This draft: September 29, 2017

Appendix for

Exchange Arrangements Entering the 21st Century: Which Anchor Will Hold?

Ethan Ilzetzki

London School of Economics

Carmen M. Reinhart

Harvard University

Kenneth S. Rogoff*

Harvard University

1. Classification Algorithm

This appendix describes the classification framework that we apply to each of the 194 countries (or territories) that comprise our sample in 2016. The raw exchange rate and inflation data are monthly and span January 1946 through October 2016, approximately seven decades. The classification algorithms perform two intertwined tasks. First, they identify the relevant anchor currency for each country over the course of the sample and second, they define the exchange rate arrangement by metrics that primarily (but not exclusively) measure the degree of flexibility.

Measuring Exchange Rate Flexibility

Choosing the anchor currency and determining the exchange rate classification is an interactive simultaneous process. For expositional purposes, we begin by describing our methodology to classify exchange rate flexibility and then describe the anchor classification. We note that the full classification includes a coarse classification, including 6 categories of exchange rate flexibility, and a fine classification, that includes 15 categories. The categories are listed in Table A.1. The coarse classification categories broadly correspond to the following degrees of exchange rate flexibility: peg (category 1); crawling pegs and narrow bands (category 2); crawling and wide bands (category 3); freely floating (category 4); freely falling (category 5); and dual market with missing parallel market data (category 6).

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 spot exchange rate. We denote the latter as $\varepsilon_{n,t}$ for country *n* in month *t*. The exchange rate is evaluated against ten candidate benchmark currencies.[1] We describe how the benchmark currency is determined from among these candidates in our discussion of anchor classification below. The exchange rate flexibility algorithm is shown schematically in Figure A.1. The top panel shows the general classification scheme, which begins by "weeding out" cases where the official exchange rate may not be informative of the exchange arrangement. We begin by separating

[1] The candidate benchmarks are USD, DEM and FFR (replaced by EUR following 1999), JPY, GBP, RUB, RMB, CHF, AUD and ZAR.

currencies with parallel markets. Where data on the parallel exchange rate is available, we use these data alongside the official data to classify the exchange rate arrangement. Where data on the dual exchange rate is unavailable, we classify the country as having a parallel market with unavailable exchange rate data (coarse category 6 and fine category 15). We next separate freely falling currencies (coarse category 5 and fine category 14) as those whose year-on-year inflation exceeded 40% for 12 consecutive months. This is important so as to distinguish exchange rates with large fluctuations due to a lack of monetary control among currencies that fluctuate freely. Next, when a country had a pre-announced exchange rate arrangement, we verify whether the exchange rate followed the announced rule. Pre-announced currency arrangements receive separate fine classifications and we classify each pre-announced category as being less flexible than the corresponding de facto one, as the announced regime implies a greater degree of de jure commitment. We classify pre-announced arrangements in the following six categories: No separate legal tender or currency union (fine category 1); pre-announced peg or currency board arrangement (fine category 2); pre-announced horizontal band that is narrower than or equal to +/-2% (fine category 3); pre-announced crawling peg (fine category 5); pre-announced crawling band that is narrower than or equal to +/-2% (fine category 6); pre-announced crawling band that is wider than or equal to +/-2% (fine category 9).

In the remainder of the cases—the majority of our sample—we use our algorithm to classify the exchange rates. The methodology for the coarse algorithm is described in the lower panel of Figure A.1. Currencies that had zero variation ($P(\varepsilon_{n,t} = 0) = 1$) for four consecutive months are classified as pegs (coarse category 1 and fine category 4). Currencies with less than 2% variation in at least 80% of monthly observations in a 2 year rolling window ($P(\varepsilon_{n,t} < 2\%) > 80\%$) are defined as narrow bands (coarse category 2, fine categories 5 to 8). A similar methodology classifies broad bands (category 3) as currencies with less than 5% variation in a similar window (coarse category 3, fine categories 10-12). Visual inspection of exchange rate variation allows us to infer whether a peg or band is horizontal, crawling, or moving (allowing for appreciation and depreciation). This last step refines the fine classification into the corresponding category.

The remaining observations are classified as floats, with an additional algorithm to separate freely floating currencies from managed floats. To do so, we create an index of exchange rate variability $\omega_{n,t}$ defined as follows:

$$\omega_{n,t} \equiv \frac{\sum_{s=-29}^{30} \varepsilon_{n,t+s}/60}{\sum_{s=-29}^{30} I(\varepsilon_{n,t+s}<0.01)/60},$$

where *I(.)* is the indicator function. The numerator of the measure gives the average absolute value of exchange rate change within a five year moving window. This average is a direct measure of exchange rate volatility and is naturally high for countries with freely floating rates. The denominator gives the probability that the exchange rate moved by less than 1% in a given month within a five year moving window. This probability is higher for countries with less flexible exchange arrangements.

To assess whether a country is freely floating, we compare its index $\omega_{n,t}$ with that of the bilateral exchange rates among main anchor currencies (USD, EUR and JPY, in recent years). Namely, we estimate the 99% confidence interval of $\omega_{n,t}$ for the main anchor currencies. Any floating currency whose index falls within this confidence interval (i.e. we are unable to reject with 99% confidence the hypothesis that it is freely floating) is classified as freely floating.

Anchor or Benchmark Currency

Having classified the degree of exchange rate flexibility for each currency against all potential anchors, we now turn to anchor classification. Figure A.2. sketches the process of anchor currency selection. First, if a currency is identified as "freely floating" it is classified as having no anchor or benchmark currency. At the other end of the spectrum, countries with arrangements that are less flexible than managed floating have a low degree of exchange rate variability viz a specific anchor. Given that the candidate anchors themselves showed significant variability, this allows an unambiguous anchor classification. Concretely, there is no five year window where a currency could be within a 2% band of both the Euro and the Dollar simultaneously.

This leaves the classification of managed floats, which comprise an increasing share of countries in recent years. For these cases, we calculate the one-year moving average of $\varepsilon_{n,t}$, the absolute value of the change in its bilateral exchange rate, relative to all candidate anchor currencies. If the currency shows smaller movements relative to any single anchor in more than 50 percent of the observations, we link the currency to this anchor. Note that moving more closely against a single currency 50% of the time is a relatively high bar, given that we allow for ten candidate anchors.

Even with this refinement, there remain 11 episodes whose anchor remains unclassified based on exchange rate behavior alone. Table 1 in the main text lists these cases and how, using supplementary information we were able to allocate these to a currency bloc.

We use four separate criteria to assign a benchmark currency to these countries. First, in which currency is the majority of foreign trade is 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? In the current sample, all four indicators conveniently point to the same benchmark currency in all countries in the table. (The one exception is Iceland, which was most recently anchored to the euro, but where the dollar dominates in all other measures).

For completeness and future reference we outline here an index that would allow us to classify the benchmark currency if these four indicators disagree. The benchmark currency index is calculated for each currency-anchor pair an arithmetic sum of the following four variables:

1) Percent of trade (with equal weights on imports and exports) invoiced in the anchor currency.
2) Percent of central bank reserves denominated in the anchor currency.
3) Percent of foreign debt denominated in the anchor currency.
4) The reciprocal of the number of years since the currency was anchored to the anchor currency based on exchange rate based criteria described above.

Table A.2. shows the benchmark currency index viz the dollar and the euro for the year 2016, for eight countries requiring classification, and where sufficient data were available. The index is essentially zero for all candidate benchmark currencies other than the dollar and the euro. The index shows that for most of these countries, the choice of benchmark currency is classified as the dollar by a large margin. Comparison across regions shows that Latin American countries score high on the dollar index and close to zero on the euro index. Canada's euro index is also negligible, but its dollar index is also smaller, because none of Canada's foreign debt is denominated in US dollars. Countries that are geographically closer to, and have greater trade with, Europe—Iceland, Israel, and Turkey—have euro indexes in the double digits, but score higher on the dollar anchor index.

To illustrate the construction of the index, consider the case of Iceland, which is the most marginal case. 38% of Iceland's trade is invoiced in dollars (32% in Euros), its debt is denominated in domestic currency, its central bank holds 52% of its reserves in dollar denominated assets (37% in euro assets). The Icelandic Krona hasn't been anchored to the dollar in recent history (giving a 0 score on the recent anchor category) and was anchored to the euro 15 years ago (giving a score of 7%). This gives Iceland a 23% score on the dollar anchor index and 19% score on the euro index.

2. Stress testing Anchors

We assess the robustness of our anchor choice (see Figure 1 in the main text) by studying two recent natural experiments. There have been two large recent swings in the bilateral USD-EUR exchange rate. Both movements can be traced back to monetary policy shocks in Europe and the US. First, on July 22, 2012, Mario Draghi, the ECB President, made his now famous speech, in which he stated that the ECB stood ready to do "whatever it takes" to preserve the euro. Second, the minutes of FOMC meeting of June 17-18, 2014 increased market perceptions that the Federal Reserve would initiate its tightening cycle, a

perception that gathered momentum throughout the rest of the year. As a result, the dollar appreciated by a cumulative 30 percent relative to the Euro through March of 2015.[2] Figure A.3 highlights these events.

The large movements of the USD-EUR bilateral exchange rate allow "stress-testing" of our anchor currency classification, at least between the critical choice of the dollar or the euro. Specifically, we would expect currencies anchored to the dollar to move more closely with the dollar during these episodes, while currencies with other anchors (most commonly the euro) might move more freely relative to the dollar. These two episodes have the advantage that they are primarily due to the monetary policies of the ECB and the Federal Reserve, not idiosyncratic shocks facing other economies. In one case the dollar depreciated while it appreciated in the other.

Figure A.4 shows the median percent depreciation of countries with either +/-5 percent exchange rate bands or classified as managed floats; the results would naturally be far sharper if we included all countries. We divide these economies into three groups, based on the algorithm we used to classify these countries' anchors. The first two groups include currencies that could be classified at the first stage based on the magnitudes of exchange rate movements relative to anchor currencies. The red (dashed) line shows countries classified as anchored to the US dollar and the blue (dotted) line shows countries classified with other anchors (three countries anchored to the Euro and one to the Australian dollar). The third group includes the borderline currencies (shown in Table 1 of the main text), where classification required additional, non-exchange-rate, information. Their movement viz the dollar is shown in the purple (dash-dotted) line. For completeness, the black (solid) line shows the euro-dollar bilateral exchange rate.

In both episodes, currencies not anchored to the US dollar moved in tandem with the Euro. These currencies appreciated 5 percent on average relative to the dollar in 2012 and depreciated 20 percent in 2014-5. In contrast, currencies classified as having a dollar anchor moved far less relative to the dollar. Following Draghi's speech, their bilateral US dollar exchange rate appreciated by less than 2%. These

[2] This differs from the proverbial "taper tantrum" of the preceeding year, when the Federal Reserve indicated plans to slow down and eventually reverse asset purchases as part of its quantitative easing policies. While this announcement did create some volatility in emerging market currencies, it had a relatively muted effect on the bilateral Euro-Dollar exchange rate.

currencies depreciated only 10 percent in 2014-15 as the Fed began signaling a tightening cycle. The difference in cumulative exchange rate movement relative to the US dollar between these two groups of countries is statistically significant at the 90 percent confidence level in the first episode and at the 99 percent confidence level in the second.

