of Finance: The Bankers Who Broke the World. (New York, NY: The Penguin Press, 2009).

Bacchetta, Philippe and Eric van Wincoop, "A Theory of the Currency Denomination of International Trade," Journal of International Economics 67: 295-319, 2005.

Bahaj, Saleem, and Ricardo Reis, "Central Bank Swap Lines," Mimeo, 2019.

Batten, Jeremy and Peter Szilagyi, "The Internationalization of the RMB: New Starts, Jumps and Tipping Points," Swift Institute Working Paper 2012-001.

Battistini, Nicolò, Marco Pagano, and Saverio Simonelli, "Systemic risk, Sovereign Yields and Bank Exposures in the Euro Crisis," Economic Policy 29(78), 203-251, 2014.

Bergsten, Fred, "The Dollar and the Euro," Foreign Affairs 76, 83–95, 1997.
Blustein, Paul, Laid Low: Inside the Crisis That Overwhelmed Europe and the IMF, (Waterloo, Ontario: CIGI Press, 2016)

Bruno, Valentina and Hyun Song Shin, "Global Dollar Credit and Carry Trades: a Firm-Level analysis," BIS Working Papers No. 510, 2015.

Cabellero, Ricardo, Emmanuel Farhi and Pierre-Olivier Gournchas, "The Safe Assets Conundrum," Journal of Economic Perspectives 31, 29-46, 2017.

Calvo, Guillermo A. and Carlos A. Vegh, "Inflation Stabilization and BOP Crises in Developing Countries," in John B. Taylor and Michael Woodford eds. Handbook of Macroeconomics, edition 1, volume 1, chapter 24, 1531-1614 (Elsevier, 1999).

Chalmers, Robert, A History of Currency in the British Colonies, p. 371. (London: Eyre and Spottiswoode, 1893). Cf. pp. 391-394.

Cimadomo Jacopo, Sebastian Hauptmeier, Alessandra Anna Palazzo and Alexander Popov, "Risk Sharing in the Euro Area," European Central Bank, ECB Economic Bulletin, Issue 3 / 2018.

Clarida, Galí, and Gertler, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," Quarterly Journal of Economics 115(1), 147-180, 2000.

Coibion, Olivier, and Yuriy Gorodnichenko, "Monetary Policy, Trend Inflation and the Great Moderation: An Alternative Interpretation," American Economic Review 101, No 1, 341-70, 2011.

Cook, Samantha, and Kimmo Soramäki, "The Global Network of Payment Flows," The Journal of Network Theory in Finance, 2, 21–52, 2015.

Coeuré, Benoit, "Should the ECB Care about the Euro's Global Role?" Voxeu February 25, 2019.

Denzel, Markus, A., Handbook of World Exchange Rates, 1590-1914. (London: Ashgate, 2010).

Dooley, Michael, David Folkerts-Landau and Peter Garber, "An Essay on the Revived Bretton Woods System," NBER Working Paper 9971, 2003

Eichengreen, Barry, Exorbitant Privilege: The rise and fall of the Dollar and the Future of the International Monetary System. (Oxford, UK: Oxford University Press, 2011).

Eichengreen, Barry, Arnaud Mehl, and Livia Chiţu, How Global Currencies Work: Past, Present, and Future, (Princeton, NJ: Princeton University Press, 2017).

Eichengreen, Barry, Arnaud Mehl and Livia Chiţu, "Mars or Mercury? The Geopolitics of Internaitonal Currency Choice" Economic Policy, forthcoming.

Emmanuel Farhi and Matteo Maggiori, "A Model of the International Monetary System," The Quarterly Journal of Economics, 133(2018), 295-355.

European Central Bank, The International Role of the Euro, June 2019.

Faudot, Adrien and Jean-François Ponsot, "The Dollar Dominance: Recent Episode of Trade Invoicing and Debt Issuance," Journal of Economic Integration, 31, 41-64, 2016.

Feldstein, Martin, "EMU and International Conflict," *Foreign Affairs* 76, pp. 60–73, 1997.
Feldstein, Martin, "The Failure of the Euro," Foreign Affairs, January/February 2012.

Fratzscher, Marcel and Arnaud Mehl, "China's Dominance Hypothesis and the Emergence of a Tri-Polar Global Currency System," European Central Bank Working Paper No. 1392, 2011.

Goldberg, Linda S. and Tille, Cédric, "Vehicle Currency Use in International Trade," Journal of International Economics 76, 177-192, 2008.

Gopinath, Gita, "The International Price System," Jackson Hole Symposium (Federal Reserve Bank of Kansas City, 2015).

Gopinath, Gita, and Jeremy Stein, "Banking, Trade, and the Making of a Dominant Currency," NBER Working Paper Series, 24485, 2018.

Hassan, Tarek A., Thomas M. Mertens and Tony Zhang, "Currency Manipulation," Mimeo, University of Chicago, 2016.

He, Zhiguo, Arvind Krishnamurthy, and Konstantin Milbradt, "A Model of Safe Asset Determination," American Economic Review 109: 1230–1262, 2019.

Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth Rogoff, "Country Chronologies and Background Material to Exchange Rate Arrangements into the 21st Century: Will the Anchor Currency Hold?," NBER Working Paper No 23135, 2017.

Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth Rogoff, "Exchange Arrangements Entering the 21st Century: Which Anchor Will Hold?" Quarterly Journal of Economics 134 (2): 599-646, 2019.

Ize, Alain and Levy-Yeyati, Eduardo, "Financial Dollarization," Journal of International Economics 59: 323-347, 2013.

Jarocinski, Marek and Peter Karadi, "Deconstructing Monetary Policy Surprises—The Role of Information Shocks," American Economic Journal: Macroeconomics, forthcoming.

Klein, Michael and Jay Shambaugh, Exchange Rate Regimes in the Modern Era, (Cambridge, MA: MIT Press, 2010).

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer, "Law and Finance," Journal of Political Economy 106 (No. 1): 1113-1155, 1998.

Levy-Yeyati, Eduardo, and Federico Sturzenegger, "Classifying Exchange Rate Regimes: Deeds vs. Words," European Economic Review 49: 1603-1635, 2015.

Levy-Yeyati, Eduardo and Federico Sturzenegger, "Classifying Exchange Rate Regimes: Fifteen Years Later," Center for International Development Working Paper 319, 2016.

Maggiori, Matteo, Brent Neiman, and Jesse Schreger, "The Rise of the Dollar and Fall of the Euro as International Currencies," AEA Papers and Proceedings 109: 521-26, 2019.

Maggiori, Matteo, Brent Neiman, and Jesse Schreger, "International Currencies and Capital Allocation," Journal of Political Economy, forthcoming.

Merler, Silvia and Jean Pisani-Ferry, "Who's Afraid of Sovereign Bonds," Bruegel Policy Contribution 2012/02, February 2012.

Mody, Ashok, EuroTragedy: A Drama in Nine Acts, (Oxford, UK: Oxford University Press, 2018)

Organization for Economic Cooperation and Development, "OECD Science, Technology and Innovation Outlook 2019," Paris OECD (November 2018)

Portes, Richard and Hélène Rey "The Emergence of the Euro as an International Currency," Economic Policy 26: 305-343, 1998.

Prasad, Eswar, The Dollar Trap: How the U.S. Dollar Tightened Its Grip on Global Finance, (Princeton, NJ: Princeton University Press, 2015).

Prasad, Eswar, Gaining Currency: The Rise of the Renminbi, (Oxford, UK: Oxford University Press, 2016).

Raposo, Inês Gonçalves and Alexander Lehmann, "Equity Finance and Capital Market Integration in Europe," Bruegel Policy Contribution 3, January 2019.

Reinhart, Carmen M., Kenneth S. Rogoff, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," Quarterly Journal of Economics 119, 1-48: 2004.

Reinhart, Carmen M, and Kenneth S Rogoff, "Recovery from Financial Crises: Evidence from 100 Episodes," American Economic Review: Papers and Proceedings 104 (5): 50-55, 2014.

Reinhart, Carmen M., Kenneth S. Rogoff and Miguel A. Savastano , "Addicted to Dollars," Annals of Economics and Finance, 15: 1-52, 2004.

Reinhart, Carmen M., Jacob F. Kirkegaard, and M. Belen Sbrancia, "Financial Repression Redux," *Finance and Development*, pp. 22-26, June 2011.

Rey, Hélène, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," in Jackson Hole Symposium (Federal Reserve Bank of Kansas City, 2013).

Rogoff, Kenneth, The Curse of Cash, (Princeton: Princeton University Press, 2016).

Schmelzing, Paul. "56 Years of Safe Asset Cycles," chapter 2, Harvard Doctoral Dissertation *Essays on Long-Term Real Rate and Safe Asset Trends: 1311-2018*, 2019.

Shambaugh, Jay C., "The Effect of Fixed Exchange Rates on Monetary Policy", Quarterly Journal of Economics, 119: 301-352, 2004.

Smant, David JC, "Has the European Central Bank followed a Bundesbank policy? Evidence from the early years," Kredit und Kapital 3(3): 327-343, 2002.

Strange, Susan, Sterling and British Policy, (London: Oxford University Press, 1971).
Swoboda, Alexander, "Vehicle Currencies and the Foreign Exchange Market: the Case of the Dollar," in Robert Z. Aliber, ed. The International Market for Foreign Exchange, Praeger Special Studies in International Economics and Development. (New York: Frederick A. Praeger, 1969).

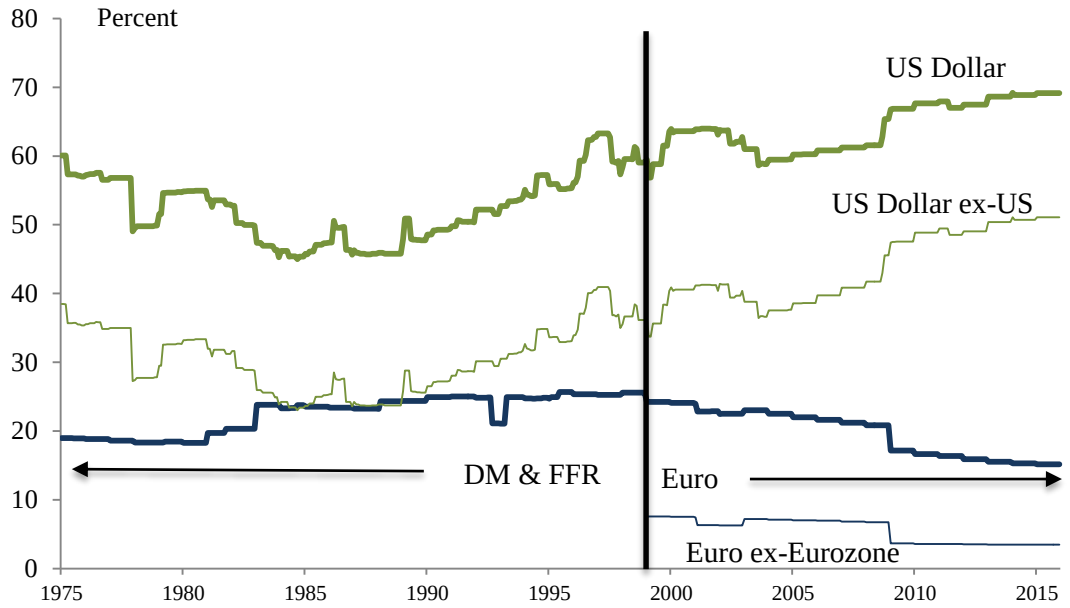
Taylor, John B., "Discretion Versus Policy Rules in Practice," Carnegie-Rochester conference series on public policy. Vol. 39, 1993. North-Holland.

Whelan, Karl, "TARGET2 and Central Bank Balance Sheets," Economic Policy, 29(77), 79-137, 2014.

