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130 YEARS OF FISCAL VULNERABILITIES AND CURRENCY CRASHES IN ADVANCED ECONOMIES

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ABSTRACT

130 years of fiscal vulnerabilities and currency crashes in advanced economies*

This paper investigates the empirical link between fiscal vulnerabilities and currency crashes in advanced economies over the last 130 years, building on a new dataset of real effective exchange rates and fiscal balances for 21 countries since 1880. We find evidence that crashes depend more on prospective fiscal deficits than on actual ones, and more on the composition of public debt (i.e. rollover/sudden stop risk) than on its level per se. We also uncover significant nonlinear effects at high levels of public debt as well as significantly negative risk premia for major reserve currencies, which enjoy a lower probability of currency crash than other currencies ceteris paribus. Yet, our estimates indicate that such premia remain small in size relative to the conditional probability of a currency crash if prospective fiscal deficits or rollover/sudden stop risk are high. This suggests that a currency's international status is not necessarily sufficient to shelter it from collapse.

JEL Classification: F30, F31 and N20
Keywords: advanced economies, banking crises, currency crashes, exchange rates, fiscal vulnerability, foreign debt, reserve currencies and total debt level

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1. Introduction

The global crisis that erupted in 2007, and the subsequent challenges for sovereign debt sustainability in several advanced economies, have brought the vulnerabilities created by unsound public finances back into the spotlight. The freefall of output that occurred at the height of the crisis resulted in rapid global policy responses, in particular through substantial fiscal measures to support financial sectors and jump-start economic activity. But these have also left as a legacy an unprecedented peacetime deterioration in public finances. This is notably the case in advanced economies, where market concerns have risen about sovereign default risk, darkening the prospects of some of these economies' future growth and the stability of their currencies.

Some observers openly fear that this story could end in currency "crashes" down the line (e.g. Rubin (2011)). Most notably, market speculation about a possible implosion of the euro area escalated in the wake of the Greek, Irish and Portuguese debt crises in 2010/11, before euro area authorities took measures to safeguard the area's financial stability. Similarly, risks associated with stubbornly large fiscal deficits and public debt in the United States or the United Kingdom are often considered as weighing on prospects for the US dollar and the pound sterling in coming years. Eichengreen (2010), for instance, argues that the dollar would "lose its international currency status" if the United States were to "fail to put its financial and fiscal house in order". At the same time, the US dollar remained resilient in the immediate aftermath of the downgrade by Standard & Poor's of the US's long term sovereign credit rating in August 2011, confounding earlier fears that such a downgrade could result into a disorderly adjustment in foreign exchange markets.

There is remarkably little empirical work on the link between fiscal vulnerabilities and currency crashes for advanced economies, in sharp contrast with that on emerging market economies.[1] Only a handful of studies have a clear advanced economy focus. Some have looked at the *causes* of crashes, including Eichengreen, Rose and Wyplosz (1995), who study the realignments of fixed exchange rates and changes of exchange rate regimes in OECD countries over 1959-1993.[2] Studies exploring the *consequences* of crashes in industrial economies have shown that currency crashes have generally not led to an increase in bond yields (Gagnon 2009a), but are associated with poor macroeconomic outcomes (Gagnon 2009b).

[1] The wealth of empirical literature on –or inspired by– currency crashes in emerging market economies is indeed simply enormous (see e.g., among many others, Obstfeld, 1986; Frankel and Rose, 1996; Corsetti, Pesenti and Roubini, 1999; Kaminsky and Reinhart, 1999; Calvo and Reinhart, 2002), not to mention that on early warning models designed to predict currency crisis in these economies (e.g. Kaminsky, Lizondo and Reinhart, 1998; Berg and Patillo, 1999; Hemming, 2003; Kumar, Moorthy and Perraudin, 2003; Bussière and Fratzscher, 2006).

[2] Other studies include Tudela (2004), who looks at various macroeconomic determinants –but not public finances per se– of the probability of entry into a currency crisis state in the OECD over the period 1970-1997; and Wright and Gagnon (2006) who, in testing for the determinants of sharp depreciations of OECD countries' exchange rates over 1970-2005, find that the current account-to-GDP ratio plays an important role.

Perhaps one reason explaining why research in this area has remained scant is that currency crashes in mature economies have been relatively rare in the last couple of decades. But when one looks further back in time, such crashes have been more common. And now that the global crisis has put the spotlight on mature economies, and that the deterioration in their public finances has gained proportions unseen in recent history, taking a much longer term perspective might prove particularly insightful.