Turning to the borderline cases, these were all classified as having the US dollar as their benchmark currency, based on supplementary data, as described in Table 1 in the main text. As might be expected from intermediate cases, their movements relative to the dollar were larger than currencies more clearly anchored to the dollar, but less so than the freely-floating euro or currencies that were not anchored to the dollar. (In both episodes, we cannot reject the hypothesis that exchange rate movement relative to the dollar in these intermediate cases was the same as either of the other two groups of countries, on average.)

In summary, we looked at two "shocks" to the bilateral euro-dollar exchange rate that were prompted by ECB or Fed announcements. Even restricting attention to currencies that were loosely anchored to their benchmark currency, we find that those currencies classified as having a dollar benchmark remained relatively more anchored to the dollar than those classified as borderline or benchmarked to a different currency. This provides a cross check for our classification algorithm.

3. Classifying the Eurozone

In what follows, we describe the approach adopted and results obtained from estimating an individual Taylor rule for the countries that make up the Eurozone. We regressed the ECB's policy interest rate on inflation, unemployment, and on a constant term. Specifically, we estimate (A.1) below for each country:

$$i_{t,n} = \alpha + \beta_1 \pi_{t,n} + \beta_2 y_{t,n} + \varepsilon_{t,n} \qquad \text{A. 1}$$

Where $\pi_{t,n}$ is year-on-year inflation for country *n*; 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*. The Taylor principle is satisfied when $\beta_1 > 1$. Given the definition of the output gap, countercyclical policy implies, $\beta_2 > 0$.

Figure A.5 shows the coefficients on inflation (top panel) and the output/unemployment gap (bottom panel) for all original Eurozone members, plus Greece. The whiskers depict the 95 percent confidence intervals of the estimates. The data is monthly and spans 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.)

The contrast between the coefficient estimates for Germany and other Eurozone members is of note. The coefficient on the inflation rate for Germany is estimated at slightly below one, but the standard error is large enough to encompass the possibility that the coefficient is greater than one, the necessary response for monetary policy to be stabilizing. This result becomes even stronger when the post-2008 crisis years are excluded. Therefore, we cannot reject the hypothesis that the ECB follows the Taylor principle—that the real interest rate should rise in response to an increase in inflation—for Germany. 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.

In contrast, for all other Eurozone members, we can reject at the standard levels of significance that the coefficient is greater than one.[3] The Taylor principle is also violated for the Eurozone as a whole. In other words, we 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 decade and a half of its existence, the ECB may have placed a de facto greater emphasis on stabilizing inflation in Germany than elsewhere. Beyond the Taylor rule, there is broad agreement and clear theoretical foundations for the notion that a central banks' interest rate policy ought to respond actively to inflation. Based on this notion, it is hard to argue that countries other than Germany have had the type of monetary autonomy that would justify classifying them as having a freely floating currency.

The coefficient on the output gap, shown in the bottom panel of Figure A.5, paints a somewhat different picture, as it is positive for all Eurozone members other than Finland and Germany with the

[3] Or that it is significantly different from zero, for that matter.

interpretation that the ECB does conduct countercyclical monetary policy for most EZ 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.

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:

$$i_t = \pi_t + .5y_t + .5(\pi_t - 2) + 2 \qquad \text{A. 2}$$

where i_t is the recommended policy rate, y_t is the output gap, and π_t is inflation over the 12 previous months. As in (A.1), the output gap is measured as the difference between average unemployment in the country in question and unemployment in month *t*.

Figures A.6 and A.7 present the evolution of the hypothetical policy rate associated with a Taylor rule as a dashed line first for two Eurozone countries: Portugal, and France; and then for Germany and the Eurozone as a whole.[4] Policy rates were far lower than the Taylor rule would have advocated for countries like France and Portugal 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.

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 has followed the Eurozone Taylor rule more closely (Figure A.7, bottom panel). In recent years it would appear that no single Eurozone member country, including Germany, has had the degree of monetary

[4] 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.

autonomy that would be implied by the independently floating label that the IMF assigns to all EZ countries.

In sum, apart from Germany's case during 1999-2007, we conclude that the de facto practice of the ECB (alongside the other criteria discussed in Section III) justifies classifying Eurozone members as tantamount to having an exchange rate arrangement with no separate legal tender.

4. Inflation Targeting Countries: A Breed Apart?

This appendix outlines our analysis of inflation targeting (IT) countries, summarized in Section II of the paper. To begin, Table A.3 lists countries that have adopted a de jure inflation target, the year in which it was adopted, and the de facto exchange rate arrangement based on our classification. As Table A.3 highlights, there is considerable variation in de facto exchange rate practices among countries with a de jure IT policy framework. Among this group (as with non-IT cases), exchange rate practices range from the freely floating currencies of Australia and the UK to Romania's de facto peg to the euro since 2012. The more flexible arrangements (categories 3 and 4 in the coarse-grid classification) include: the freely floating case, managed floating, and *moving* bands that are narrower than or equal to +/-2 percent.[5] Slightly less than 2/3rds of the IT group (17 of 27) falls into this basket. De facto pegs, crawling pegs and narrow crawling bands (categories 1 and 2 in the coarse-grid classification) make up the remaining ten IT countries. More than half of the Fix-IT group is from of Emerging Europe.

This suggests that the de-jure IT category masks significant differences in monetary practices and that our classification provides information beyond the headline IT label. In effect, there is a subset of cases where the mantra of IT has hidden a continued "fear of floating" by many central banks (Calvo and Reinhart, 2002).

Beyond the analysis of the exchange rate through our various filters, we provide two different but complementary empirical strategies to assess whether the behavior of IT countries and their non-IT

[5] A moving band refers to the cases where periods of sustained appreciations are also evident; with crawling bands, changes are always in the direction of depreciation.

counterparts are similar or distinct. The first of these focuses on a pair of event studies over 2008-2014 while the second involves estimating an augmented Taylor rule for the IT group over the period 1990-2015. The aim of these exercises is to ascertain whether IT countries behave distinctly as a single group or whether that overarching de jure label needs to be qualified with additional considerations.

Lehman, September 2008 and FOMC Minutes, June 2014

We consider two major macroeconomic shocks from recent years, one real and the other nominal. In Figure A.8 we compare the exchange rate movement of countries divided along two dimensions: first their de jure classification IT or not IT, and second their exchange rate classification in broad categories of "fixed" (coarse classification categories 1 and 2) and "flexible" (coarse classification categories 3 and 4). The average response of (nearly) all currencies during two episodes is plotted in the two panels of Figure A.8. The period surrounding the collapse of Lehman in the fall of 2008 is shown in the top panel while the bottom panel presents the comparable data around the June 2014 meeting of the Federal Open Market Committee (FOMC). The grey solid and dashed lines trace the responses of currencies within the less flexible arrangements, which include de jure and de facto pegs, crawling pegs, or narrow (less than +/-2%) bands or crawling bands (coarse-grid 1 and 2). The black solid and dashed lines chart the responses of currencies with managed or freely floating regimes (coarse-grid 3 and 4). Solid lines give the average exchange rate index of IT countries vis a vis their anchor currency and dashed lines present the comparable index for the control group of non-IT countries.

As shown in Figure A.8, the depreciation cycle around the Lehman shock in fact began in July of 2008, when commodity prices peaked and the ECB increased its policy rate. Depreciations accelerated following the collapse of Lehman Brothers. For the IT cases (solid lines), it is evident that our classification picks up large differences in exchange rate practices. Currencies that we classify as floating depreciated sharply: peaking at more than 20%. In contrast, exchange rate movements were more muted among IT countries we classify as having a variant of a peg, with a median depreciation of merely 10%. The difference between the average depreciation in these two groups of countries is statistically significant at the 95% confidence interval. The response of the IT group with a de-facto crawling peg was

almost identical to their counterparts with coarse classifications 1 or 2 without an inflation target. Currencies' response to the defining shock of the 2008-9 global recession shows that our classification adds important information to the de-jure label of IT, when considering exchange rate movements.

A similar pattern is evident as the Fed tightened policy in 2014. IT countries with flexible exchange arrangements posted a depreciation of 10% from the FOMC meeting in June to the end of the year. This contrasts with a 2% cumulative depreciation among IT cases with comparatively fixed exchange arrangements. The difference between the two groups is again statistically significant at the 95% confidence interval. As before, exchange rate movements among inflation targeters that we classify as having a fixed exchange arrangement is strikingly similar to the non-IT control group. The temporary bout of exchange rate flexibility in mid-December among IT countries with fixed or semi fixed exchange arrangements reinforces rather than contradicts our argument. This spike is driven by a single currency—the Armenian dram, with a de-facto inflation target, but which we classify as having a narrow crawling band.

Following a 30% depreciation in a single week, the dram recovered by 28% in two trading days (December 17-18).[6] Tracing the dram's monthly movements over a number of years (Figure A.9) it is evident that the currency's trajectory is strikingly similar to currencies under a traditional crawling peg (or crawling narrow band), and illustrates the value of lower frequency measures of exchange flexibility. The dram shows remarkable stability vis a vis the US dollar for long stretches, punctuated with the occasional devaluation.

Augmented Taylor Rule

We further demonstrate our contention that IT cases are far less distinctive as a group than advertised by estimating an augmented Taylor rule for the sample of countries with an inflation targeting framework in place. Specifically,

[6] The Central Bank of Armenia auctioned $4 million in reserves on the 17th, although it claimed that it attracted no purchase bids. The ruble recovered 9% on the 17th and it is impossible to reject the possibility that the dram's movements were merely a reaction to the recovering ruble.

$$i_{t,n} = \bar{r} + \pi_{t,n} + a(\pi_{t,n} - \bar{\pi}) + by_{t,n} + cs_{t,n} \qquad A.3$$

where $\pi_{t,n}$ is year on year inflation in country *n* in month *t*, $y_{t,n}$ is the output gap, measured by the difference between a country's average unemployment rate and that in month *t*. The usual specification is augmented by the inclusion of the exchange rate, $s_{t,n}$ viz country *n*'s benchmark currency. Of course, Taylor rules aren't the only way to characterize monetary policy, but they do contain the key variables of interest to most central banks. As we shall see, the exercise is quite revealing.

The version of equation A.3 we estimate for a panel of IT countries is given by equation A.4. The regressions include country fixed effects, so that they exploit the time variation within countries, giving the average Taylor rule coefficient for countries in the panel. We then augment our Taylor rule with a reaction to exchange rates. Formally, we estimate the following regression:

$$i_{t,n} = \beta_1 \pi_{t,n} + \beta_2 y_{t,n} + \beta_3 FIX_{t,n}\pi_{t,n} + \beta_4 FIX_{t,n} y_{t,n} + \alpha_n + \varepsilon_{t,n} \qquad A.4$$

where $FIX_{t,n}$ is a dummy variable that obtains a value of 1 if we classify country n as following a variant of a peg or crawling peg in month *t*, and α_n is a vector of country fixed effects.