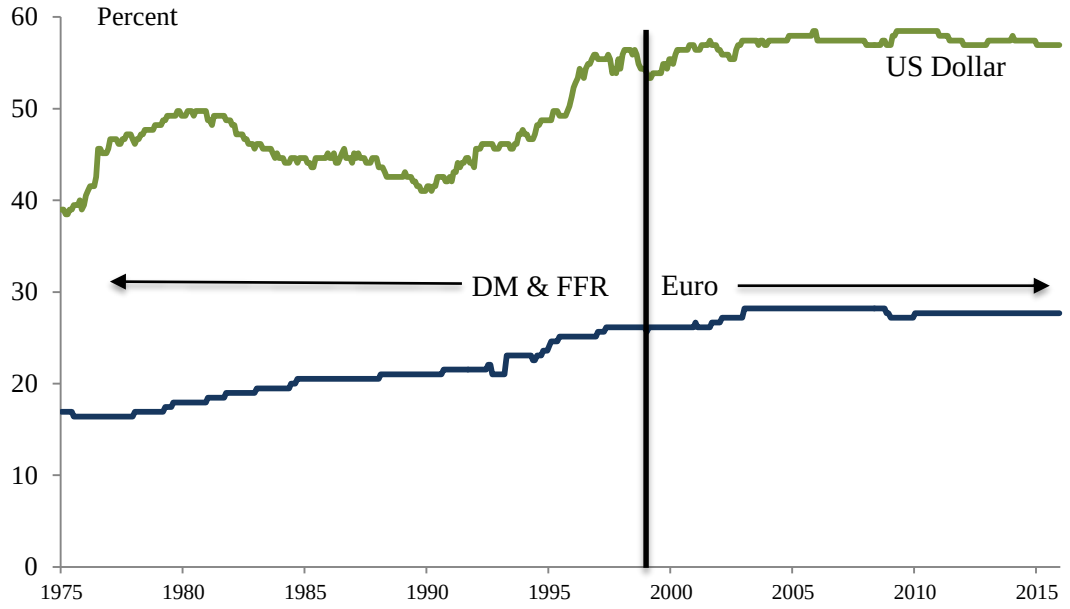
Whelan, Karl, "Should We Be Concerned About TARGET Balances?" European Parliament Monetary Dialogue, November 2017.

Figure I. Evolution of Anchor Currencies: Dollar and Euro

Number of countries weighted by their share in world GDP, 1975-2015



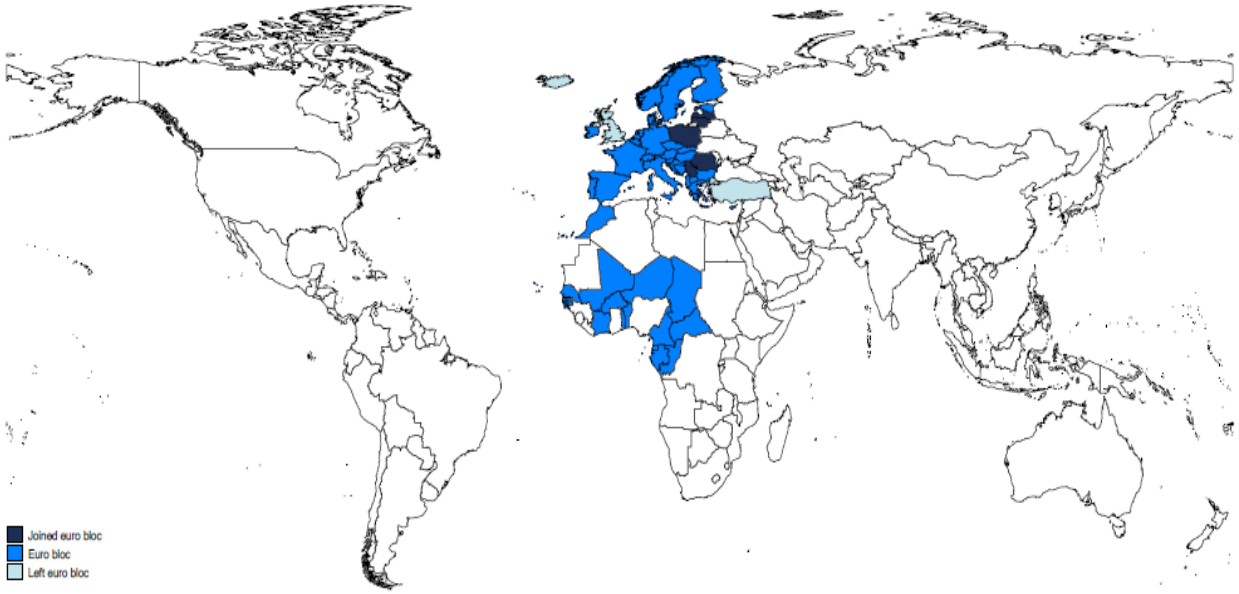
Number of countries 1975-2015



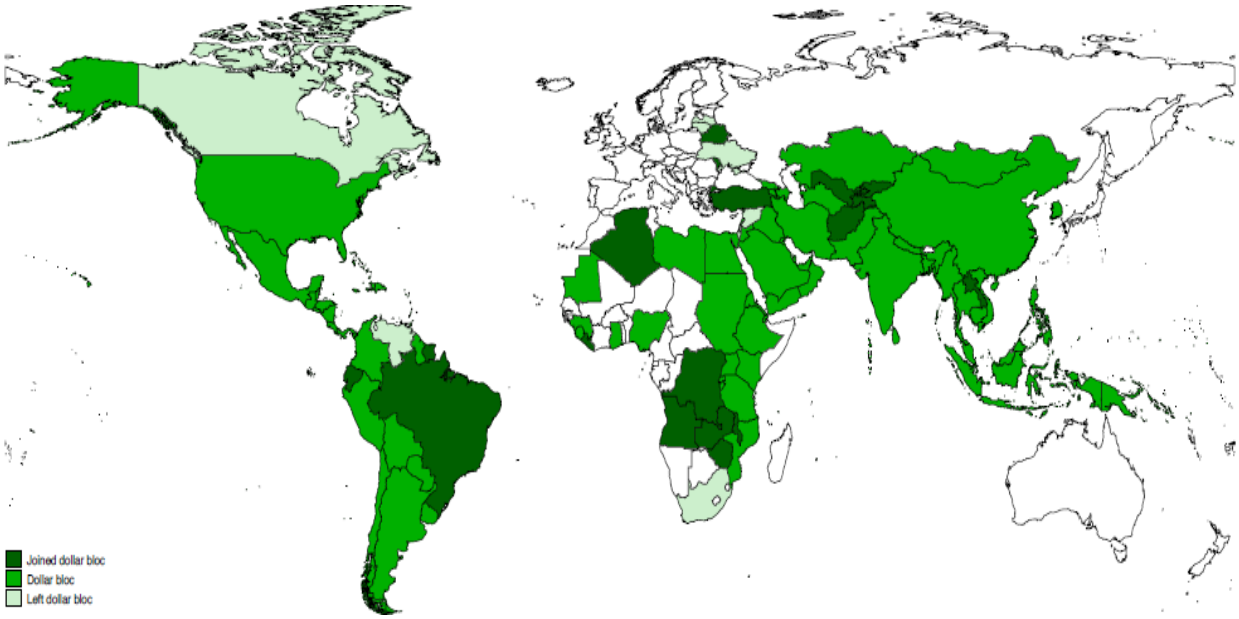
Note: The figure shows the share of countries anchored to the US dollar (top, green line) and to the euro (post 1999) and German Deutschemark and French Franc (pre 1999) (bottom, blue line). The thin lines exclude the US from the dollar bloc and current Eurozone members from the euro bloc. The top panel weighs the anchored countries by their share in world GDP. The bottom panel gives an unweighted measure. The vertical lines show the date of euro adoption. Sources: Reinhart and Rogoff (2004), Ilzetzki, Reinhart, and Rogoff (2019), and the authors.

Figure II. Countries with Euro (top) and US Dollar (bottom) Anchors, 1999 and 2016

Euro Anchors

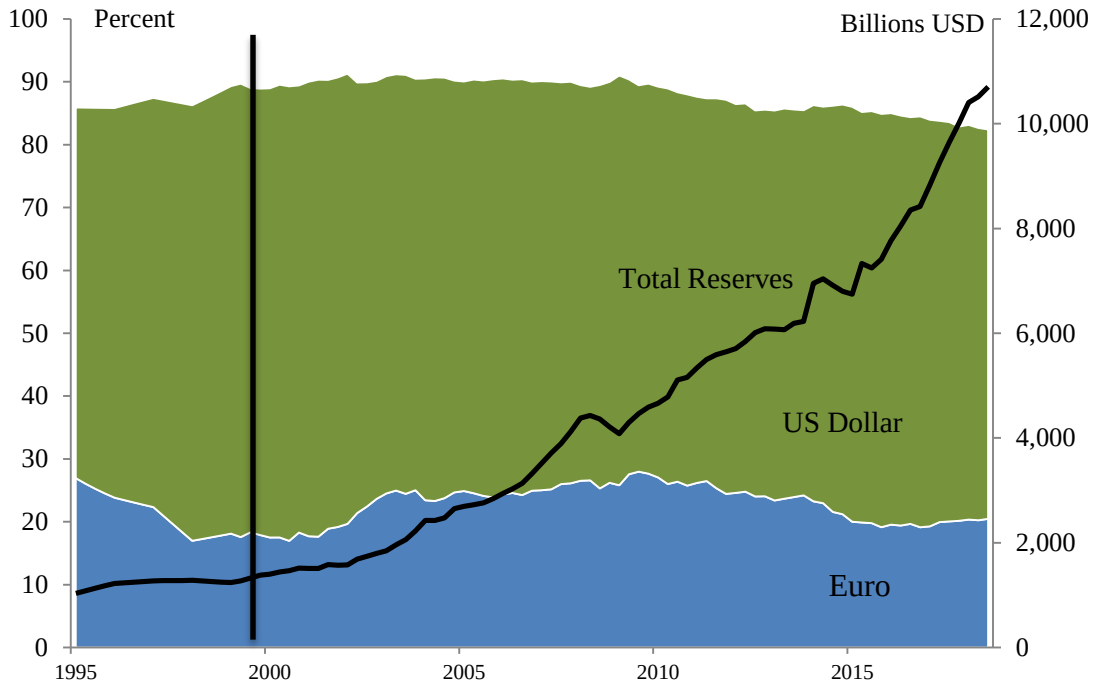


Dollar Anchors



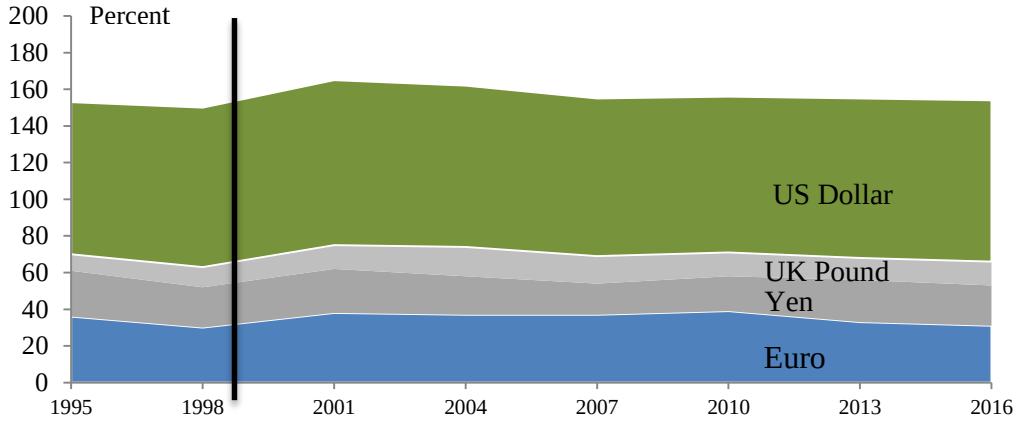
Note: The maps show countries whose currencies were anchored to the euro (top panel) and the US dollar (bottom panel). Brightly-shaded countries were anchored in both 1999 and 2016. Dark shades represent countries that were anchored in 2016, but not in 1999 (joined the bloc). Pale shades represent countries that were anchored in 1999, but not in 2016 (departed from the block). Sources: Reinhart and Rogoff (2004), Ilzetzki, Reinhart, and Rogoff (2019), and the authors.