The intended contribution of our paper is to investigate whether and how fiscal vulnerabilities lead to currency crashes in mature economies, and to test empirically the importance of four key vulnerabilities over the last 130 years. The paper relies on a new dataset constructed by the authors on annual real effective exchange rates and fiscal balances over the period 1880-2009 for a sample of 17 OECD economies plus 4 emerging economies as a control group. This new database builds on the seminal work by e.g. Reinhart and Rogoff (2008a, 2008b, 2009a, 2009b, 2010), Reinhart (2010), Ali Abbas et al. (2010), Bordo, Meissner and Stuckler (2010) as well as Schularick and Taylor (forthcoming) on long-run macroeconomic time series, notably public debt and credit growth, and extends this work to fiscal balances and real effective exchange rates.

The long time span of our data is a significant improvement relative to existing datasets as we are able to add at least 80 years of annual observations. This allows us to examine global exchange rate developments at times when the global economy was hit by a crisis of a dimension akin to that of 2007-09 (i.e. the Great Depression of the 1930s) or when public debt and deficits were at similar or at even higher levels than they are today (e.g. during the first and second world wars, and other periods). We estimate binomial logit models to test whether the probability of a currency crash in our sample of countries depends on four key fiscal vulnerabilities that have been emphasised in the literature. In our benchmark specification, we define a currency crash as a depreciation of the real effective exchange rate (REER) in excess of 10% per year, which is about the 5th percentile of the distribution in our sample since 1880, though we also test for the robustness of our empirical analysis using several alternative specifications in terms of magnitude, time horizon and also looking at nominal exchange rates.

The literature emphasises at least four main fiscal vulnerabilities that could induce exchange rate crashes. A first one, which is linked to the actual size of fiscal deficits, derives from first-generation currency crisis models pioneered by Krugman (1979) and Flood and Garber (1984) in the aftermath of the collapse of the Bretton Woods system. The main point made by these models is that today's fiscal deficit, and the monetisation of such deficit, ultimately leads to a currency crash. Three decades afterwards, this view is still echoed in debates that emerged after the 2007-2009 global crisis, particularly on the ultimate impact of the quantitative easing measures taken by central banks in some advanced economies.

A second possible fiscal vulnerability relates to *prospective* rather than actual fiscal deficits. Such vulnerabilities became notably visible in the aftermath of the Asian crisis (Corsetti, Pesenti and Roubini, 1999; Burnside, Eichenbaum, Rebelo, 2001). Even if today's fiscal positions are sound (which was for instance also the case of most emerging Asian economies before the regional crisis that erupted in the late 1990s), *prospective* fiscal deficits and potential contingent liabilities (such as the cost of future bailouts of the banking system) can lead to a currency crisis *today* (see also Kaminsky and Reinhart, 1999). To the extent that the global crisis of 2007-2009 showed that even supposedly modern and sophisticated banking systems in advanced economies were not sheltered from a full-blown crisis, this view is of clear relevance not only to emerging market economies, but also to more mature ones.

A third potential fiscal vulnerability relates to roll-over and sudden stop risks (see for instance Calvo, 2006) and is also related to the discussion on the fiscal theory of the price level (Corsetti and Mackowiak, 2005; 2006). A high share of foreign debt heightens the vulnerability of a country to a sudden stop in capital flows and the probability of a currency crash because a pulling out of foreign investors is then more likely to trigger capital outflows and hence currency instability. A large share of foreign debt also raises the likelihood and magnitude of a currency collapse, as sudden stops and capital flight magnify the impact of a given fiscal deficit. The evidence we will present below suggests that there is significant heterogeneity in the composition of public debt issued by advanced economies, both across countries and time, which has therefore potentially strong implications in terms of their vulnerability to currency crashes.

A final fiscal vulnerability is linked to the level of public debt itself, rather than its composition. When the nominal debt burden is high, the government may either try to reduce its real debt via inflation or try to default on debt coming due. Rational agents will take this into account and demand a higher risk premium, thereby further increasing public financing requirements and making currency crises more likely. Benigno and Missale (2004) in this context show that the likelihood of a devaluation increases when the level of nominal debt is high. The authors call this the 'debt burden' effect.