Results are summarized in Table A.4. In the first three columns, we treat central banks as having a strict inflation target. Regressing the policy rate on inflation alone gives a coefficient of 0.68. This is consistent with a response to inflation, albeit not sufficient to increase the (ex-post) real interest rate in response to inflation. In the second column, we include the natural logarithm of the bilateral exchange rate with respect to each country's anchor currency. We find that the policy rate responds to the exchange rate, with a sign that is consistent with exchange rate stabilization. IT central banks increase the policy rate by an average of 20 basis points in response to a10 percent exchange rate depreciation.

Column 3 provides interaction terms that allow a separate Taylor rule estimates for countries with "fixed" exchange rates and those with more flexible arrangements. We classify countries with a coarse classification of 2 as "fixed" and those with coarse classifications of 3 or 4 as "flexible". We see that

inflation targeting central banks with more flexible exchange arrangements stabilize inflation more aggressively, with a coefficient of 0.74 on inflation. They nevertheless do appear to respond to the exchange rate. However, countries with more rigid de-facto exchange rate arrangements target inflation less aggressively, with a coefficient of 0.55. Instead, they respond more aggressively to exchange rate movements, with a coefficient that is 17% larger than in countries with more flexible arrangements. This may in fact understate the full difference between countries with different exchange arrangements as much currency intervention is conducted with non-interest-rate tools.

Column 4 includes unemployment in the Taylor rule. The coefficient is of the "wrong" sign, with central banks increasing interest rates when unemployment is high. This is plausible if a country follows a strict inflation target.

It is possible that the exchange rate may embed information about future inflation and the central bank is responding to this information in its interest rate policy. While we cannot fully reject this possibility, we include a forward looking variable in the regression reported in column 5. Commodity prices have been suggested as an important forward looking variable, whose exclusion may bias estimates of central banks' policy rules (see Sims 1992). We use an index of the prices of global commodities (from the IMF's International Finance Statistics) to measure commodity price inflation. Central banks do respond to commodity price inflation, with a coefficient of 1, although the coefficient is not precisely estimated. Once accounting for the response to commodity prices, the average response to the exchange rate is smaller. The difference across exchange arrangements, however, remains almost identical, with countries classified as having fixed exchange arrangement responding less aggressively to inflation and more to the exchange rate. Similar results follow when controlling for oil prices or food prices.

The event studies show that the exchange rates of inflation targetters with a de facto crawling peg react almost identically on average to shocks as do countries with a de facto peg and no inflation target. Similarly, IT countries that we classify as floating react similarly to other floaters. That is, our classification gives information about exchange rate behavior that goes beyond the de jure IT moniker.

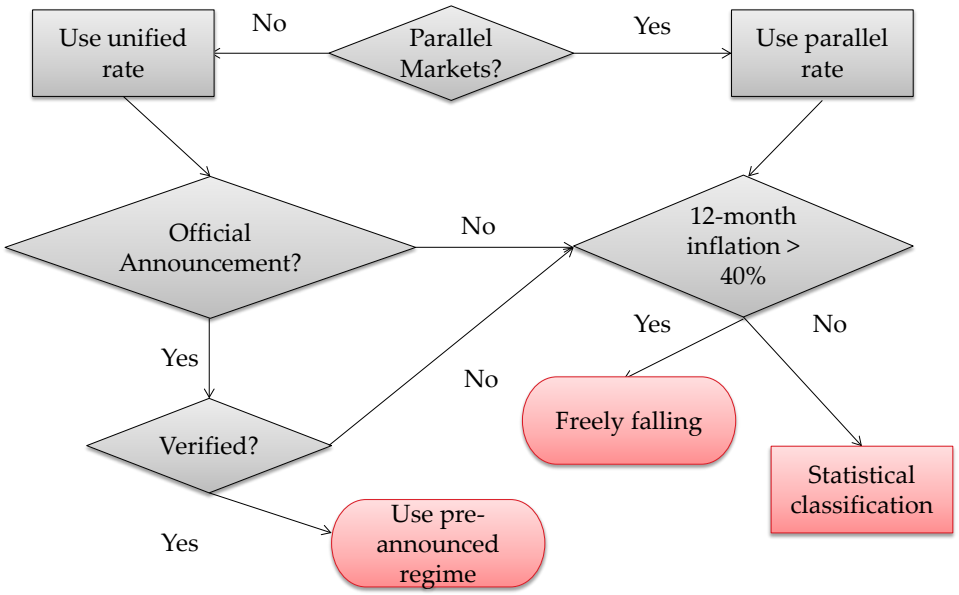
The take-away from the Taylor rule estimates is similar. In countries we classify as having a crawling peg, the policy interest rate responds less aggressively to inflation and more aggressively to exchange rate movements than in countries with flexible exchange arrangements, supporting the conclusions of the event studies. These insights suggest that IT by itself is too vague and encompassing to constitute a separate category as its own exchange rate arrangement. The de facto exchange rate classification appears to do a far better job in predicting exchange rate variability in IT countries than the de jure classification of inflation targeting.

5. Trade Invoicing Index

Using data from Gopinanth (2016), who studies trade invoicing patterns and exchange rate pass-through, we create an index of trade invoicing by anchor currency. Based on her data for 49 countries over the period 1999-2014, we construct a composite measure of invoicing importance for the four major currencies: the US dollar, the euro, the UK pound, and the Japanese yen. This measure combines information on the incidence of use of the four currencies for invoicing (i.e., the share of countries who quote some of their trade in these currencies) and the quantitative importance, as measured by the share of total imports and exports in each currency. The two components are complementary since it is possible that many countries invoice some of their trade in, say, the UK pound. However, it may be the case, that the fraction of total trade that is invoiced in pounds is so small that its overall quantitative importance is quite limited. Table A.5 summarizes the components and the summary measure of the trade invoicing index for the four anchor currencies.

Figure A.1. Exchange Rate Arrangement Classification Algorithm

Sequence and general scheme



Statistical tests

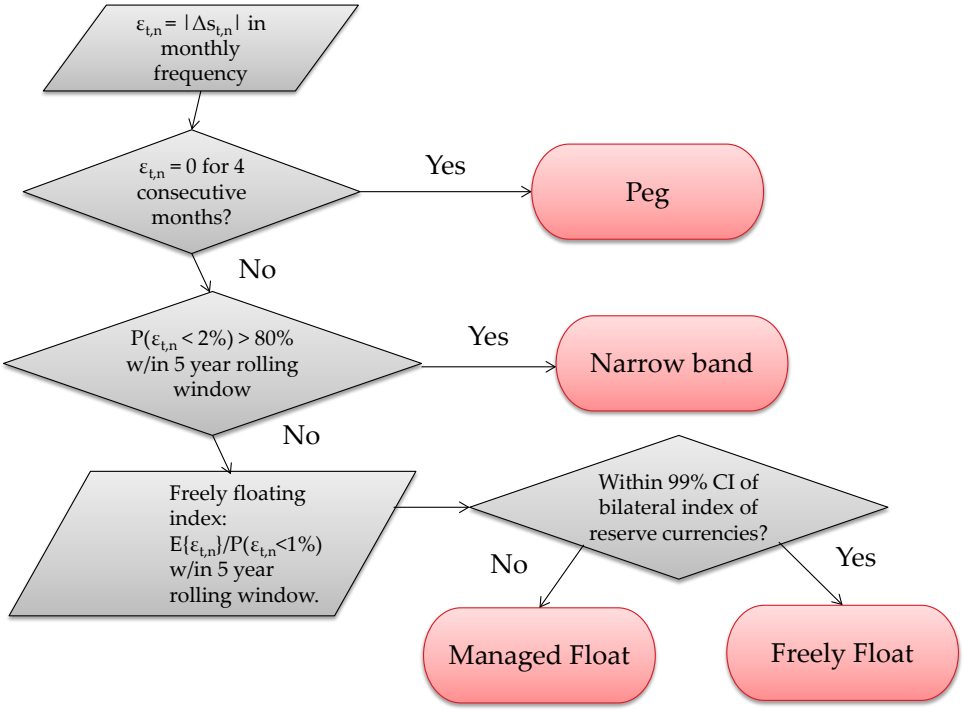


Figure A.2: Anchor Currency Selection Process

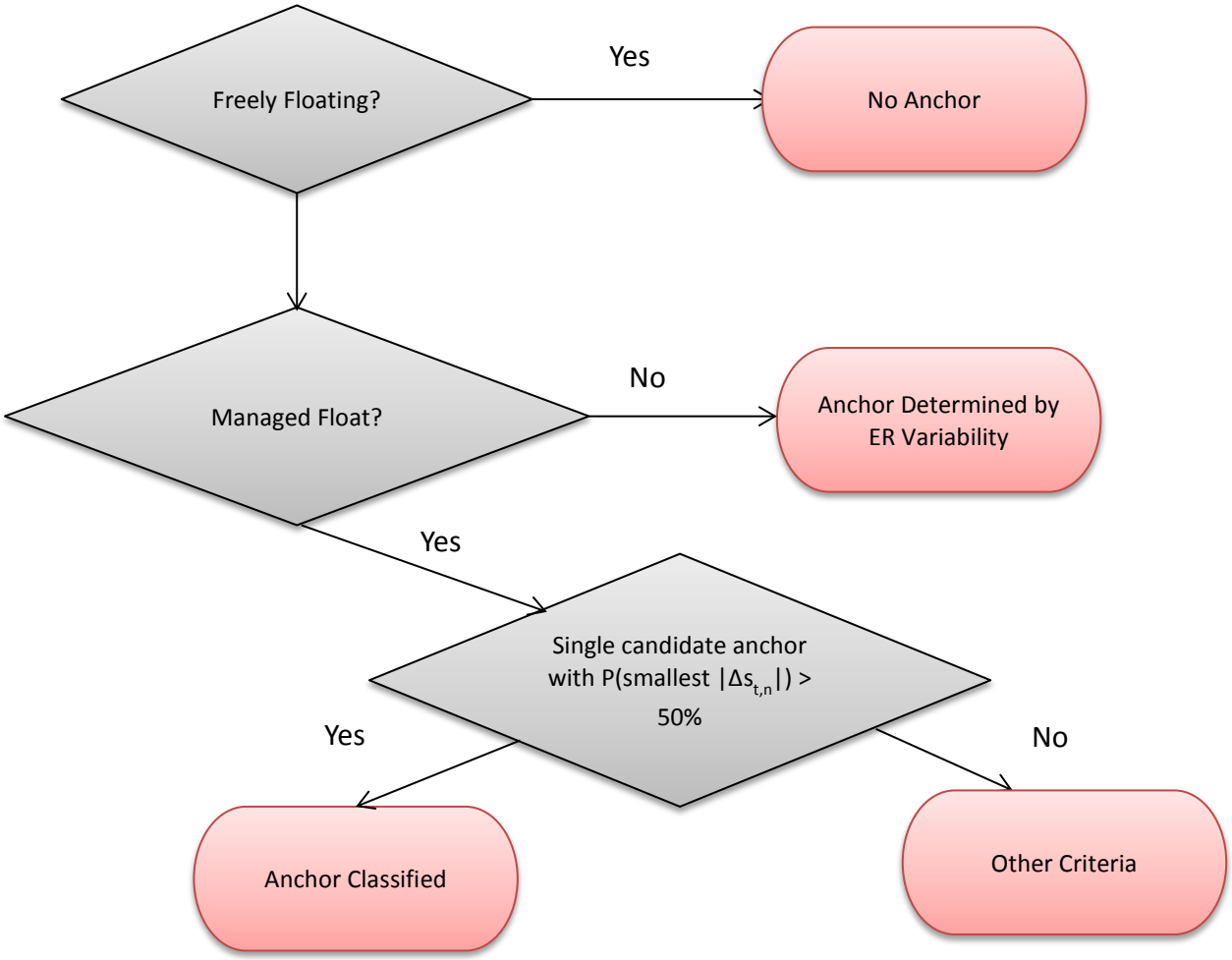
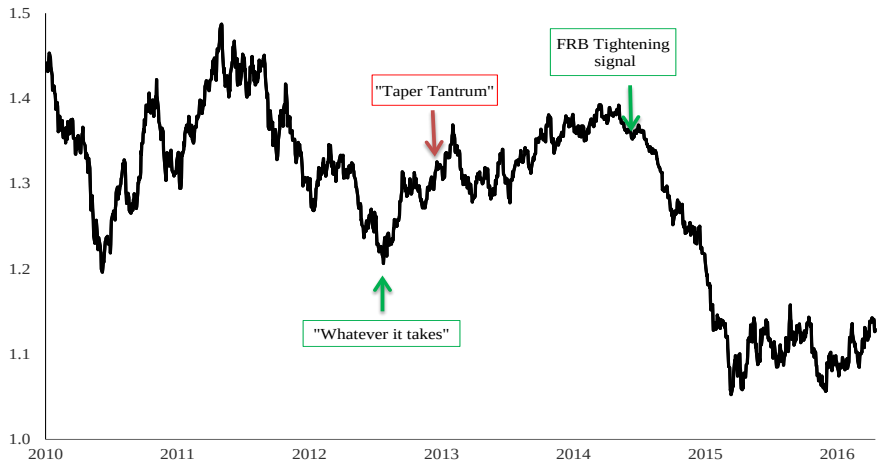