Figure III. Currency Composition of Central Bank Reserves: Dollar and Euro, 1995-2018



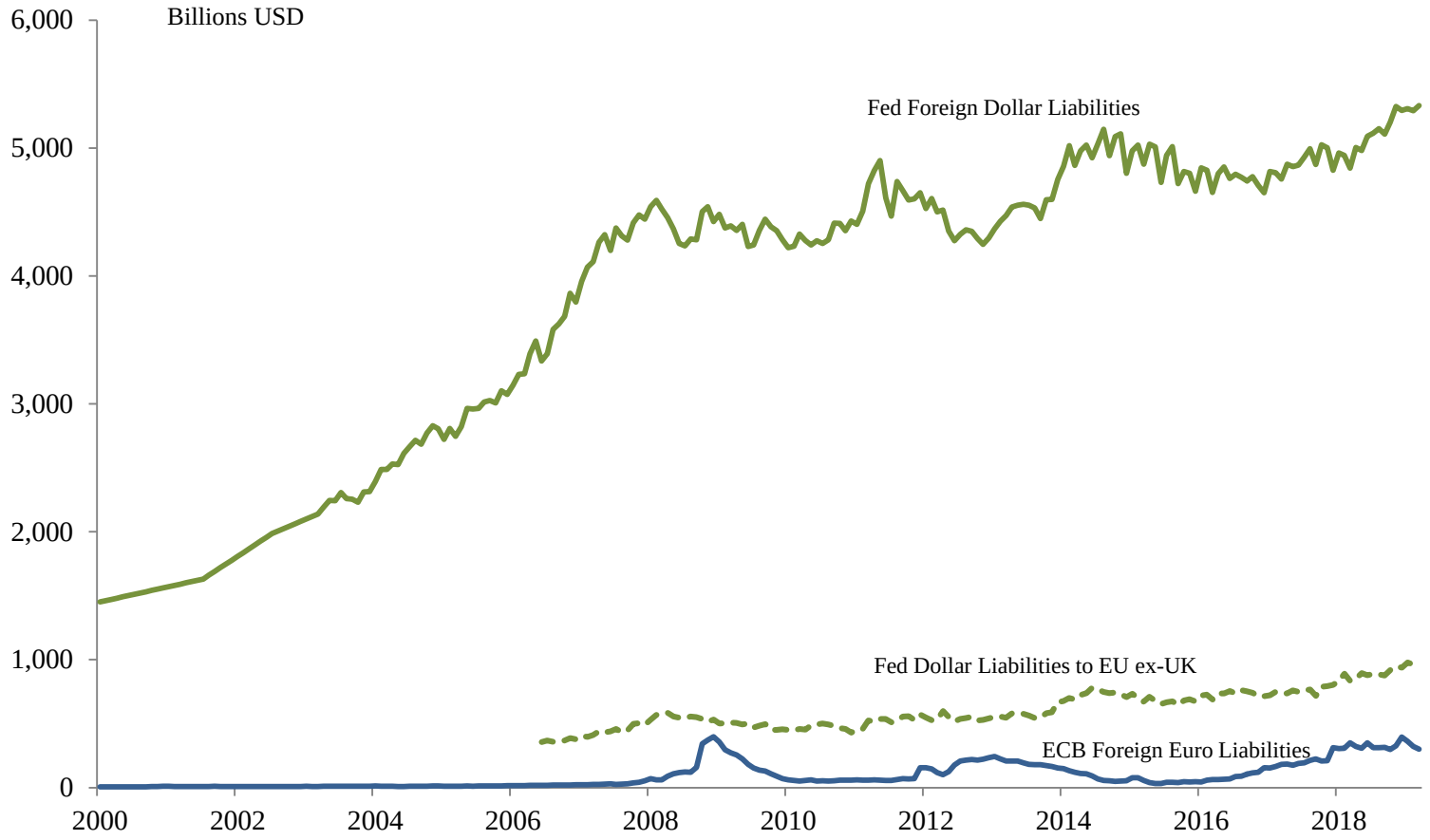
Note: The figure shows the share of allocated central bank reserves denominated in euro (bottom, blue) and dollar (top, green; both left-hand axis). The line (right-hand axis) shows total world central bank allocated reserves in billions of US dollars. The vertical line shows the date of euro adoption. Prior to euro adoption, "euro" reserves are replaced with reserves denominated in Deutschemarks, French francs, Dutch guilder, and ECU, so that the figure slightly understates total Eurozone reserves before 1999. Source: International Monetary Fund's *Currency Composition of Official Foreign Exchange Reserves* and the authors.

Figure IV. Foreign Exchange Turnover: Shares of Major Currencies, 1995-2016



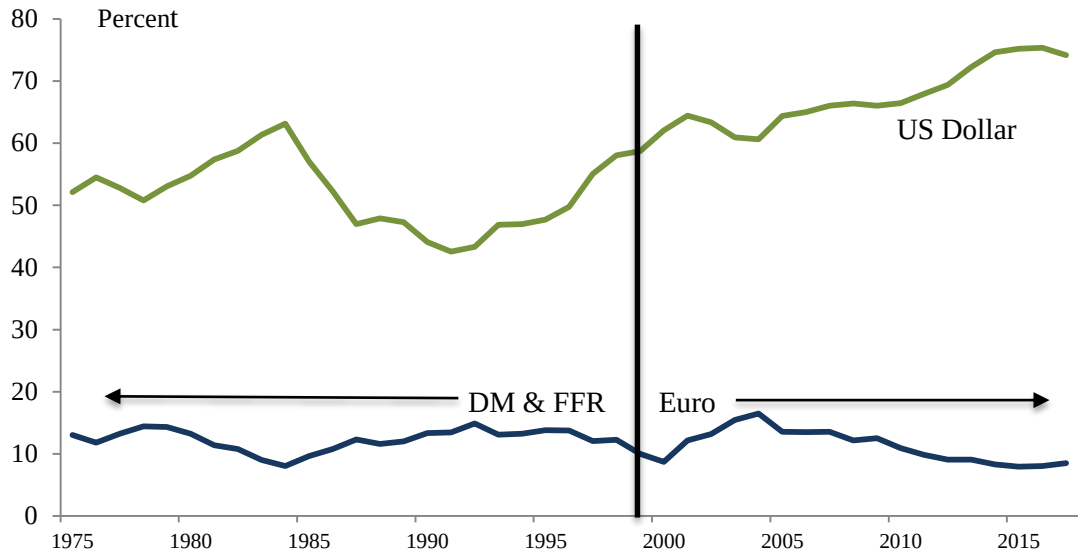
Note: The figure shows the share of foreign exchange transactions in which each of presented currencies was one side of the transaction. The euro is replaced by the Deutschemark prior to 1999. On one hand this understates the share of pre-1999 Eurozone transactions, because it excludes all Eurozone economies other than Germany. On the other hand it overstates this share because it counts trans-national intra-Eurozone transactions. Source: Bank for International Settlements *Triennial Survey of FX and OTC derivatives trading*.

Figure V. Federal Reserve Dollar Liabilities to non-US residents and ECB Euro Liabilities to non-Eurozone Residents



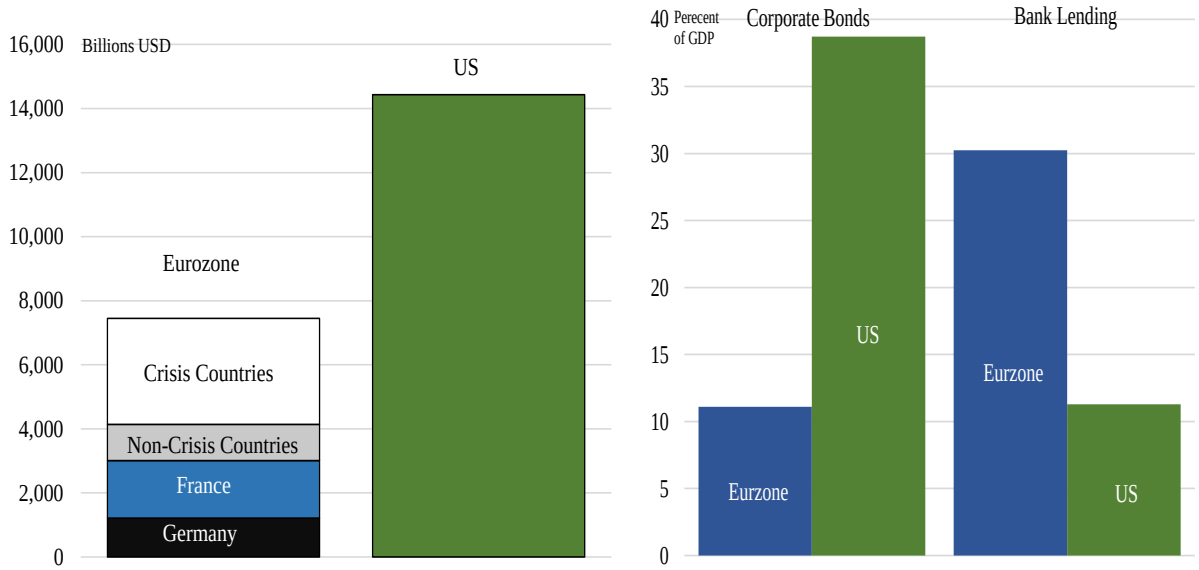
Note: The top line shows the total liabilities of the Federal Reserve to non-US residents (Source: Federal Reserve Bank of New York), January 2000 to March 2019. The dotted line shows the liabilities held by residents of the EU excluding the UK. The bottom line shows the liabilities of the European Central Bank to non-Eurozone residents (Source: ECB). Euro liabilities were converted to dollars at current market exchange rates.

Figure VI. Borrowing in Euros and Dollars: Developing Country Public Debt



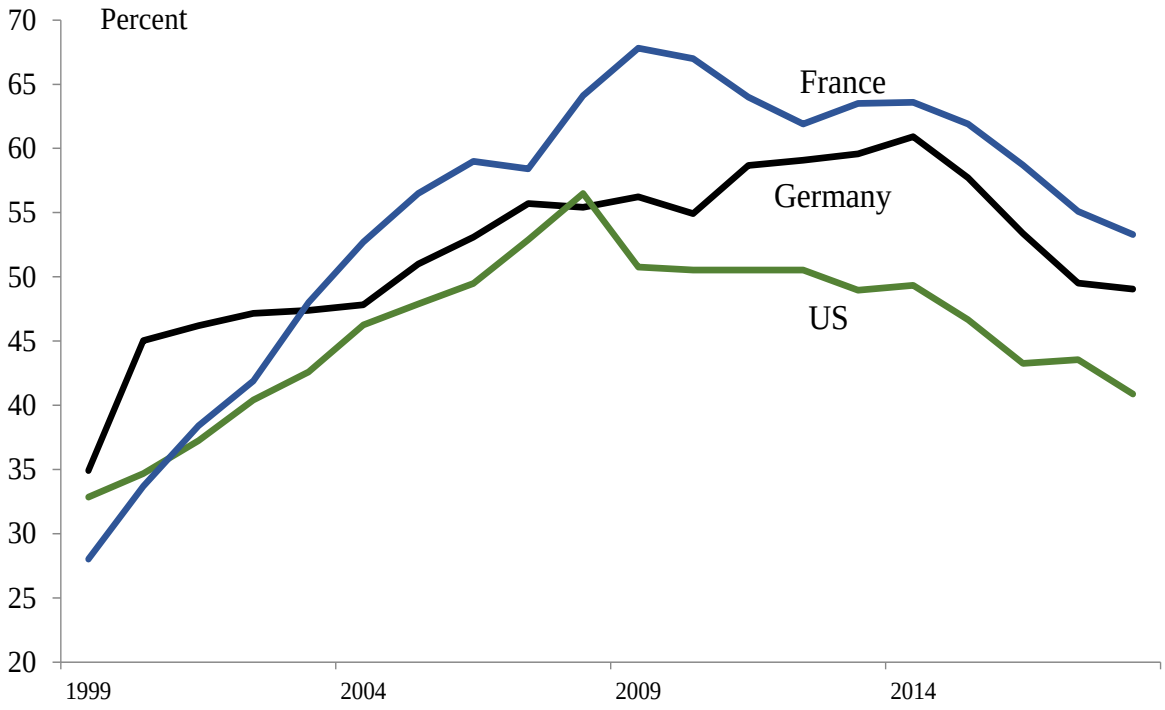
Note: The figure shows the share of developing countries' external public and publicly guaranteed debt denominated in dollars (top, green line) and to the euro (post 1999) and German Deutschemark and French Franc (pre 1999) (bottom, blue line) as a share of total foreign currency denominated external debt. Source: World Bank *International Debt Statstics*.