Our main results are as follows. First, we find that fiscal vulnerabilities do lead to currency crashes, but that not all transmission channels matter to the same extent. We find weak evidence, in line with the empirical literature on emerging market exchange rate crashes, that actual fiscal deficits help explain why mature economies' currencies crashed over the last century. Larger actual fiscal deficits are found to be associated with an increase in the probability of a currency crash, but only to a limited extent. We find much stronger evidence for a role of prospective fiscal deficits, by contrast. Our results suggest that banking crises greatly magnify, by a factor of about six, the impact of a given fiscal deficit on the probability of a currency crash. For instance, in this case, we estimate that a fiscal deficit of about 10% of GDP (i.e. close to those of some of the worst performing advanced economies after today's global crisis) translates into a crash probability of about 30% over the next two years.

We also find limited evidence that large public debt levels per se have resulted in currency crashes in mature economies of the last 130 years. The evidence relating to the riskiness of debt composition is much stronger, however. Our estimates indicate that higher rollover/sudden-stop risk (i.e. more foreign debt) magnifies greatly, again by a factor of up to six, the impact of a given fiscal deficit on the probability of a currency crash. This suggests that a fiscal deficit of about 10% of GDP also translates into a crash probability of about 30%, when debt is largely foreign.

We also consider the presence of non-linear interactions between the debt burden and the other sources of fiscal vulnerability. In the theoretical literature, several studies (Feldstein, 1982; Giavazzi and Pagano, 1990; Blanchard, 1990; Perotti, 1999) support the view that public deficits can create strong nonlinear effects in relation to the level of debt.[3] Our results confirm the presence of such nonlinearities. In particular, whatever the source of vulnerability (be it actual or prospective fiscal deficits, or even vulnerability to rollover/sudden stop risk), the results indicate that the impact of a given fiscal deficit on the probability of a currency crash is systematically much larger at very high levels of debt (i.e. above 90% of GDP), possibly echoing the existence of Ricardian effects.

Finally, we find significant evidence of heterogeneity across countries, and notably of negative risk premia for allegedly safe haven currencies (the US dollar, the German Mark and the Swiss franc) suggesting that –ceteris paribus and conditioning on all other explanatory variables– these currencies enjoy a lower probability of currency crash than other mature economies' currencies. Importantly, we find that these premia are rather large relative to the *unconditional* probability of a currency crash in a given year, and that they could almost halve this probability. But they remain small relative to the *conditional* probability of a currency crash if prospective fiscal deficits are large or rollover/sudden stop risk is high, which suggests that a currency's international status is not sufficient to shelter it from crashing once a banking crisis occurs or the public debt structure is heavily tilted towards foreign ownership.

The rest of the paper is structured as follows. Section 2 presents our estimation strategy and the hypotheses tested. Section 3 describes our new dataset as well as key stylised facts and insights immediately gained from the data. Section 4 reviews the baseline estimation results and section 5 the robustness checks. Section 6 concludes and draws policy implications.

[3] These studies find that raising public deficits may generate Keynesian or anti-Keynesian effects, depending on the government position. In this context, when public debt is high, cutting deficits may reduce the default probability of the public sector and enhance confidence, which may have implications for exchange rate (in)stability.

2. Estimation and hypotheses

In this section, we outline the key motivations for our empirical analysis by linking our four fiscal vulnerabilities to currency crashes as proposed in the literature, and then present our empirical model specification.

2.1 Theoretical motivations

Why would fiscal vulnerabilities result in currency crashes? The literature has highlighted at least four fiscal vulnerabilities. A first vulnerability focuses on actual fiscal deficits and derives from first-generation currency crisis models pioneered by Krugman (1979) and Flood and Garber (1984) in the years after the collapse of the Bretton Woods system. The main point made by these models is that today's fiscal deficits, to the extent that they are financed by money printing, ultimately lead to a collapse of a currency peg.

A key assumption in Krugman (1979)'s model indeed, is that governments pay for their deficits either by issuing money (i.e. through seigniorage) or by drawing on foreign exchange reserves. In this setting, as long as a government is committed to an exchange rate peg, it "has no control over how its deficit is financed" (Krugman, 1979, p. 318). If it issues more money than the private sector is willing to hold, this excess money will be traded against foreign exchange, and reserves will fall. It is therefore the private sector's willingness to acquire newly issued money that determines the government's ability to finance its deficit by running down foreign exchange reserves. Krugman shows that a direct implication of this is that a currency crisis becomes ultimately inevitable if the government runs a fiscal deficit, no matter how large foreign exchange reserves initially are.