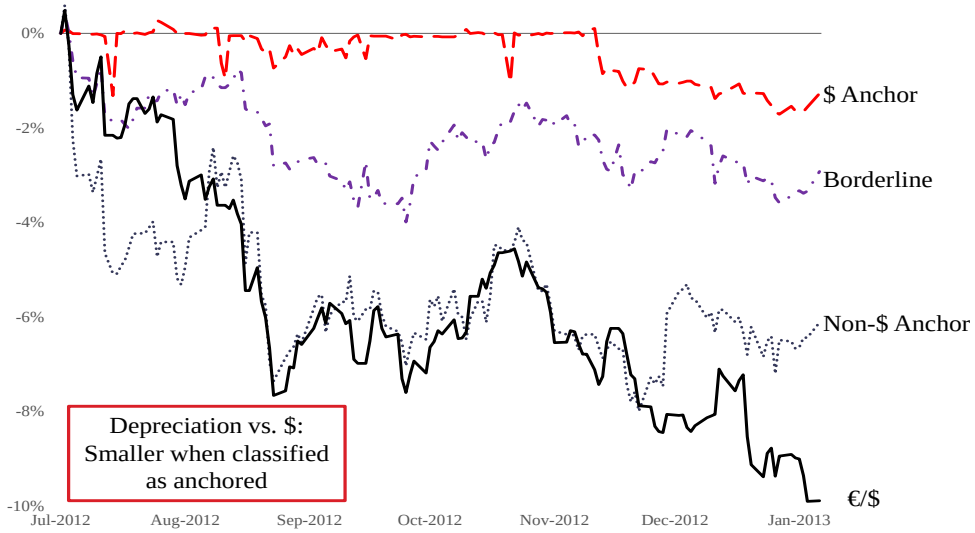
Figure A.3: US dollar-Euro Exchange Rate, 2010-2016



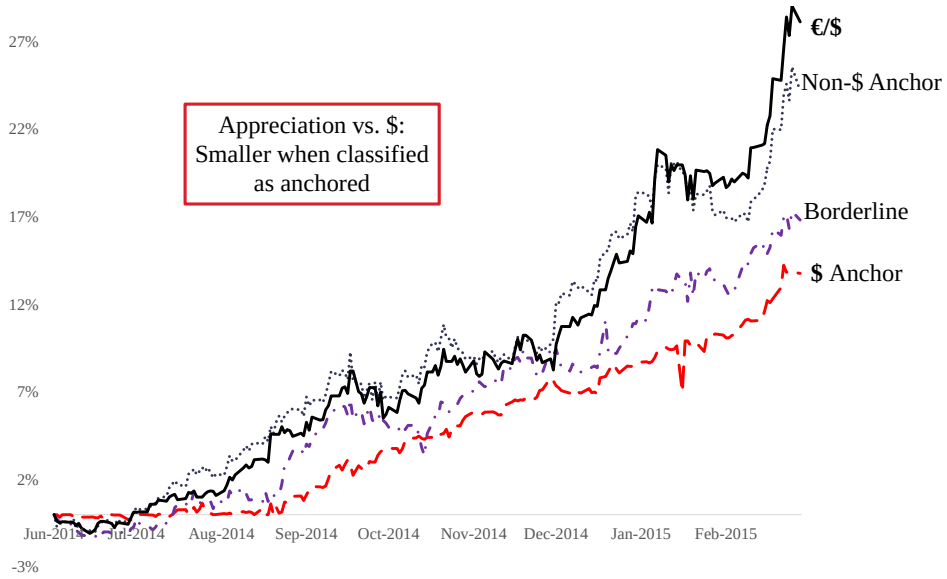
Source: Bloomberg.

Figure A.4: Stress Testing Benchmark Currency Classification: Two Monetary Policy Events, 2012 and 2014

Draghi's Whatever it Takes, 2012

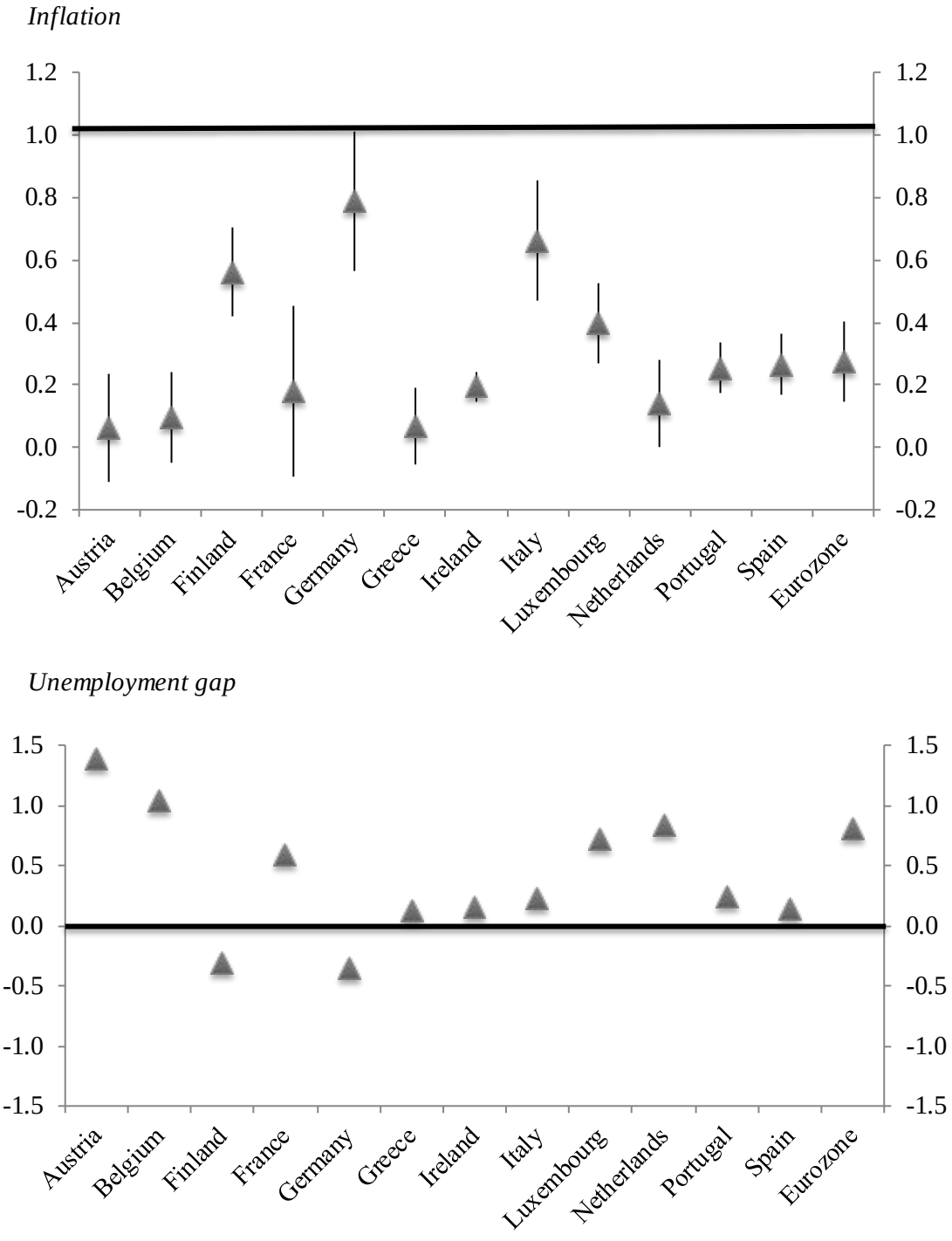


Fed Tightening, 2014



Source: Bloomberg and authors' calculations.

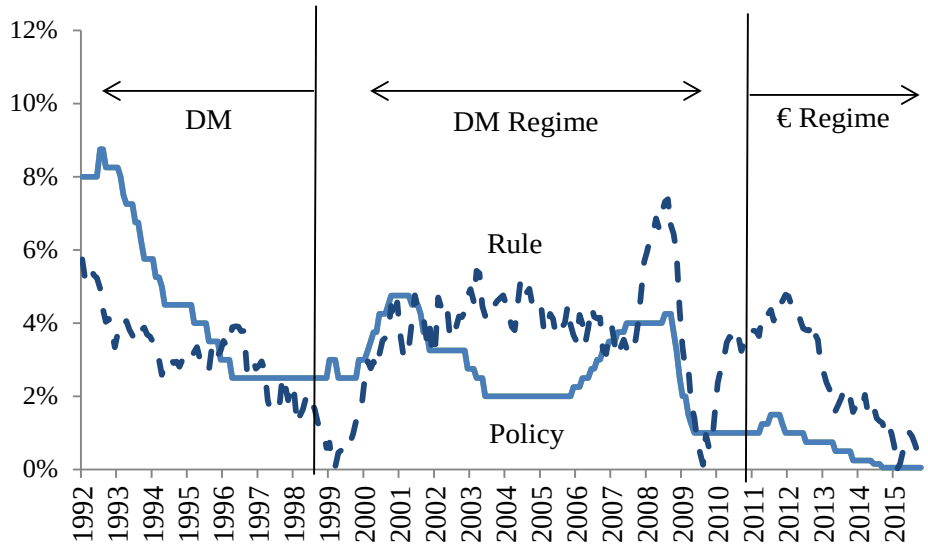
Figure A.5. Taylor Rule Coefficients and Confidence Bands: January 1999 – September 2014