Figure VII. Marketable Debt Outstanding, 2018



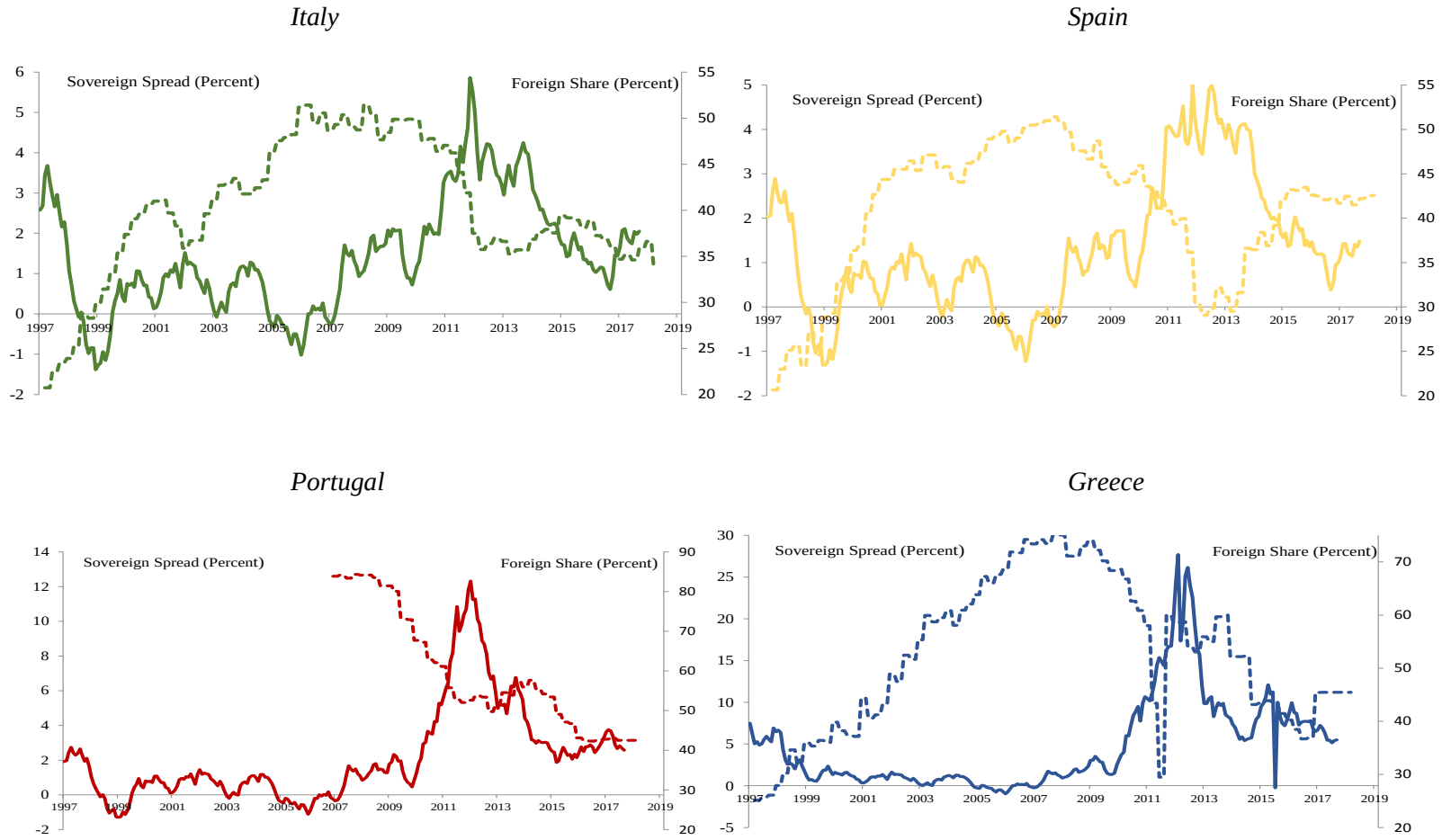
Note: The left panel shows the marketable central government outstanding in billions of US dollars in 2018 for Eurozone countries and the US. Eurozone economies are divided into Germany, France, other non-crisis countries, and the crisis countries. Sources: US Treasury, L'Agence France Trésor, and Finanzagentur GmbH. The right-hand panel shows corporate bonds outstanding and total corporate bank lending as a percent of GDP in the Eurozone and the US. Sources: Federal Reserve Board, Bureau of Economic Analysis, European Central Bank, and authors' calculations.

Figure VIII. Foreign Holdings as a Share of Marketable Government Debt, 1999-2018



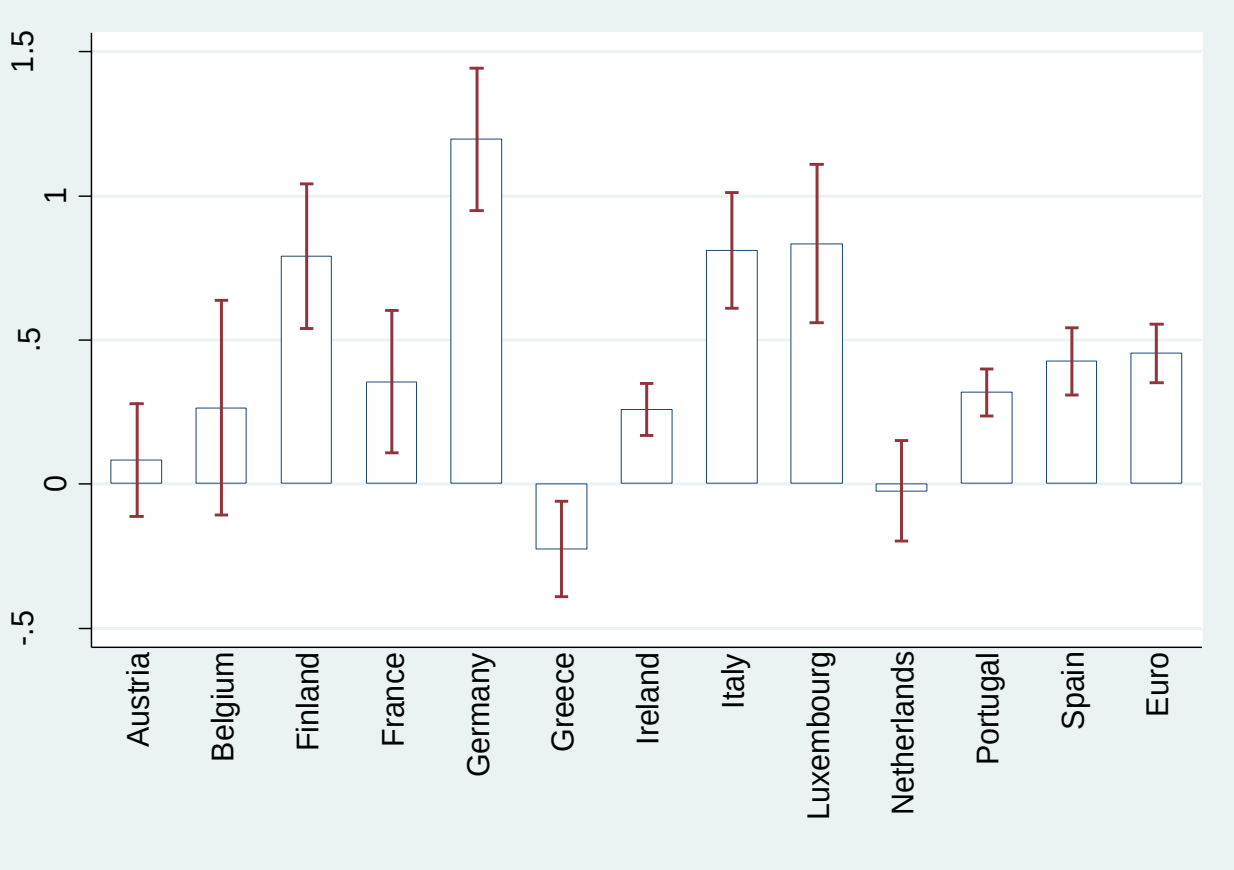
Note: The figure shows the percent share of marketable government that is held by foreign investors (private and official sectors) for the US, Germany and France. Sources: US Treasury, the Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012), and the authors.

Figure IX. Sovereign Spreads and Foreign Holdings as a Share of Marketable Gov. Debt, 1997-2018



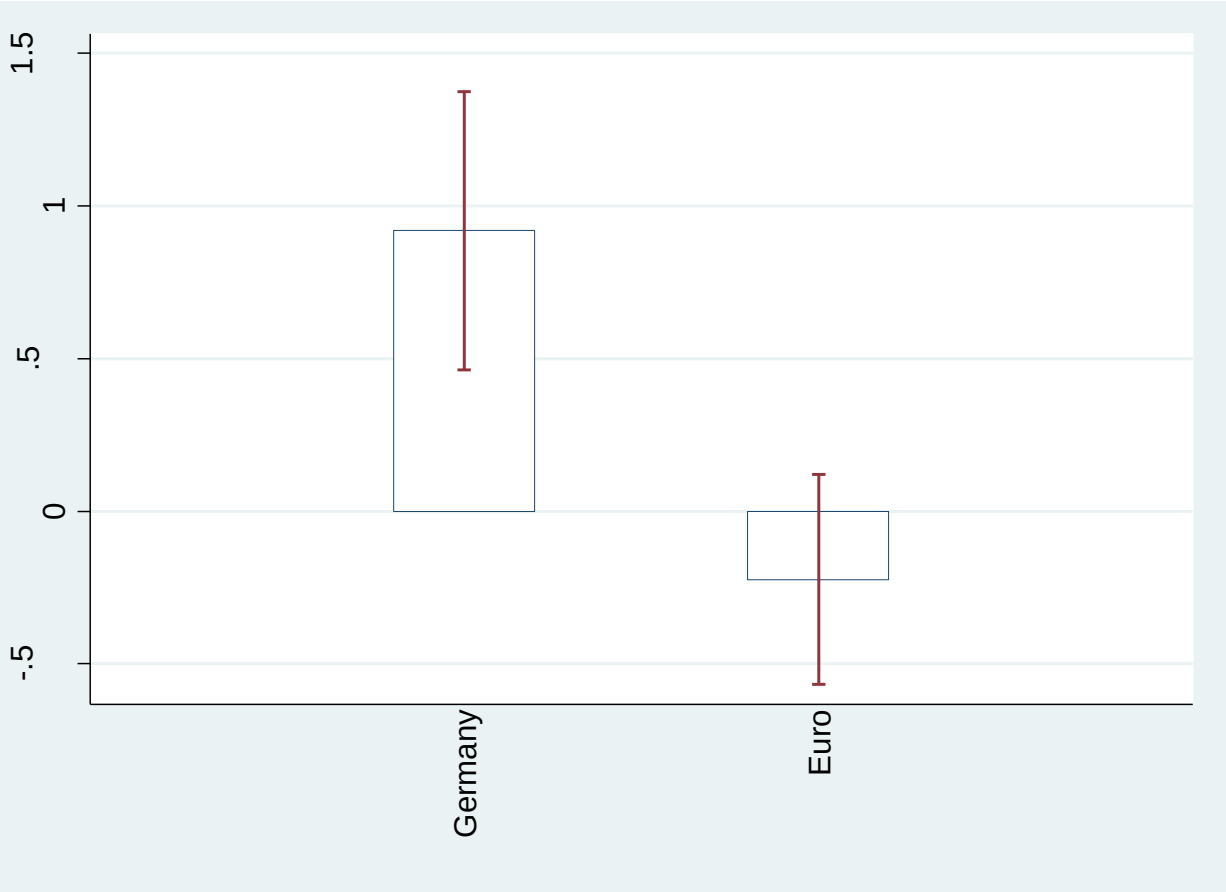
Note: The figure shows the percent share of marketable government that is held by foreign investors (private and official sectors, dashed lines, right-hand axis) and the spread of the 10 year bond of the country in question over Germany's (left-hand axis). Panels are for (clockwise from top left-hand panel) Italy, Spain, Greece, and Portugal, 1997-2018. Sources: Eurostat, the Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012), and the authors.