Flood and Garber (1984) develop this insight one step further with a continuous-time, perfect foresight model, which allows calculating the time of a currency crash explicitly (t^*), i.e.:

$$t^* = \frac{R(0)}{\mu} - \frac{\alpha}{\beta}$$

where $R(0)$ is the initial stock of reserves at time $t = 0$; μ is the rate of domestic credit growth (akin to the rate of domestic money growth in this model); α and β are constants (which need not be specified further for our purpose here). An immediate implication of their calculations is that faster money growth μ (i.e. more money printing due to higher fiscal deficits) accelerates the collapse of a currency.

A second fiscal vulnerability relates to prospective (rather than actual) fiscal deficits. It became clearly visible in the wake of the Asian crisis, and was analysed notably in Corsetti, Pesenti and Roubini (1999) as well as Burnside, Eichenbaum and Rebelo (2001). As the latter observe, the financing of fiscal deficits by money printing is unlikely to have played a major role in the crash of emerging Asia's currencies in

1997-98, since many economies in the region ran small fiscal deficits or even surpluses. At the same time, large potential contingent liabilities and prospective fiscal deficits associated with implicit bailout guarantees to failing banking systems might have been a likelier trigger of those currency collapses, to the extent that these future deficits were at least partially financed by seigniorage.

They articulate this view in a simple model of which the key feature is that a speculative attack becomes inevitable once the present value of future government deficits rise. To that end, they make a distinction between four specific time periods, namely: $t = 0$, i.e. when the banking crisis erupts and the private sector becomes aware that banks will have to be bailed out (and that future government deficits will rise); $t = t^*$, i.e. the time of the currency crash; $t = T$, i.e. the time when the currency reaches its new (steady-state) floating equilibrium after the crash (and money supply correspondingly increases); and $t = T'$, i.e. the time when the banking sector is bailed out. They show that, under certain conditions,

$$t^* = T - \frac{1}{\sigma b} \ln \frac{a - bP_T^{-\sigma}}{a - bS^{-\sigma}}$$

where P is the domestic price level; S the initially pegged (constant) exchange rate; σ the inverse of the elasticity of inter-temporal substitution of consumption; a and b (positive) functions of inter alia foreign money supply, consumption and the domestic interest. What comes out clearly from this equation is that, since the government increases the money supply at time T, P_T will generally be greater than S. In turn, this suggests that the collapse of the exchange rate will take place after the private sector has learned about the eruption of the banking crisis (and associated *expected* rise in fiscal deficits), but before banks have been bailed out.

A third fiscal vulnerability relates to rollover/sudden stop risk and is linked to the structure of government liabilities. A high share of foreign debt heightens the vulnerability of a country to sudden stops in capital flows and the probability of a currency crash, because the pulling out of foreign investors is then more likely to trigger currency instability.[4] A large share of foreign debt also magnifies a currency crisis and the impact of a given fiscal deficit, as sudden stops and capital flight magnify the impact of a given fiscal deficit. In particular, Corsetti and Mackowiak (2005, 2006), in extending Krugman (1979)'s classic model, show that the equilibrium devaluation rate at time $t^* = t$ in their setting and under certain conditions is:

[4] Some have arguably challenged the view that a high share of foreign debt is a source of financial vulnerability. For instance, Frankel and Schmukler (1996) found that domestic Mexican investors were the "front runners" in the peso crisis of December 1994, turning pessimistic before foreign investors. Different expectations about their own economy, perhaps due to asymmetric information, prompted Mexican investors to be the first ones to pull out from the country.

$$\frac{S_t}{S} = \frac{\frac{1+i^p}{i^p} + B_{t-1}}{\frac{(1+\pi_t^*)(1+r)}{r} + (1+\pi_t^*)B_{t-1} + \pi_t^* F_{t-1} - \frac{\Delta}{\ell_{t-1}}}$$

where r is the foreign interest rate; Δ a measure of the extent of fiscal adjustment that the government undertakes further to an exogenous shock (one example they consider is a foreign deflationary shock); i^p is the post-devaluation nominal interest rate; B the ratio of short-term to long-term government debt; F the ratio of foreign debt to long-term government debt; ℓ the real value of long term government debt (conditional on no devaluation); and π^*_t unexpected foreign inflation. In this framework, the higher the fraction of foreign debt, the larger the devaluation's magnitude is.[5]

A final vulnerability relates to the level of public debt. Concerns about the level of public debt have recently regained prominence as high debt levels tend to be more often associated with lower growth, higher inflation and currency crashes (see e.g. Reinhart and Rogoff, 2009b). Theoretically, Benigno and Missale (2004) show, using a three period, open economy version of the classic Barro-Gordon model, that the impact of public debt on the expectations of a first-period devaluation depends on the relative importance of debt burden and signalling effects. At low levels of debt, they show that the signalling effect prevails: public debt strengthens the signal of a successful defense of a fixed exchange rate. As the private sector anticipates that the government has an incentive to improve reputation, it assigns a lower probability to the event of a first-period devaluation. But at high levels of debt, it is the debt-burden effect that prevails: debt accumulation worsens the credibility of the exchange rate peg and, ultimately, heightens expectations of its collapse.