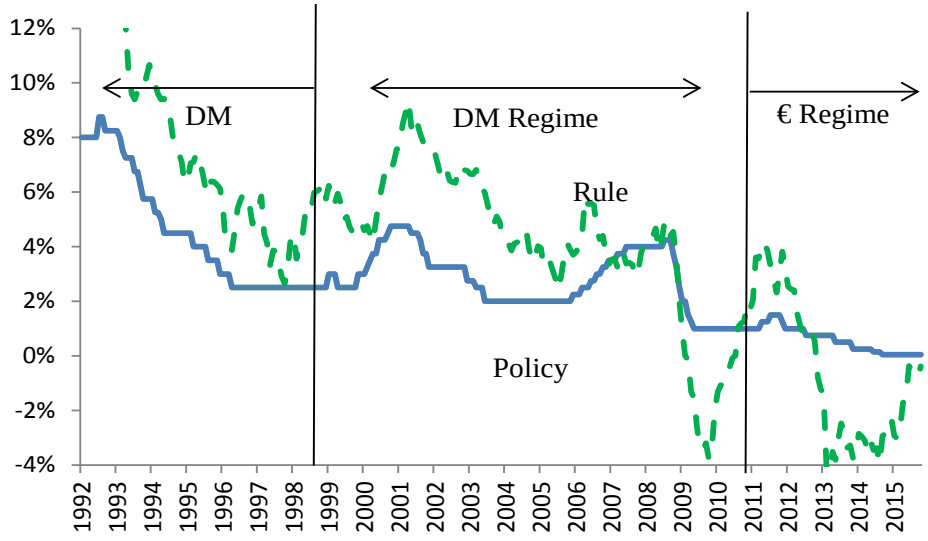
Sources: Eurostat, OECD, International Monetary Fund, and the authors.

Figure A.6. Taylor Rule versus Actual Policy Rate: France and Portugal, 1992 to 2015

France



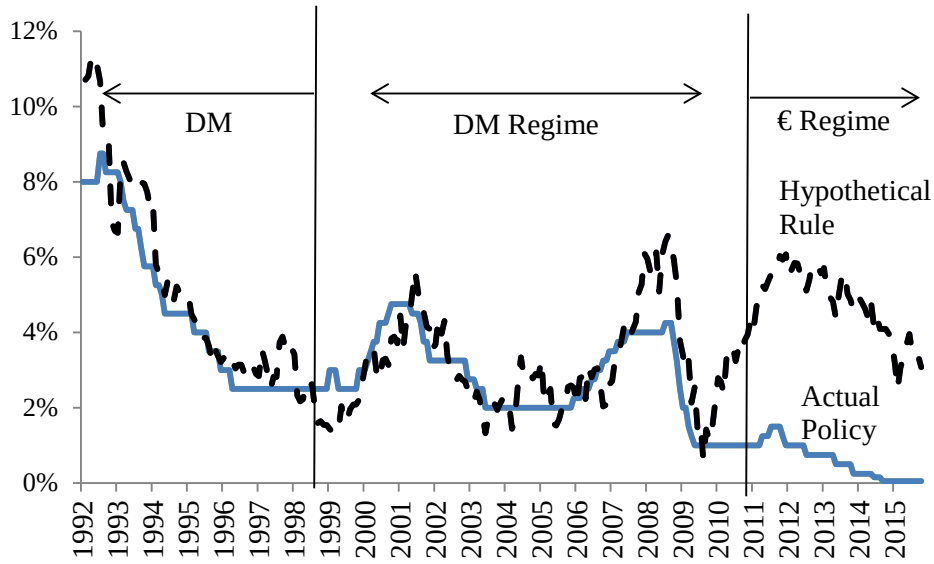
Portugal



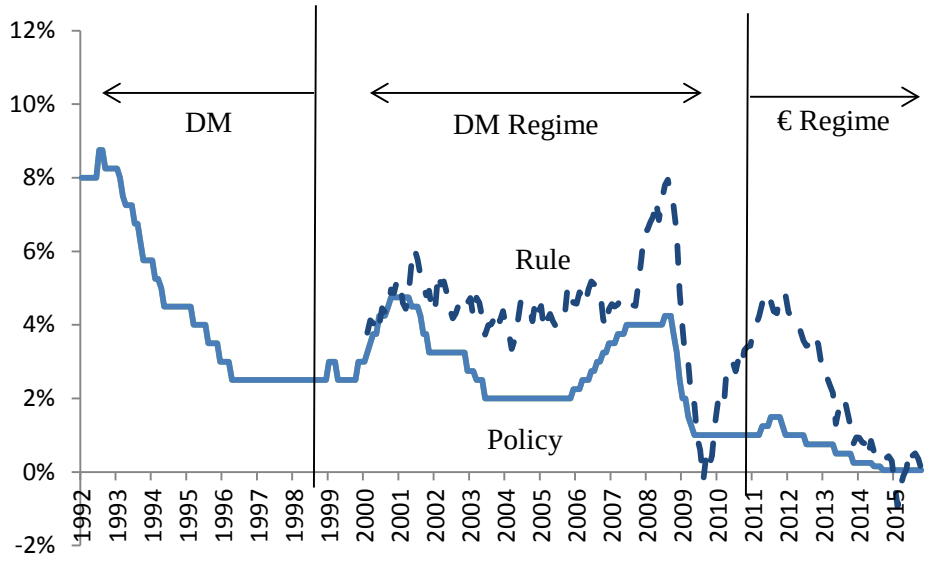
Sources: Eurostat, International Monetary Fund, OECD, and the authors.

Figure A.7. Taylor Rule versus Actual Policy Rate: Germany and Eurozone, 1992 to 2015

Germany



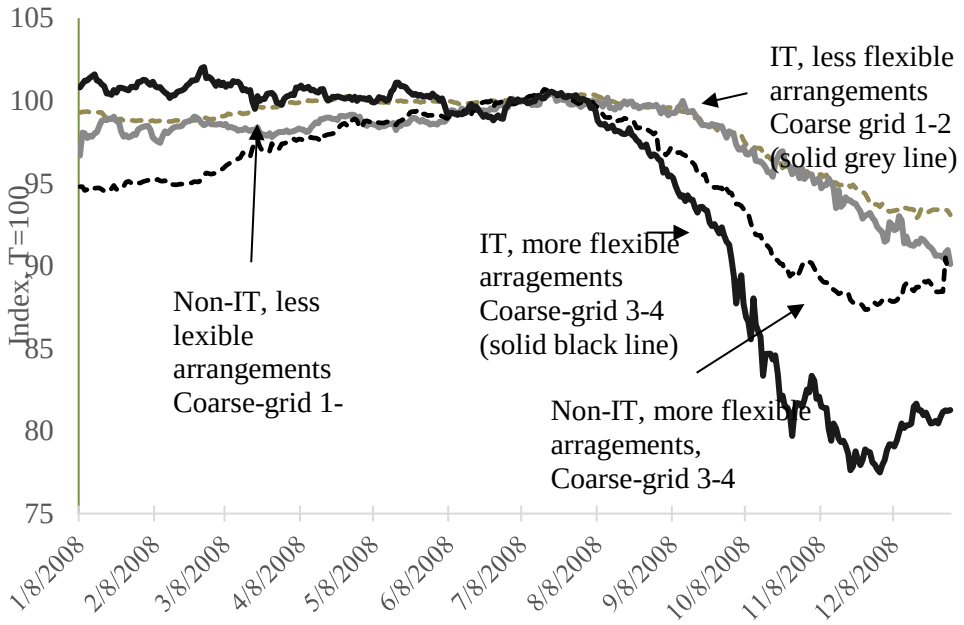
Eurozone



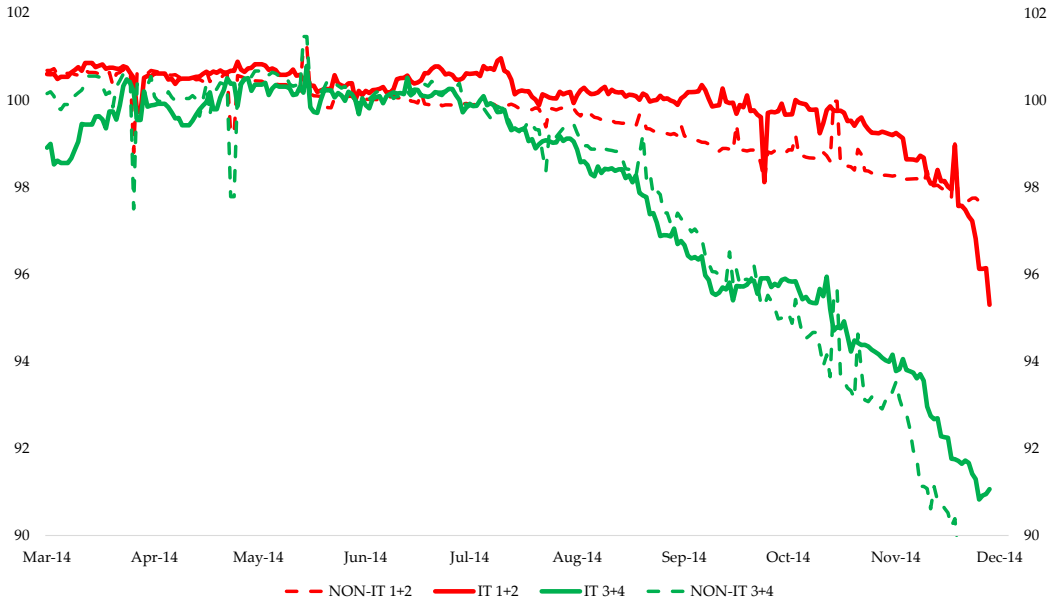
Sources: Eurostat, International Monetary Fund, OECD, and the authors.

Figure A.8. Stress Testing Inflation Targeters' Benchmark Currency Classification: Two Macreconomic Events, 2008 and 2014

Lehman, September 2008

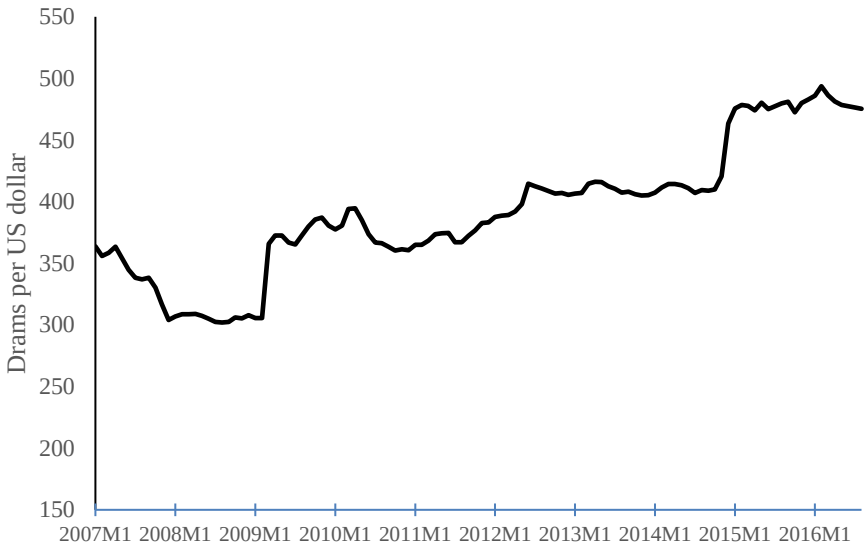


FOMC Minutes June 17-18, 2014



Sources: Bloomberg and the authors' calculations.