Figure X. Taylor Rule Coefficients for Euro-Area Economies estimated via GMM, 2000-2014: Inflation



Note: The figures give the Taylor rule coefficients for Euro-area economies and the Eurozone deriving from an estimate of the following equation via GMM with 6 monthly lags of inflation and unemployment as instruments: $i_t = \alpha_n + \rho_n i_{t-1} + (1-\rho_n)\left(\beta_n E_t \pi_{n,t+1} + \gamma_n E_t y_{n,t+1}\right) + \varepsilon_{t,n}$. The coefficients β_n are displayed as bars with 95% confidence intervals given with whiskers. $\beta_n > 1$ only for Germany.

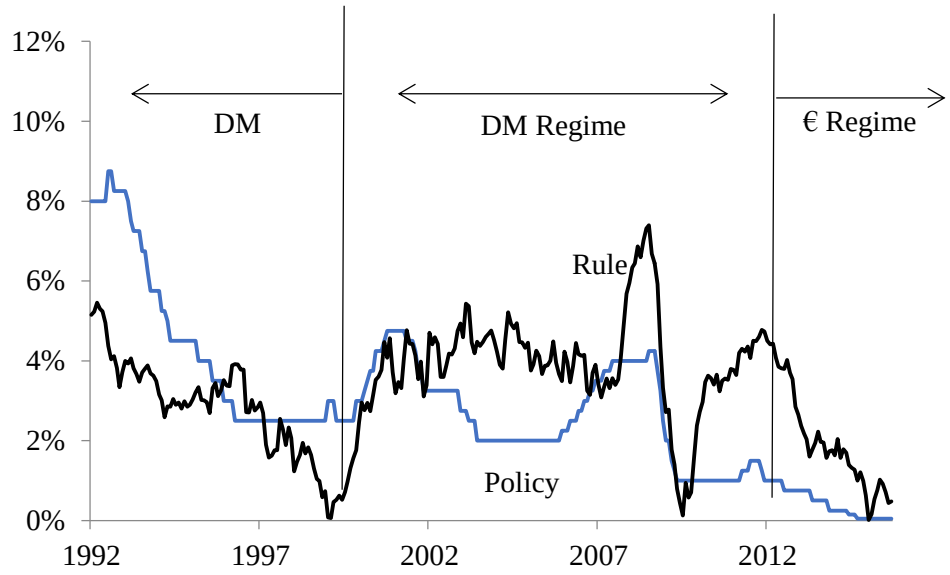
Figure XI. Horse Race between German and Eurozone Taylor Rules, 2000-2014: Inflation Coefficients



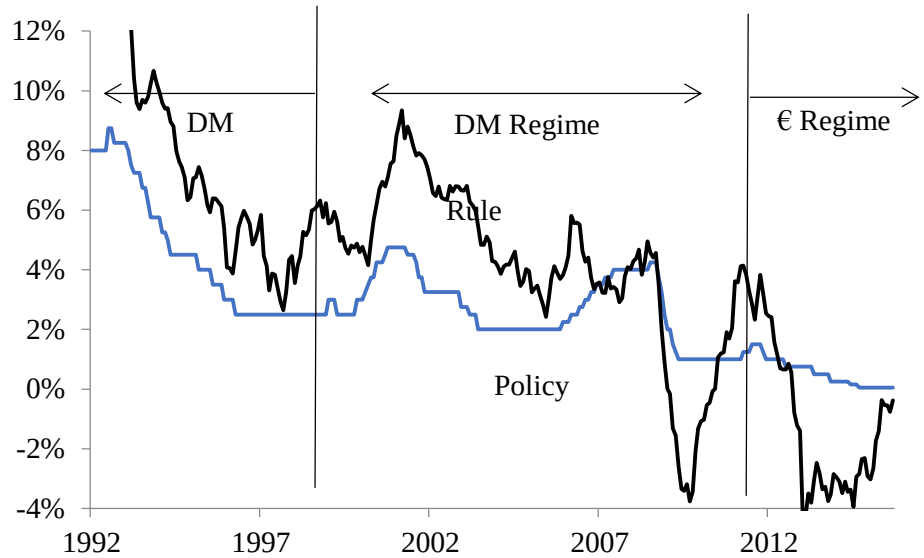
Note: The figures give the inflation coefficients for a Taylor rule that combines both German and Eurozone infaltion: $i_t = \alpha_n + \rho_n i_{t-1} + (1-\rho_n)\left(\beta_{DE}E_t\pi_{DE,t+1} + \gamma_{DE}E_t y_{n,t+1} + \beta_{EU}E_t\pi_{EU,t+1} + \gamma_{EU}E_t y_{EU,t+1}\right) + \varepsilon_{t,n}$. Estimates are via GMM with 6 monthly lags of inflation and unemployment as instruments. The coefficients β_{DE} and β_{EU} are displayed as bars with 95% confidence intervals given with whiskers.

Figure XII. Taylor Rule versus Central Bank Policy Rate, 1992-2015

France



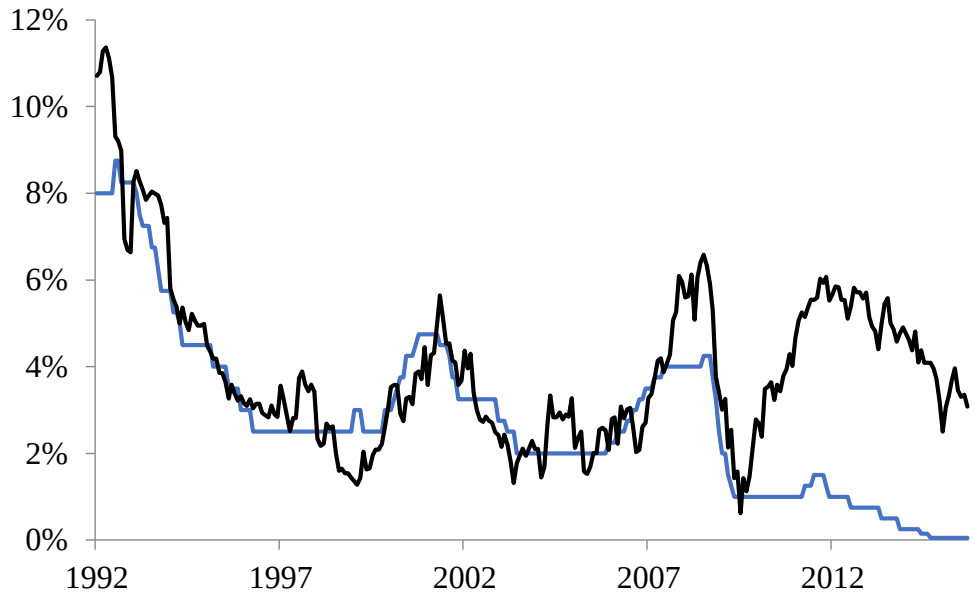
Portugal



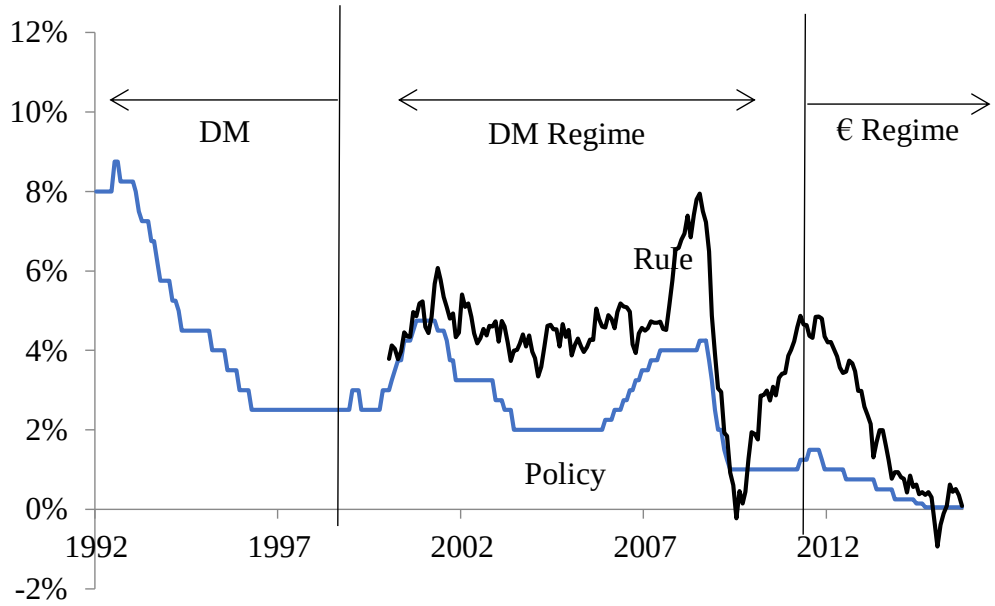
Note: the figure shows (in black) the interest rate policy that would result if a central bank followed a Taylor rule, using Taylor's (1993) original coefficients and specification, for the country in question. The original rule is given by $i_t = \pi_t + .5y_t + .5(\pi_t - 2) + 2$. This is compared with the ECB's policy rate, in blue, replaced by the Bundesbank's rate prior to 1999. Sources: Eurostat, International Monetary Fund, OECD, and the authors.

Figure XII (cont.) Taylor Rule versus Central Bank Policy Rate, 1992-2015

Germany



Eurozone



Note: the figure shows (in black) the interest rate policy that would result if a central bank followed a Taylor rule, using Taylor's (1993) original coefficients and specification, for the country in question. The original rule is given by $i_t = \pi_t + .5y_t + .5(\pi_t - 2) + 2$. This is compared with the ECB's policy rate, in blue, replaced by the Bundesbank's rate prior to 1999. Sources: Eurostat, International Monetary Fund, OECD, and the authors.

Table I. Markers of an Anchor Currency: Comparing the Dollar and the Euro

Indicator	US/Dollar	Eurozone/Euro
Share of Countries Anchored	59	29
Share of World GDP Anchored	69	15
Share of World Reserves	64	21
Share of Developing Country External Debt	74	8
Share of Bank Assets in Local Currency	85	71
Share of Bank Liabilities in Local Currency	76	59
Trade Invoicing Index	69	56 [53]
Share of World GDP	**18**	**12**
Share of World Exports	**9**	**26** [54]

[53] The euros's trade invoicing index would be smaller, and the dollar's higher, if adjusted to exclude intra-Eurozone trade. If all intra-Eurozone trade is invoiced in euros, the dollar index would come to roughly 75 and the euro index would decline to below 50 under this adjustment.

[54] This figure may overstate the gap between US and Eurozone trade, as the latter includes intra-Eurozone trade. A rough estimate of the Eurozone's exports to the rest of the world is still nearly twice the US share. Source: Eurostat balance of payments statistics and the WTO.

Table II. Market Capitalization and Volume of Major Stock Exchanges, December 2018

Exchange	Market Capitalization ($ Billion US)	Monthly Trade Volume ($ Billion US)
Total US	**33,780**	**2,714**
NY Stock Exchange	22,923	1,452
NASDAQ	10,857	1,262
Total Eurozone	**7,329**	**356**
Euronext	3,927	174
Deutche Borse (Frankfurt)	1,864	140
Borsa Italiana (Milan)	610	-
other Eurozone	928	42
Total China (incl. HK)	**10,143**	**888**
Shanghai	3,919	325
Hong Kong	3,819	120
Shenzhen	2,405	443
Japan	**5,296**	**482**
UK (London Stock Exchange)	**3,027**	**166**

Note: The table gives the total market capitalization as of December, 2018 and the monthly trade volume during that month in billions of US dollars. Sources: World Federation of Exchanges and London Stock Exchange Group.