2.2 Econometric specification

We do not aim to provide a formal test for these models stricto sensu, but to test whether the key insights they convey hold empirically. Our benchmark specification is based on a standard, pooled binomial logit model that tests whether the four main fiscal vulnerabilities outlined in the theoretical motivation above contributed to increase the probability of currency crashes over the last 130 years in advanced economies, i.e.:

$$Y_{i,t} = \beta_i + \beta_2 X_{i,t-j} + \boldsymbol{\alpha}'\mathbf{Z}_{\mathbf{i,t-j}} + u_{i,t-j} \quad (1)$$

for actual fiscal deficits,

$$Y_{i,t} = \beta_i + \beta_2 X_{i,t-j} + \beta_3 (X_{i,t-j} \times D_{i,t-j}) + \beta_4 D_{i,t-j} + \boldsymbol{\alpha}'\mathbf{Z}_{\mathbf{i,t-j}} + u_{i,t-j} \quad (2)$$

[5] Indeed, if F increases, for a constant B, ℓ decreases and S_t/S increases.

for prospective fiscal deficits,

$$Y_{i,t} = \beta_i + \beta_2 X_{i,t-j} + \beta_3 (X_{i,t-j} \times \Phi_{i,t-j}) + \beta_4 \Phi_{i,t-j} + \boldsymbol{\alpha}'\mathbf{Z}_{\mathbf{i,t-j}} + u_{i,t-j} \tag{3}$$

for rollover/sudden stop risk,

$$Y_{i,t} = \beta_i + \beta_2 X_{i,t-j} + \beta_3 (X_{i,t-j} \times B_{i,t-j}) + \beta_4 B_{i,t-j} + \boldsymbol{\alpha}'\mathbf{Z}_{\mathbf{i,t-j}} + u_{i,t-j} \tag{4}$$

for the total debt level.

$Y_{i,t}$ is the log of the odds ratio of observing a currency crash in country i at time t and where the corresponding conditional probability of a crash $P_{i,t}$ follows a logistic distribution (i.e. $P_{i,t} = 1/[1+\exp(-Y_{i,t})]$); $X_{i,t}$ is the fiscal balance-to-GDP ratio, $u_{i,t}$ the residuals, the βs and αs are parameters to be estimated; $j = 1,\ldots\ n$ where n is the maximum lag order allowed in the regressions (set equal to 2 following various information criteria); D is a dummy which equals 1 when a banking crisis occurs in country i in year t and 0 otherwise; Φ is the share of foreign debt in total public debt in country i in year t; and B is the corresponding share of total public debt to GDP. We use a common constant in the benchmark specifications, but we allow for country-specific effects in the robustness checks, and test for their statistical significance.

Vector $\mathbf{Z}_{\mathbf{i,t}}$ includes control variables that, beyond the fiscal balance, banking crises or risky domestic debt structures, have been shown in past empirical research to be strongly associated with currency crises or crashes (see e.g. Frankel and Rose, 1996; Kaminsky, Lizondo and Reinhart, 1998; Kaminsky and Reinhart, 1999; Wright and Gagnon, 2006; Bussière and Fratzscher, 2006; as well as Reinhart and Rogoff, 2009b, for a survey of this literature). These controls include the deviation of the real effective exchange rate from its (15-year moving average) trend, the current account balance-to-GDP ratio (proxied here by the trade balance-to-GDP ratio, due to data availability), real GDP growth, real equity price changes, export growth (in local currency), the level of foreign yields.[6] We also control for global effects with an index of global commodity prices, and add control dummies for sovereign defaults and for the two world wars.