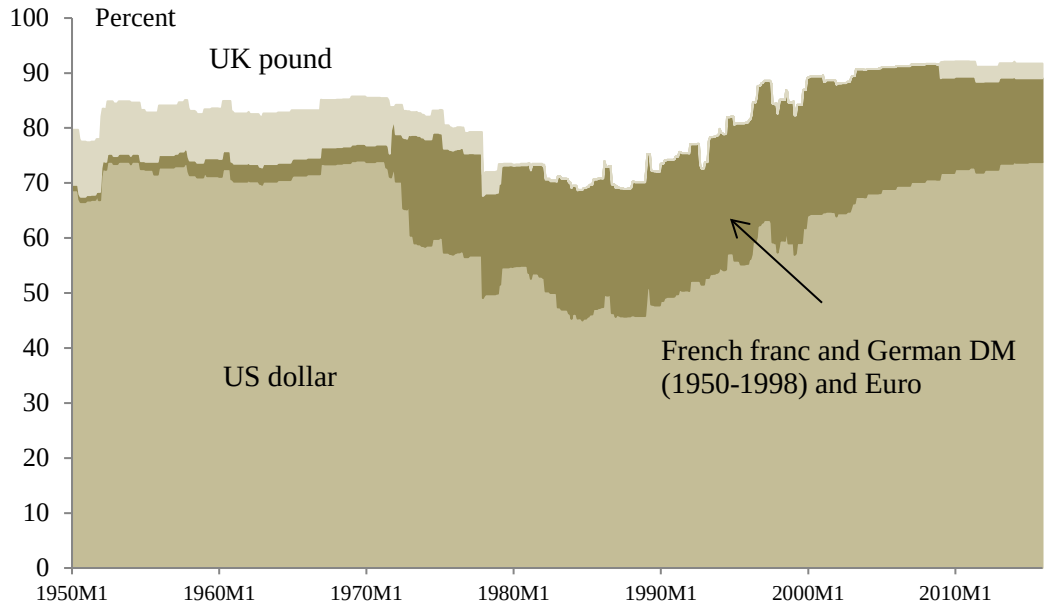
Figure A.9. The Armenian Dram-US Dollar Exchange Rate, 2007:1 to 2016:8



Source: International Monetary Fund, *International Financial Statistics.*

Figure A.10. Post-World War II Major Anchor Currencies

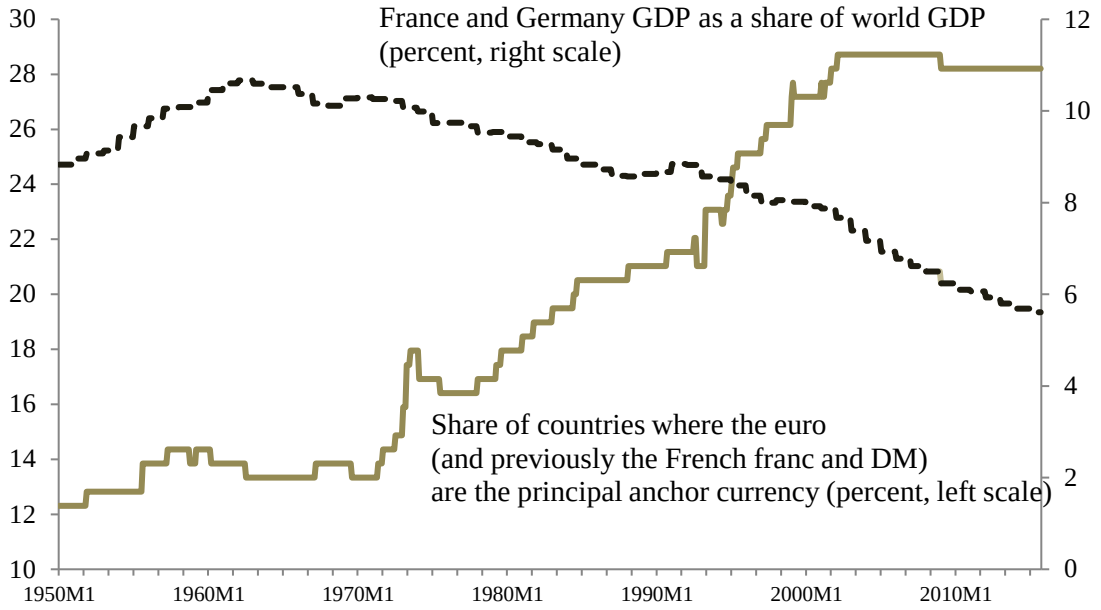
Number of countries weighted by their share in world GDP, 1950-2015, excludes freely falling cases



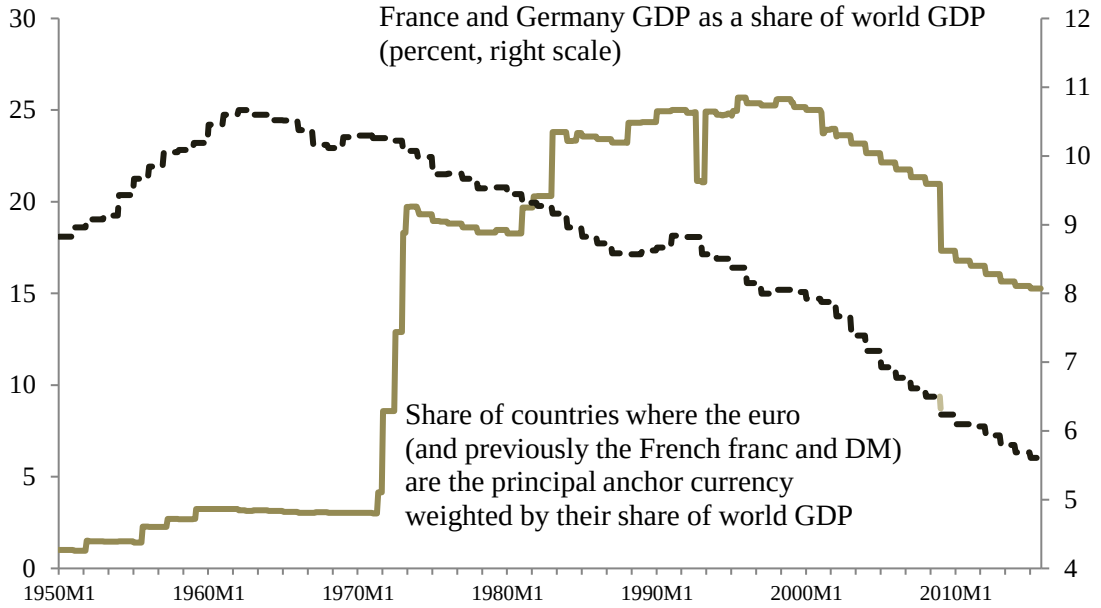
Sources: The Conference Board *Total Economy Database*, International Monetary Fund *International Financial Statistics*, and the authors' calculations
Note: The Country Chronologies that supplement this paper show the evolution of the anchor currency on a country-by-country basis.

Figure A.11: Measures of the Role of the French Franc, Deutschmark (1950-1998), and Euro (1999-2015) and French and German Economies in a Global Context

Share of countries measure



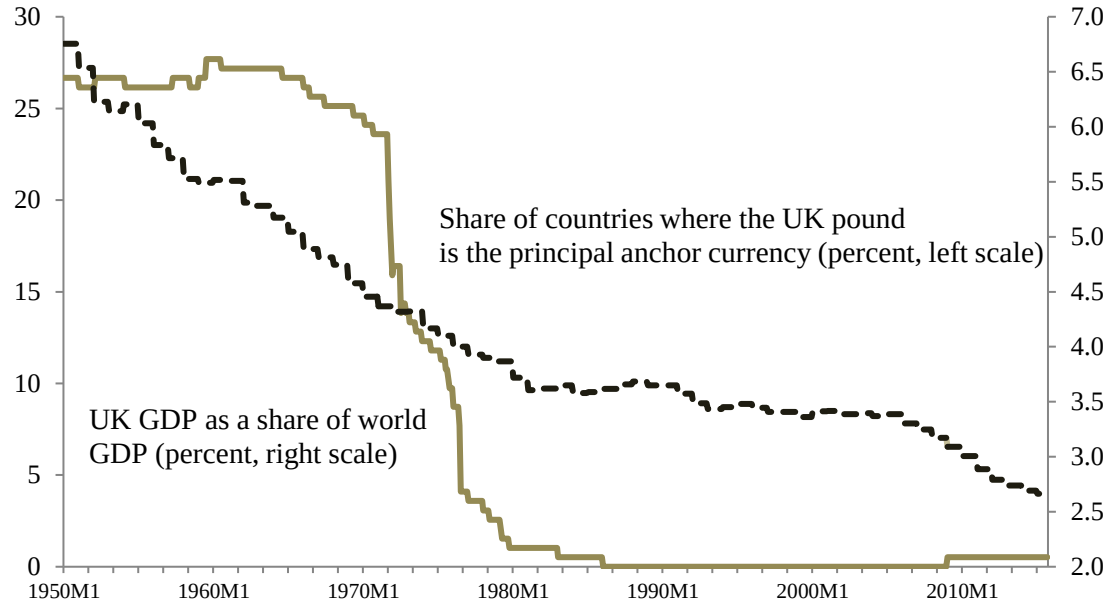
Share of countries measure weighted by share of world income



Sources: The Conference Board *Total Economy Database*, International Monetary Fund *International Financial Statistics*, and the authors' calculations.