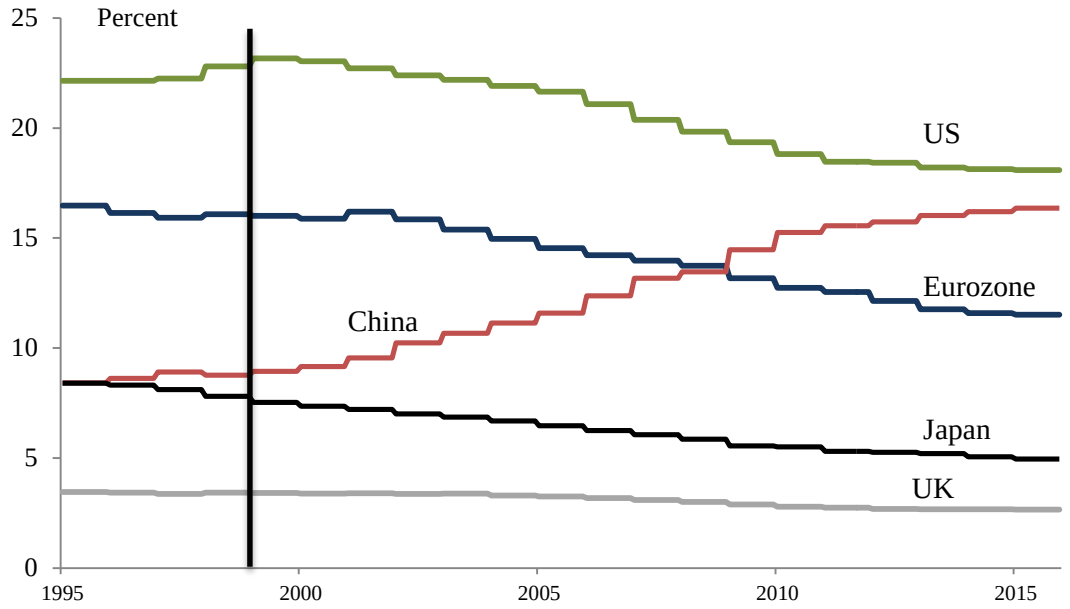
Table III. Mean Squared Error between ECB Policy Rate and Counterfactual Taylor Rule.

Country	$\rho = 0$	$\rho = 0.9$
Austria	3.71	3.45
Belgium	6.25	6.03
Finland	7.14	6.71
France	3.45	3.55
Germany	2.30	2.14
Greece	10.91	11.40
Ireland	33.58	33.34
Italy	6.06	6.04
Luxembourg	3.41	3.07
Netherlands	5.32	5.60
Portugal	6.18	6.36
Spain	19.11	19.03
Euro	4.02	4.03

Note: The table gives the Mean Squared Error between the ECB's policy rate and a counterfactual interest rate if a central bank had followed a Taylor rule for the country in question from January 1999 to October 2011. Mario Draghi began his tenure as ECB President in November 2011. The counterfactual Taylor rule is estimated using the original Taylor (1993) formula, $i_t = \pi_t + .5y_t + .5(\pi_t - 2) + 2$. The second column augments this Taylor rule to allow interest rate persistence with an autocorrelation coefficient of 0.9.

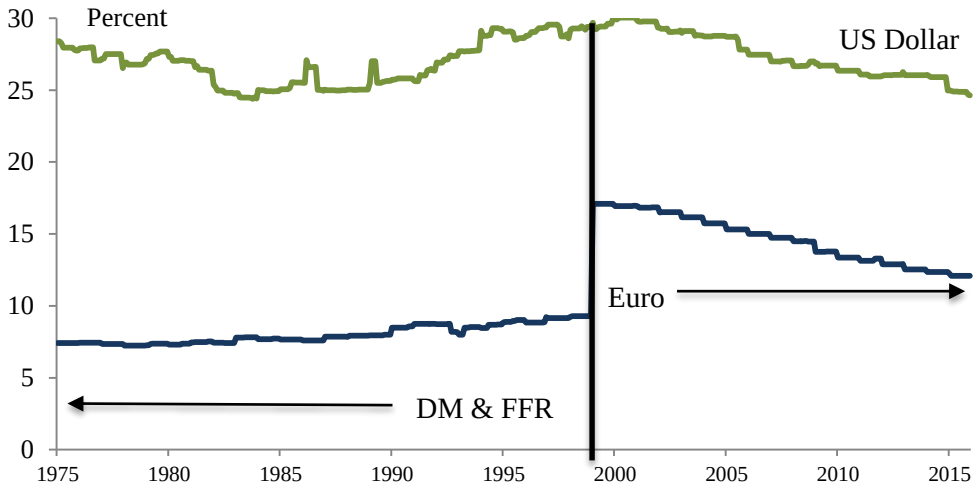
Appendix Materials

Figure A.1. Major Economies' Shares in World GDP, 1995-2016



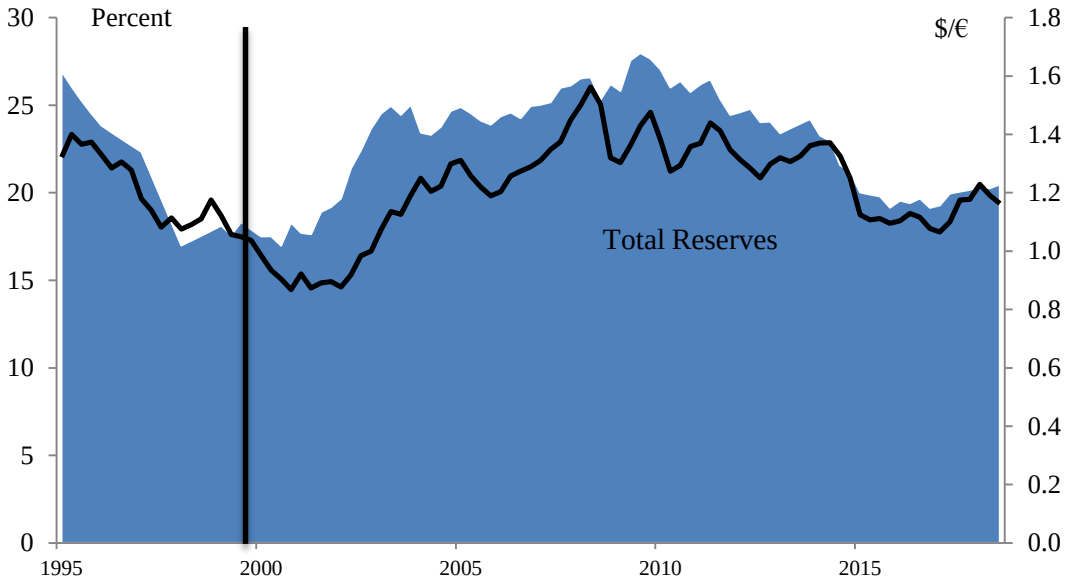
Note: The figure shows the GDP shares of major economies in world GDP.

Figure A.2. Share of World GDP Anchored to the Dollar and Euro, Weighted by Exchange Arrangement



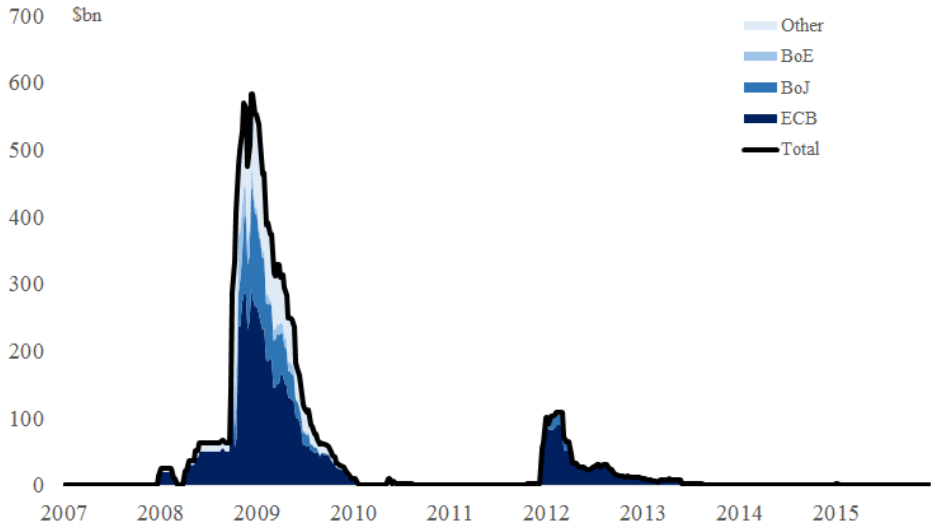
Note: The figure shows the share of world GDP anchored to the dollar (top) and the euro (bottom), where each country is weighted by the inverse of its fine exchange rate arrangement in IRR (2019)—a classification that includes 15 categories. For example, this gives a weight of one to countries part of a currency area (such as Eurozone members), of one half to hard pegs (such as the renminbi peg to the dollar), and $\frac{1}{12}$ to a managed floating currency.

Figure A.3. Share of Central Bank Reserves Held in Euros and the Dollar-Euro Exchange Rate



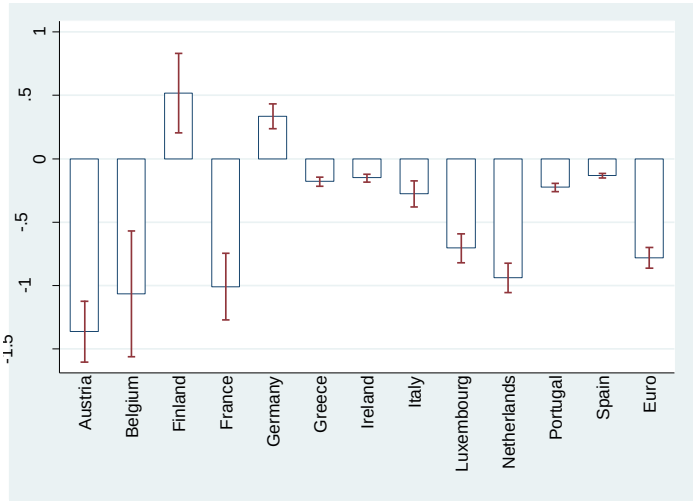
The figure shows the share of allocated central bank reserves denominated in euro (left-hand axis.) The line (right-hand axis) shows the dollar-euro exchange rate (spliced with the Deutschemark-dollar exchange rate at 1999). Source: International Monetary Fund's *Currency Composition of Official Foreign Exchange Reserves*, Federal Reserve, and the authors.

Figure A.4. Federal Reserve Swap Lines During the Global Financial Crisis



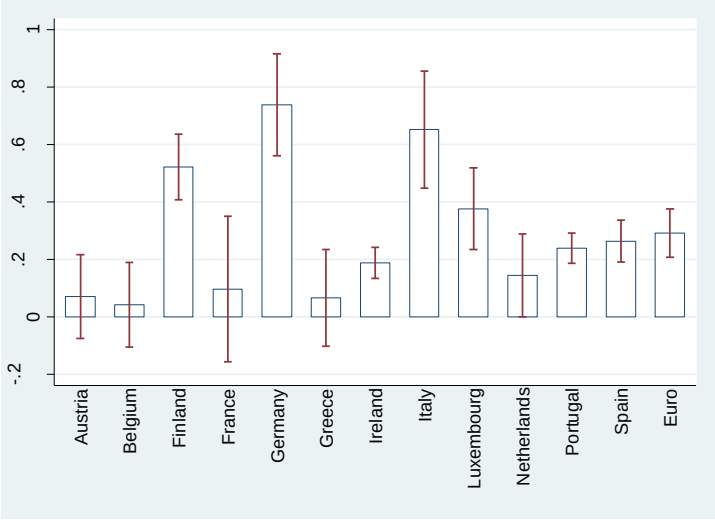
Note: Adpated from Bahaj and Reis (2019), courtesey of the authors. The figure shows the dollar amount of swaps provided by the Federal Reserve to other central banks.

Figure A.5. Taylor Rule Coefficients for Euro-Area Economies, 2000-2014: Output Gap



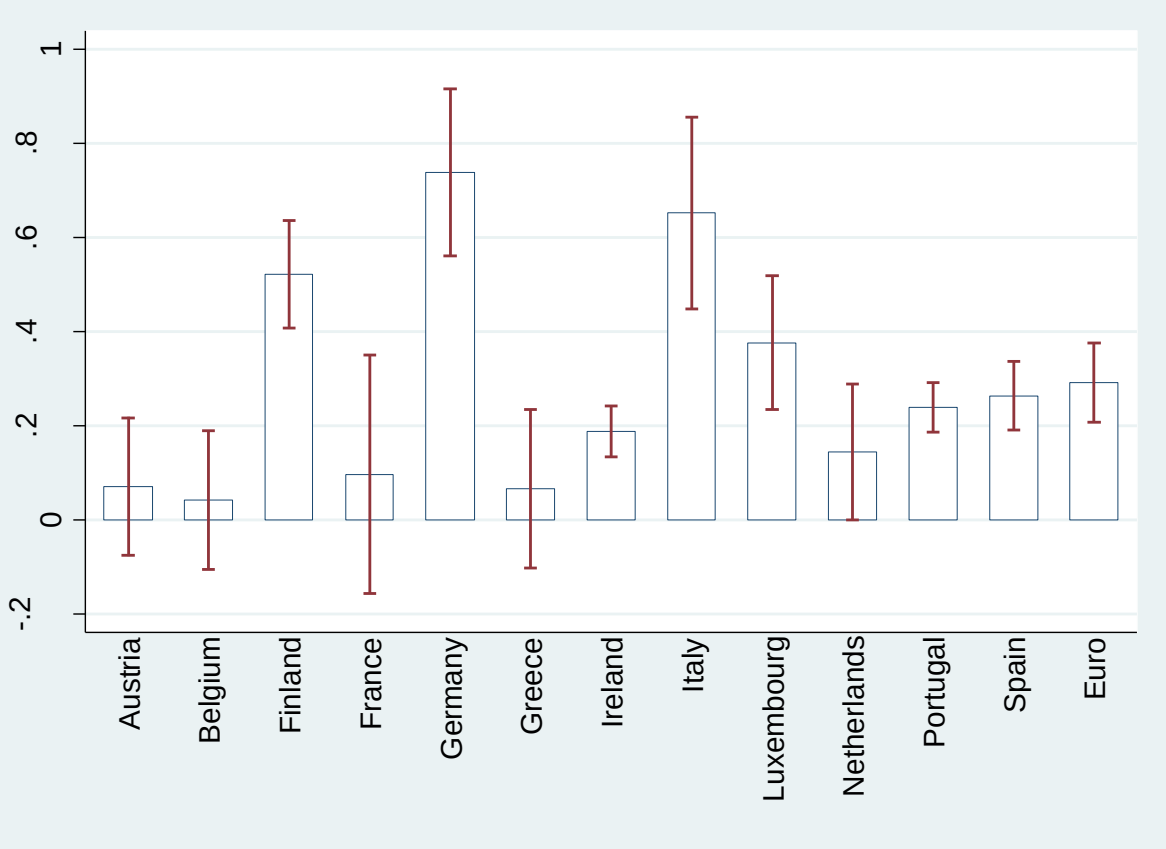
Note: The figures give the Taylor rule coefficients for Euro-area economies and the Eurozone deriving from an estimate of the following equation via GMM with 6 monthly lags of inflation and unemployment as instruments: $i_t = \alpha_n + \rho_n i_{t-1} + (1-\rho_n)\left(\beta_n E_t \pi_{n,t+1} + \gamma_n E_t y_{n,t+1}\right) + \varepsilon_{t,n}$.

Figure A.6. Taylor Rule Coefficients for Euro-Area Economies estimated via OLS, 2000-2014: Inflation



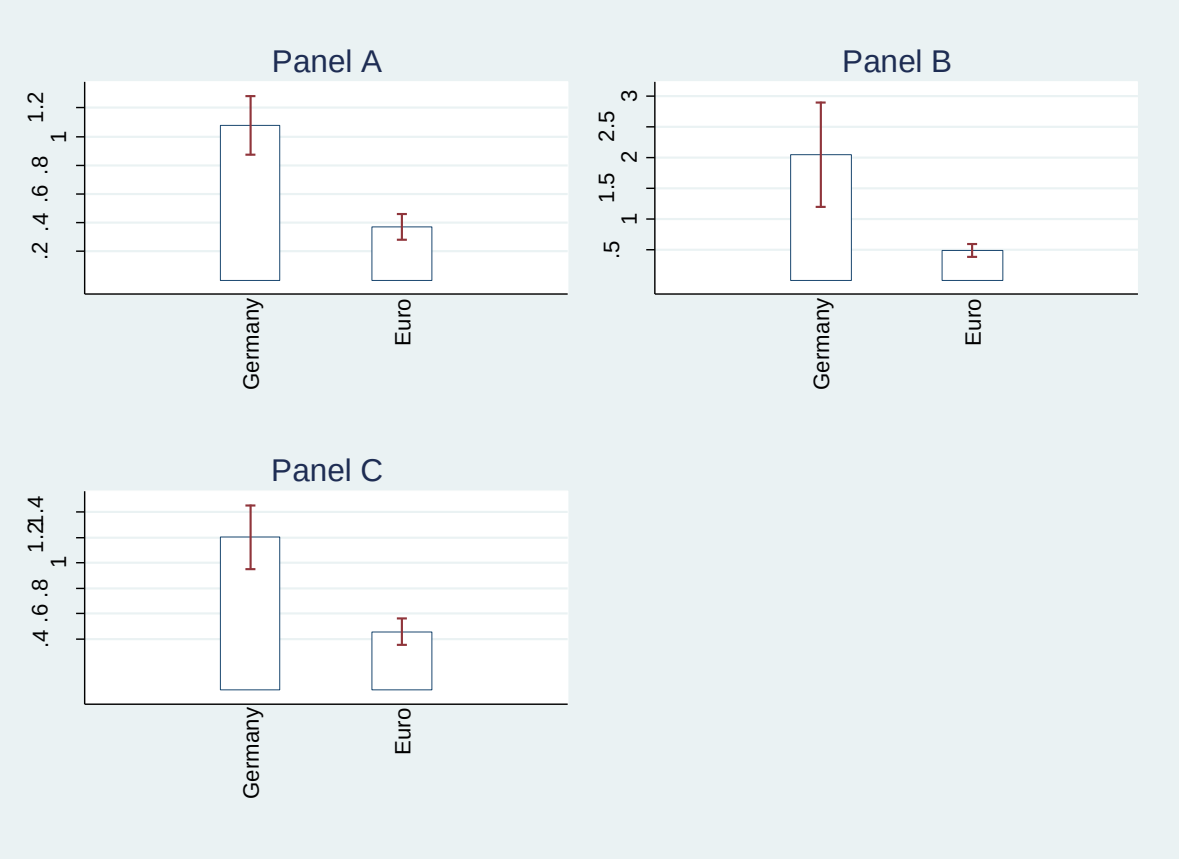
Note: The figures give the Taylor rule coefficients for Euro-area economies and the Eurozone deriving from an estimate of the following equation via OLS: $i_t = \alpha_n + \beta_n \pi_n + \gamma_n y_n + \varepsilon_{t,n}$. The coefficients β_n are displayed as bars with 95% confidence intervals given with whiskers. The hyphothesis $\beta_n > 1$ can be rejected for all countries in the sample except for Gemany and Italy with 95% confidence. The hypothesis $\beta_{EU} > \beta_{DE}$ can also be rejected with similar confidence.

Figure A.7. Taylor Rule Coefficients for Euro-Area Economies estimated via GMM, 2000-2014: Inflation



Note: The figures give the Taylor rule coefficients for Euro-area economies and the Eurozone deriving from an estimate of the following equation via GMM with 6 monthly lags of inflation and unemployment as instruments: $i_t = \alpha_n + \rho i_{t-1} + (1-\rho)\left(\beta_n E_t \pi_{n,t+1} + \gamma_n E_t y_{n,t+1}\right) + \varepsilon_{t,n}$, with ρ=0.42 for all countries. The coefficients β_n are displayed as bars with 95% confidence intervals given with whiskers. The hyphothesis $\beta_n > 1$ can be rejected for all countries in the sample except for Gemany and Italy with 95% confidence. The hypothesis $\beta_{EU} > \beta_{DE}$ can also be rejected with similar confidence.

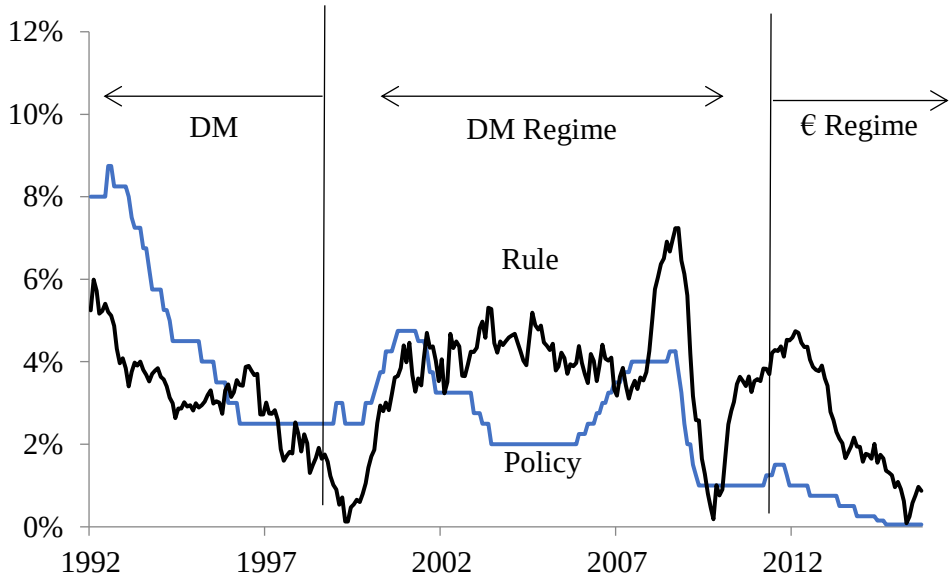
Figure A.8. Roubstness of Taylor Rule Coefficients for Euro-Area Economies estimated via GMM, 2000-2014: Inflation



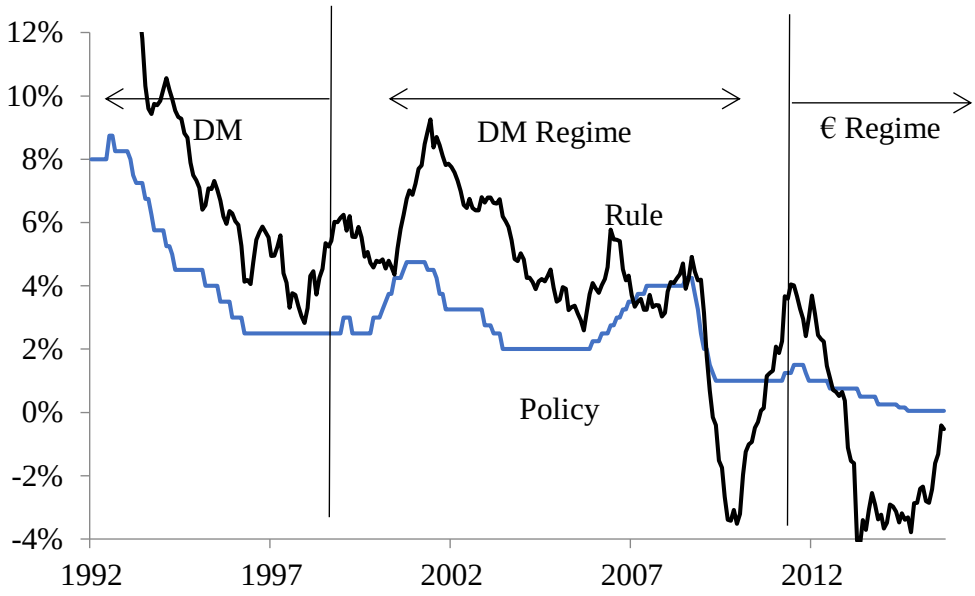
Note: The figure gives the Taylor rule coefficients for Euro-area economies and the Eurozone deriving from an estimate of the following equation via GMM with 6 monthly lags of inflation and unemployment as instruments: $i_t = \alpha_n + \rho_n i_{t-1} + (1-\rho_n)\left(\beta_n E_t \pi_{n,t+1} + \gamma_n E_t y_{n,t+1}\right) + \varepsilon_{t,n}$. The coefficients β_n are displayed as bars with 95% confidence intervals given with whiskers. Panel A replaces expected inflation and unemployment with their current values. Panel B includes current oil prices as an additional instrument. Pannel C includes Jarocinski and Karadi (2018) monetary policy shocks as an additional control.