Figure A.12. Measures of the Role of the UK Pound and the UK Economy in a Global Context, 1950-2015

Share of countries measure



Share of countries measure weighted by share of world income

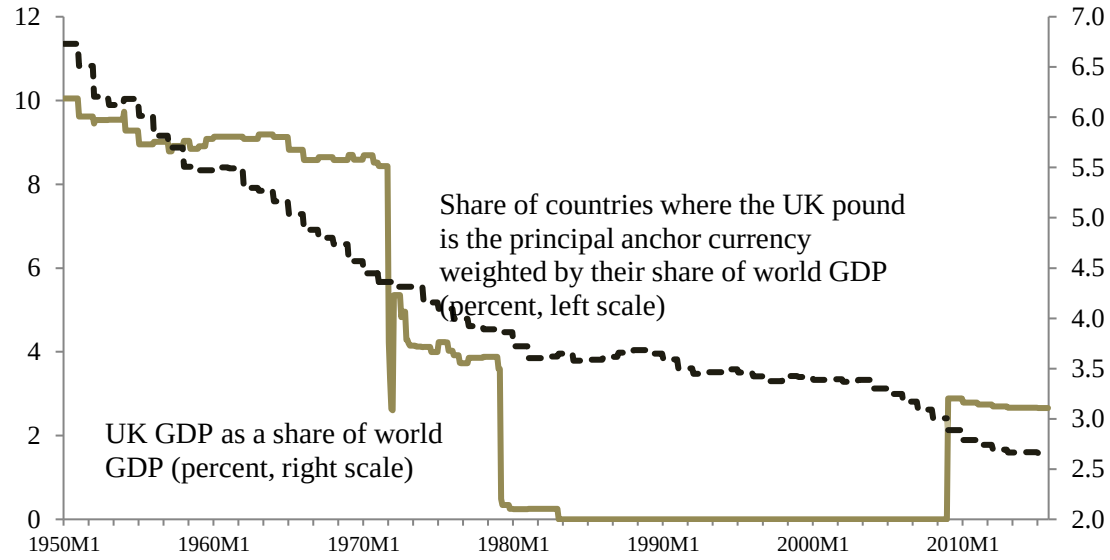
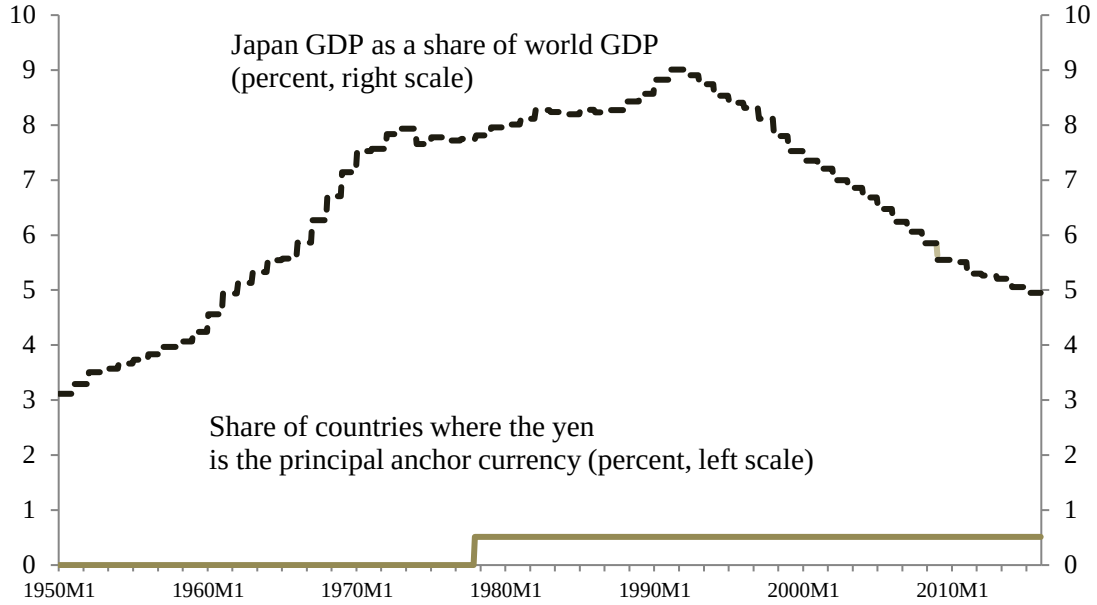


Figure A.13: Measures of the Role of the Yen and the Japanese Economy in a Global Context, 1950-2015
Share of countries measure



Share of countries measure weighted by share of world income

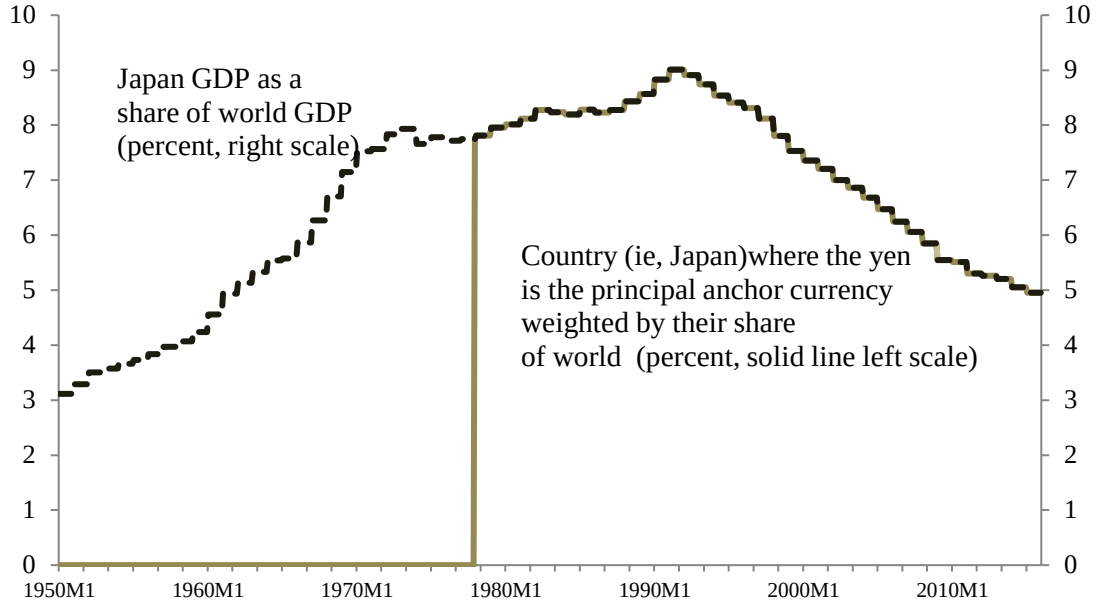
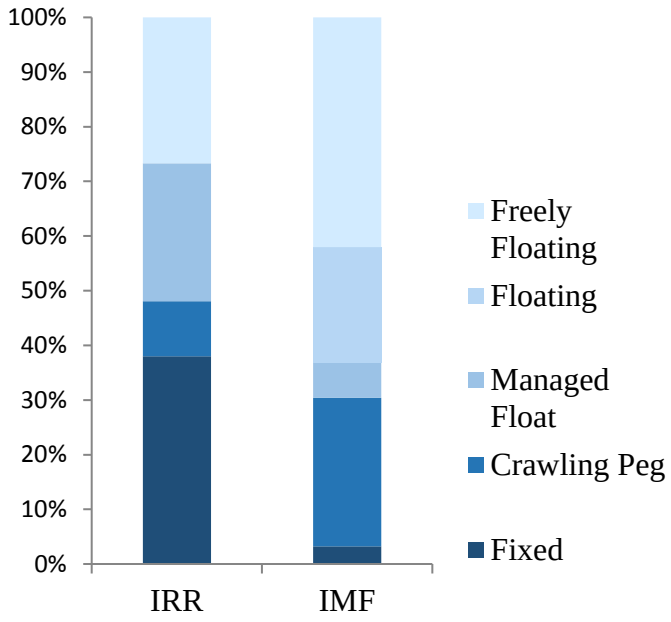


Figure A.14: Share of World GDP by Exchange Arrangement: Ilzetzki, Reinhart and Rogoff (2016) and IMF (2014)



Sources: International Monetary Fund *Annual Report on Exchange Arrangements and Exchange Restrictions* and the authors.

Table A.1. Fine and Coarse De Facto Exchange Rate Arrangement Classification

	The fine classification codes are:
1	• No separate legal tender or currency union
2	• Pre announced peg or currency board arrangement
3	• Pre announced horizontal band that is narrower than or equal to +/-2%
4	• De facto peg
5	• Pre announced crawling peg; de facto moving band narrower than or equal to +/-1%
6	• Pre announced crawling band that is narrower than or equal to +/-2% or de facto horizontal band that is narrower than or equal to +/-2%
7	• De facto crawling peg
8	• De facto crawling band that is narrower than or equal to +/-2%
9	• Pre announced crawling band that is wider than or equal to +/-2%
10	• De facto crawling band that is narrower than or equal to +/-5%
11	• Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)
12	• De facto moving band +/-5%/ Managed floating
13	• Freely floating
14	• Freely falling
15	• Dual market in which parallel market data is missing.

	The coarse classification codes are:
1	• No separate legal tender
1	• Pre announced peg or currency board arrangement
1	• Pre announced horizontal band that is narrower than or equal to +/-2%
1	• De facto peg
2	• Pre announced crawling peg
2	• Pre announced crawling band that is narrower than or equal to +/-2%
2	• De factor crawling peg
2	• De facto crawling band that is narrower than or equal to +/-2%
3	• Pre announced crawling band that is wider than or equal to +/-2%
3	• De facto crawling band that is narrower than or equal to +/-5%
3	• Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)
3	• Managed floating
4	• Freely floating
5	• Freely falling
6	• Dual market in which parallel market data is missing.

Table A.2. Dollar and Euro Benchmark Currency Indexes for Eight Marginal Anchor Classifications 2016

Country	Dollar Benchmark Index	Euro Benchmark Index
Brazil	62%	4%
Canada	35%	5%
Chile	48%	9%
Columbia	71%	0%
Iceland	23%	19%
India	63%	7%
Israel	37%	12%
Turkey	40%	25%

Sources: Authors' calculations based on Gopinath (2015), World Bank intl. debt statistics and national central banks.

Table A.3. Countries with Inflation Targets and Their De Facto Exchange Rate Arrangements

Country	Start date	Exchange rate arrangement
Armenia, Republic of	January 2006	+/-2% crawling band. US dollar.
Australia	June 1993	Freely floating
Brazil	June 1999	Managed floating
Canada	February 1991	Managed floating
Chile	September 1999	Managed floating
Colombia	October 1999	Managed floating
Czech Republic	December 1997	+/-2% band. Euro
Ghana	May 2007	De facto crawling peg and later +/-2% band. Large devaluations and nearly freely falling. Managed floating since December 2010.
Guatemala	December 2005	Crawling peg
Hungary	June 2001	De facto crawling band +/- 2% since 2009. Euro. Broader band prior.
Iceland	March 2003	Managed floating.
Indonesia	July 2005	De facto crawling band +/-2 to 5% range, depending on the sub-period considered. US dollar.
Israel	June 1997	Managed floating
Korea, Republic of	April 1998	De facto moving band +/-2 to 5% range, depending on the sub-period considered.
Mexico	December 2001	Managed floating
New Zealand	December 1989	Managed floating
Norway	March 2001	De facto moving band +/-2%. Euro.
Peru	January 2002	De facto crawling band +/-2%. US dollar.
Philippines	January 2002	De facto crawling band +/-2%. US dollar.
Poland	December 1998	De facto crawling band +/-2 to 5% range, depending on the sub-period considered. Euro.
Romania	August 2005	De facto peg since 2012. Euro. De facto crawling band, 2-5%, depending on sub-period.
Serbia	January 2009	De facto crawling peg. Euro.
South Africa	February 2000	Managed floating
Sweden	December 1995	De facto moving band +/-2% since 2008. Euro.
Thailand	May 2000	De facto Moving band +/-2%. US dollar.
Turkey	January 2006	Managed floating
United Kingdom	October 1992	Freely floating since January 2009. Moving band, +/-2%. Euro earlier subsample.
Memorandum items:		
Number (share) of IT cases with more flexible arrangements (Coarse grid 3-4)	17 (63%)	Australia, Brazil, Canada, Chile, Colombia, Iceland, Israel, Korea, Mexico, New Zealand, Norway, South Africa, Sweden, Thailand, Turkey, United Kingdom, and Ghana more recently.
Number (share of IT cases with least flexible arrangements (Coarse grid 1-2)	10 (37%)	Armenia, Czech Republic, Guatemala, Hungary, Indonesia, Peru, Philippines, Poland, Romania, and Serbia