Figure A.9. Taylor Rule versus Central Bank Policy Rate, 1992-2015, Allowing for Policy Persitence

France



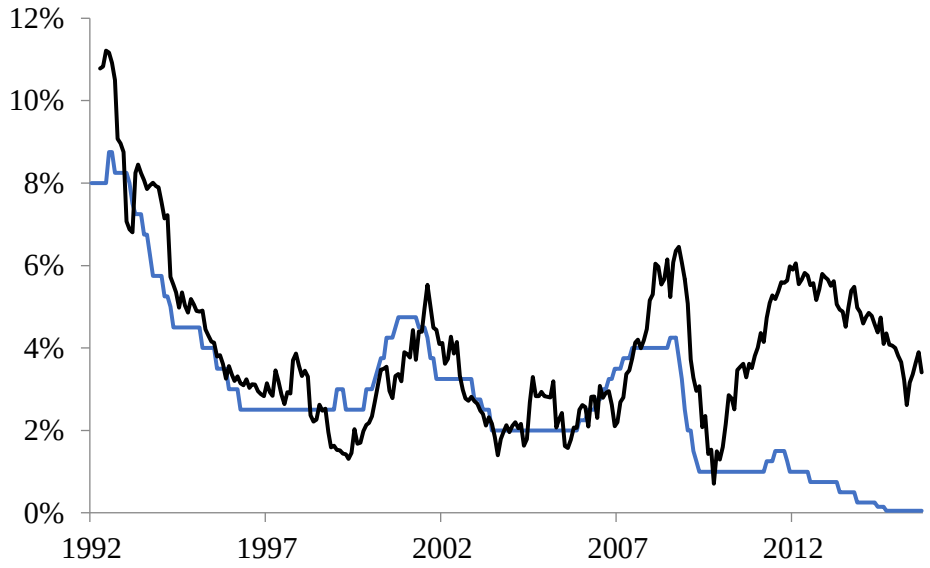
Portugal



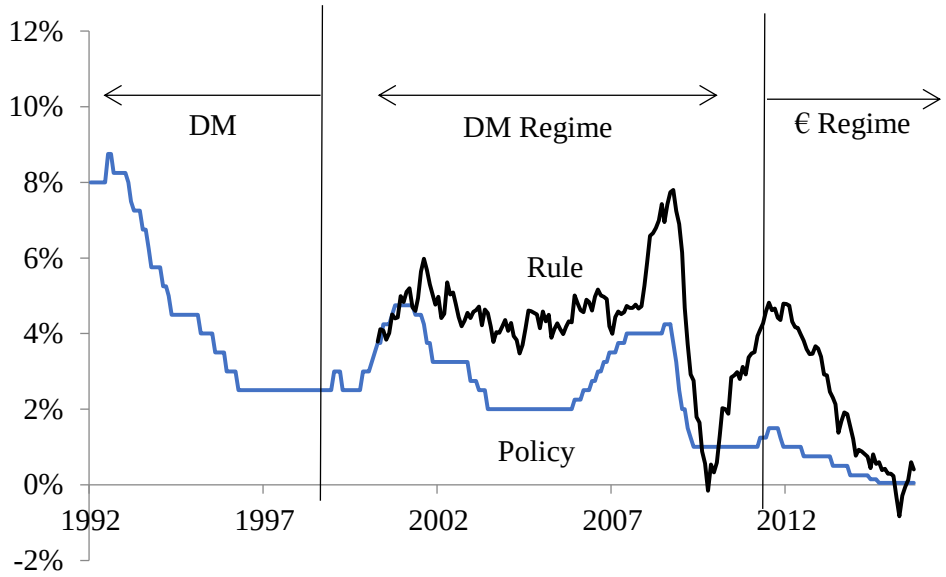
Note: the figure shows (in black) the interest rate policy that would result if a central bank followed a Taylor rule, using Taylor's (1993) original coefficients and specification, allowing for policy persistence with a coefficient of $\rho = 0.9$ for the country in question. This gives a policy rule: $i_t = \rho i_{t-1} + (1-\rho)(\pi_t + .5y_t + .5(\pi_t - 2) + 2)$. This is compared with the ECB's policy rate, in blue, replaced by the Bundesbank's rate prior to 1999. Sources: Eurostat, International Monetary Fund, OECD, and the authors.

Figure A.9 (cont.) Taylor Rule versus Central Bank Policy Rate, 1992-2015, Allowing for Policy Persitence

Germany

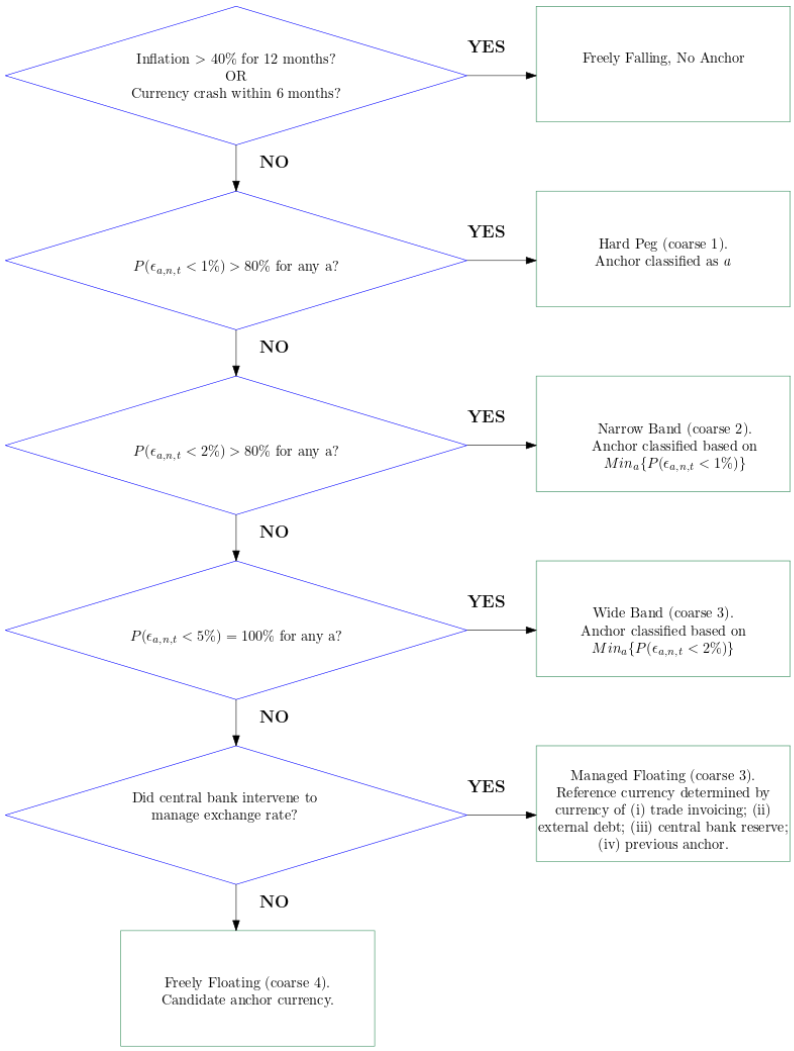


Eurozone



Note: the figure shows (in black) the interest rate policy that would result if a central bank followed a Taylor rule, using Taylor's (1993) original coefficients and specification, allowing for policy persistence with a coefficient of $\rho = 0.9$ for the country in question. This gives a policy rule: $i_t = \rho i_{t-1} + (1-\rho)(\pi_t + .5y_t + .5(\pi_t - 2) + 2)$. This is compared with the ECB's policy rate, in blue, replaced by the Bundesbank's rate prior to 1999. Sources: Eurostat, International Monetary Fund, OECD, and the authors.

Figure A.10. Flowchart of the Ilzetzki, Reinhart, and Rogoff (2019) Algorithm



Appendix I: The Classification Algorithm

This appendix gives a brief and rough exposition of the algorithm used to classify the exchange arrangements and anchor currencies of the 194 countries and territories that comprise our sample. Full details can be found in IRR (2019). A flowchart summarizing the algorithm is found in Figure A.10 in the appendix. We first assess whether the currency in question has a parallel market. If so, we use the market rather than the official rate for purpose of our analysis. Countries with a parallel market where no market data was available are classified as having no anchor currency for the purpose of this paper.

For each of the 194 countries and territories studied, the raw data include the month-on-month rate of inflation and the absolute value of the monthly change in the (average) spot exchange rate. We denote the latter as $\varepsilon_{a,n,t}$ for country *n* in month *t*, with respect to anchor currency *a*. The exchange rate is evaluated against eleven candidate anchor currencies.[55] The candidate anchors were chosen based on historical practice and currencies that are widely included in exchange rate baskets. In addition, currencies that are classified as freely floating themselves become candidate anchors in the relevant years.[56] In the current classification, the Chinese renminbi is not considered a candidate anchor as it has been strongly linked to the dollar itself and is not convertible. We allow for de facto currency baskets as potential anchors. Baskets include a dollar-euro, dollar-yen, euro-yen, and dollar-euro-yen basket, with equal weights on the anchors in each basket. In practice, no currencies were anchored to the latter two baskets. Countries with a dollar-euro anchor are split evenly between the two anchors in the analysis.

The remainder of the algorithm is outlined in Figure A.6. The first step is to separate currencies that were freely falling among those with floating exchange rates. A currency is deemed "freely falling" if the country experienced a year on year inflation rate exceeding 40% for 12 months *or* experienced a currency crash. A currency crash is defined by a 25 percent month on month deprecation if the rate of depreciation was more than 10 percentage points greater than in the previous month. The regime is classified as freely falling in the six-month window following a currency crash. This dimension of our algorithm separates the cases where the exchange rate undergoes large fluctuations due to a lack of monetary control from

[55] The candidate anchors are the US dollar, the Deutschmark, and French franc (replaced by the euro following 1999), the Japanese yen, the British pound, the Russian ruble, the Swiss franc, the Australian dollar, the South African rand, and the Brazilian real.

[56] This adds the Canadian dollar and the Turkish lira in some years.

currencies that fluctuate freely in tranquil times. Freely falling currencies are classified as having no anchor or reference currency.

The remaining countries are classified based on exchange rate bands that were determined based on historical practice (see IRR, 2019 for more detail on the choice of band widths and frequencies): 1%, 2%, and 5%. Each stage of the algorithm assesses whether the frequency at which the currency in question remained within the given band, i.e. $P(\varepsilon_{a,n,t} < b)$ for some band *b*, within a 5-year rolling window. If the currency is within a 1% band for at least 80% of observations ($P(\varepsilon_{a,n,t} < 1\%) > 80\%$), the currency is classified as having a hard peg to anchor *a* and is assigned *a* as its anchor currency.

If the currency is within a 2% band for at least 80% of observations ($P(\varepsilon_{a,n,t} < 1\%) > 80\%$), for any anchor *a*, the currency is classified as having a narrow band. If the currency is within a narrow band of more than one anchor, the anchor currency is determined by the anchor with respect to which the exchange rate remained within a 1% band at highest frequency. That is, the anchor is classified based on $Min_a\{P(\varepsilon_{a,n,t} < 1\%)\}$.

Similarly, if the currency is within a 5% band for 100% of observations $P(\varepsilon_{a,n,t} < 5\%) = 100\%$, for any anchor *a*, the currency is classified as having a wide band. If the currency is within a wide band of more than one anchor, the anchor currency is determined by the anchor with respect to which the exchange rate remained within a 2% band at highest frequency. That is, the anchor is classified based on $Min_a\{P(\varepsilon_{a,n,t} < 2\%)\}$.

Currencies that were not within any of the aforementioned bands are classified as floating. Among these, countries whose central banks intervened with the explicit intention of affecting the level or variability of the exchange rate are classified as "managed floating", with the remaining countries classified as "freely floating". Freely floating currencies do not have an anchor and are themselves candidate anchor currencies. For managed floating currencies, we use the term "reference currency" rather than "anchor currency" to differentiate their looser association with the international currency in question. We use four separate criteria to assign a reference currency to these countries. First, in which currency is the majority of foreign trade invoiced? Second, in which currency is the largest share of external (public and publically guaranteed) debt denominated? Third, which currency comprises the largest share of central bank foreign reserves? And finally, which was the most recent anchor currency? Conveniently, all four indicators point to the same reference currency in almost all countries with a managed floating regime allowing an unambiguous classification of reference currency. For more details see IRR (2019).