Table A.4. Estimated Taylor Rules for Inflation Targeting Countries
Unbalanced Panel 1990-2015

	Regression Results w. Country Fixed Effects Dependent Variable = Nominal Interest Rate				
	1	2	3	4	5
Inflation	.68***	.67***	.74***	.74***	.73***
	(.014)	(.015)	(.017)	(.017)	(.017)
Log(Exchange Rate)		2.24***	2.03***	1.99***	1.60***
		(.144)	(.147)	(.150)	(.150)
Unemployment				.10***	.07***
				(.017)	(.017)
Commodity Price Inflation					1.00
					(.628)
Inflation*"Fixed"			-.19***	-.19***	-.18***
			(.026)	(.026)	(.026)
Log(Exchange Rate)*"Fixed"			.34***	.36***	.34***
			(.053)	(.053)	(.054)
Commodity Price Inflation*"Fixed"					.22
					(.168)
R^2	0.32	0.35	0.36	0.36	0.36
N	4717	4666	4665	4574	4529

Table A.5. Trade Invoicing Patterns in 49 Countries, 1999:Q1-2014:Q4

	Share of countries (excluding home country) where invoicing in the anchor currency > 0			Average share (excluding home country): imports, exports, trade in the anchor currency			Summary of incidence
	Imports	Exports	Trade	Imports	Exports	Trade	and volume
US dollar	93.8	95.8	94.8	43.0	44.1	43.6	69.2
Euro	93.3	83.9	88.6	25.0	19.7	22.3	55.5
UK pound	18.8	14.6	16.7	0.3	0.4	0.4	8.5
Japanese yen	22.9	14.6	18.8	0.7	0.3	0.5	9.6

Source: Gopinath (2015) and authors' calculations.

Table A.6. Country Coverage

Country	Official exchange rate	Parallel market exchange rate
Albania	1954:12-2001:12	1954:12-1998:12
Algeria	1946:1-2001:12	1955:1-1998:12
Argentina	1946:1-2001:12	1946:1-1998:12
Armenia	1992:4-2001:12	n.a.
Australia	1946:1-2001:12	1946:1-1998:12
Austria	1946:1-2001:12	1946:1-1998:12
Azerbaijan	1992:12-2001:12	n.a.
Belarus	1992:1-2001:12	1991:8-1998:12
Belgium	1946:1-2001:12	1946:1-1998:12
Benin	1946:1-2001:12	1970:7-1998:12
Bolivia	1946:1-2001:12	1948:1-1998:12
Bosnia-Herzegovina	1997:1-2001:12	n.a.
Botswana	1946:1-2001:12	1989:1-1998:12
Brazil	1946:1-2001:12	1946:1-1998:12
Bulgaria	1946:7-2001:12	1946:7-1998:12
Burkina Faso	1946:1-2001:12	1970:7-1998:12
Burundi	1946:1-2001:12	1983:1-1998:12
Cameroon	1946:1-2001:12	1970:7-1998:12
Canada	1946:1-2001:12	1947:1-1998:12
Central African Republic	1946:1-2001:12	1970:7-1998:12
Chad	1946:1-2001:12	1970:7-1998:12
Chile	1946:1-2001:12	1948:1-1998:12
China	1951:1-2001:12	1949:9-1998:12
Colombia	1946:1-2001:12	1952:1-1998:12
Congo, Democratic Republic of	1946:1-2001:12	1962:1-1996:12
Congo, Republic of	1946:1-2001:12	1970:7-1998:12
Costa Rica	1946:1-2001:12	1948:1-1998:12
Cote D'Ivoire	1946:1-2001:12	1970:7-1998:12
Croatia	1992:12-2001:12	1991:12-1998:12
Cyprus	1955:1-2001:12	1970:7-1998:12
Czech Republic	1946:1-2001:12	1946:1-1998:12
Denmark	1946:1-2001:12	1946:1-1998:12
Dominican Republic	1946:1-2001:12	1960:3-1998:12
Ecuador	1946:1-2001:12	1947:1-1998:12
Egypt	1946:1-2001:12	1946:1-1998:12
El Salvador	1946:1-2001:12	1961:1-1998:12
Equatorial Guinea	1946:1-2001:12	1970:7-1998:12
Estonia	1992:62001:12	1991:8-1998:12
Finland	1946:1-2001:12	1946:1-1998:12
France	1946:1-2001:12	1946:1-1998:12
Gabon	1946:1-2001:12	1970:7-1998:12
Gambia	1946:1- 2001:12	1985:1-1998:12
Georgia	1995:10-2001:12	n.a.
Germany	1946:1-2001:12	1946:1-1998:12
Ghana	1946:1- 2001:12	1962:3-1998:12
Greece	1946:1-2001:12	1946:1-1998:12

Table A.6. Country Coverage (continued)

Country	Official exchange rate	Parallel market exchange rate
Guatemala	1946:1-2001:12	1985:1-1998:12
Guinea	1949:1-2001:12	1970:7-1998:12
Guinea-Bissau	1946:1-2001:12	1970:7-1998:12
Guyana	1946:1-2001:12	1985:1-1998:12
Haiti	1946:1-2001:12	1985:1-1998:12
Honduras	1946:1-2001:12	1985:1-1998:12
Hong Kong	1946:1-2001:12	1946:1-1998:12
Hungary	1946:8-2001:12	1946:8-1998:12
Iceland	1946:1-2001:12	1949:1-1998:12
India	1946:1-2001:12	1946:1-1998:12
Indonesia	1946:1-2001:12	1947:1-1998:12
Iran	1946:1-2001:12	1947:1-1998:12
Iraq	1946:1-2001:12	1947:2-1998:12
Ireland	1946:1-2001:12	1946:1-1998:12
Israel	1948:5-2001:12	1946:1-1998:12
Italy	1946:3-2001:12	1946:1-1998:12
Jamaica	1946:1-2001:12	1974:1-1998:12
Japan	1946:3-2001:12	1946:3-1998:12
Jordan	1950:7-2001:12	1955:1-1998:12
Kazakhstan	1993:11-2001:12	n.a.
Kenya	1946:12- 2001:12	1966:12-1998:12
Kuwait	1949:9-2001:12	1970:7-1998:12
Kyrgyz Republic	1993:5-2001:12	n.a.
Laos	1946:1-2001:12	1959:1-1998:12
Latvia	1992:2-2001:12	1991:8-1998:12
Lebanon	1946:1- 2001:12	1946:1-1998:12
Lesotho	1946:1-2001:12	1985:1-1998:12
Liberia	1946:1-2001:12	1989:1-1998:12
Libyan Arab Republic	1952:1-2001:12	1955:1-1998:12
Lithuania	1992:1-2001:12	1991:9-1998:12
Luxembourg	1946:1-2001:12	1946:1-1998:12
Macedonia	1993:12-2001:12	1997:6-1998:12
Madagascar	1946:1- 2001:12	1985:1-1998:12
Malawi	1946:1 2001:12	1970:7-1998:12
Malaysia	1946:1-2001:12	1946:1-1998:12
Mali	1946:1-2001:12	1970:7-1998:12
Malta	1946:1-2001:12	1985:1-1998:12
Mauritania	1946:1- 2001:12	1974:1-1998:12
Mauritius	1946:1-2001:12	1985:1-1998:12
Mexico	1946:1-2001:12	1947:1-1998:12
Moldova	1991:12-2001:12	n.a.
Mongolia	1970:3-2001:12	1970:3-1998:12
Morocco	1956:10-2001:12	1959:1-1998:12
Myanmar	1946:1-2001:12	1955:1-1998:12
Nepal	1955:12-2001:12	1970:7-1998:12
Netherlands	1946:1-2001:12	1946:1-1998:12
New Zealand	1946:1-2001:12	1948:1-1998:12
Nicaragua	1946:1-2001:12	1947:1-1998:12
Niger	1946:1-2001:12	1970:7-1998:12
Nigeria	1946:1-2001:12	1970:7-1998:12

Table A.6. Country Coverage (concluded)

Country	Official exchange rate	Parallel market exchange rate
Norway	1946:1-2001:12	1946:1-1998:12
Pakistan	1946:1-2001:12	1948:4-1998:12
Panama	1946:1-2001:12	n.a.
Paraguay	1946:1-2001:12	1951:3-1998:12
Peru	1946:1-2001:12	1946:1-1998:12
Philippines	1946:1-2001:12	1949:8-1998:12
Poland	1946:1-2001:12	1946:1-1998:12
Portugal	1946:1-2001:12	1946:1-1998:12
Romania	1957:1-2001:12	1946:7-1998:12
Russian Federation	1992:6-2001:12	1946:1-1998:12
Saudi Arabia	1952:10-2001:12	1959:12-1998:12
Senegal	1946:1-2001:12	1970:7-1998:12
Singapore	1946:4-2001:12	1973:5-1998:12
Slovak Republic	1993:1-2001:12	1993:1-1998:12
Slovenia	1991:12-2001:12	n.a.
South Africa	1946:1-2001:12	1946:1-1998:12
South Korea	1946:1-2001:12	1946:1-1998:12
Spain	1946:1- 2001:12	1946:1-1998:12
Sri Lanka	1946:1-2001:12	1956:1-1998:12
Suriname	1949:9-2001:12	1970:7-1998:12
Swaziland	1946:1-2001:12	1985:1-1998:12
Sweden	1946:1-2001:12	1946:6-1998:12
Switzerland	1946:1-2001:12	1946:1-1998:12
Syrian Arab Republic	1947:7-2001:12	1970:7-1998:12
Tajikistan	1992:1-2001:12	n.a.
Tanzania	1946:12- 2001:12	1970:7-1998:12
Thailand	1946:5-2001:12	1948:1-1998:12
Togo	1946:1-2001:12	1970:7-1998:12
Tunisia	1956:3-2001:12	1960:1-1998:12
Turkey	1946:1- 2001:12	1946:1-1998:12
Turkmenistan	1993:11-2001:12	n.a.
Uganda	1946:12- 2001:12	1970:7-1998:12
Ukraine	1992:12-2001:12	1991:8-1998:12
United Kingdom	1946:1-2001:12	1946:1-1998:12
United States	1946:1-2001:12	n.a.
Uruguay	1946:12- 2001:12	1946:1-1998:12
Venezuela	1946:1-2001:12	1960:11-1998:12
Zambia	1946:12- 2001:12	1970:7-1998:12
Zimbabwe	1946:12- 2001:12	1970:7-1998:12

Table AI.2. Data Sources

Variable	Source
Official exchange rate, 1946-1956	Pick's Currency Yearbook and Pick's World Currency Report, various issues.
Official exchange rate, 1957-2001	IMF, International Financial Statistics
Parallel Market exchange rate 1946-1980	Pick's Currency Yearbook, Pick's Black Market Yearbooks, and Pick's World Currency Report, various issues.
Parallel Market exchange rate 1980-1998	World Currency Yearbook, various issues.
Consumer price index, 1957-2001	IMF, International Financial Statistics