Importantly, to further control for the impact of foreign developments on exchange rates and on the domestic economy, we systematically include the corresponding US counterpart of the variables entered in the regressions. This is important because the effective exchange rate is a relative price to that of a country's

[6] We define the level of foreign yields as follows: for all countries (excluding the UK and the US), the foreign yield is the UK's yield before 1945 and the US's yield afterwards; for the US, the foreign yield is the UK's yield before 1945 and Germany's yield afterwards; for the UK, the foreign yield is the US's yield before and after 1945.

trading partners. This implies that the effect of e.g. fiscal policy of the home country on the exchange rate may also depend on the fiscal stance abroad.[7]

Parsimonious models are obtained following a general-to-specific approach to our estimation, building on the seminal work of Hendry (see, for instance, Hendry and Krolzig, 2005) to pare down the regression to a manageable number of independent variables. To that end, we start by estimating the model with all controls. We then eliminate the least statistically significant variable, using a significance threshold of 20%. We proceed step-by-step by excluding individual variables, and simultaneously testing at each step whether an already excluded variable should be included again (at the 10% level), until we arrive at a final model specification.

The key parameters of interest for our purpose are β_2 (the coefficient of the actual fiscal deficit) and β_3 (the coefficient of the interacted effect with prospective deficits, the debt composition or the level of total public debt). An empirical test of whether –and why– fiscal deficits lead to currency crashes is tantamount to rejecting the following null hypotheses:

$$H_0 : \hat{\beta}_2 \geq 0 \quad \text{(actual fiscal deficit)} \tag{5}$$
$$H_0 : (\hat{\beta}_2 + \hat{\beta}_3) \geq 0 \quad \text{(prospective fiscal deficits, rollover/sudden stop risk, public debt level)}$$

and accepting the alternative hypothesis that larger fiscal surpluses decrease the probability of observing a currency crash or, put differently, larger deficits (i.e. a more negative fiscal balance) increase this probability directly or when compounded by high prospective deficits, higher rollover/sudden stop risk or higher public debt.

In order to provide a better overview of the mapping between theory and estimation, Table A of Supplementary Appendix III reports a grid where each row pertains to a specific fiscal vulnerability along with (in subsequent columns) the main related theoretical papers, key variables used in the estimation to proxy such fiscal vulnerabilities, and the control variables.

We carry out a range of checks to test whether the results are robust to the benchmark specification. In particular, we test all the channels simultaneously (rather than separately) in an encompassing model. We also test for the existence of country heterogeneity in the constants, using random effect estimations, with a view to assessing whether the currencies in our sample are characterised by different risk premia. In addition, we consider the presence of non-linear interactions between the debt burden and the other sources of fiscal vulnerability. As our prime objective is to examine empirical regularities, we put all the information together in the baseline.

[7] We include the US as the foreign counterpart, rather than a weighted set of foreign countries, for data reasons but also as the US assumed the role of the main international currency as early as the 1920s (see Eichengreen, 2010). For the US itself, we use the UK before World War II and Germany thereafter as a counterpart.

However, we also test the extent to which the results are sensitive to alternative country samples, time periods, definitions of currency crashes and to using nominal (rather than real) exchange rates as further robustness checks.

2.3 Identifying currency crashes

Identifying currency crashes empirically – i.e. a large, infrequent and rapid depreciation of the exchange rate – is clearly definition-dependent. As an undisputed definition is lacking, we follow an agnostic approach. [8] We use alternative definitions of currency crashes based on pure statistical terms, following established practices in the literature, together with a more qualitative distinction between "sudden" and "protracted" ones.

We focus our analysis on real effective exchange rates. The focus on real – rather than nominal– exchange rates stems from the fact that we aim to capture currency movements that do have disruptive implications for the real economy, as they are most relevant from a policy perspective. We also concentrate our attention on effective–rather than bilateral– exchange rates with a view to identifying currency crashes with greater assurance.[9] Arguably, the models described in sub-section 2.1 were developed in the context of nominal exchange rate pegs, but what we intend to capture here are fundamental economic forces or pressures that build up and possibly lead a currency to a crash, hence our focus on REERs. However, we also examine nominal effective exchange rates in the robustness checks.

Our benchmark specification focuses on "sudden" currency crashes, which we define as the annual rate of depreciation of a country's REER in excess of 10%. Importantly, we employ a one-year exclusion window in order to avoid counting the same collapse twice. A 10% threshold is clearly ad-hoc, although it is economically sensible to capture the notion of a "sudden" crash. It filters through only those depreciations that are relatively abrupt (i.e. within one year), relatively infrequent (roughly the bottom 5th percentile of the distribution of one-year real effective exchange rate changes across the sample) and large (typically from 10% to above 40%, with a median at -16%).[10]

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[8] For instance, Frankel and Rose (1996, p. 353) define currency crashes in emerging economies as a nominal bilateral depreciation vis-à-vis the US dollar "of at least 25%". Fratzscher and Bussière (2006, p. 959) define a currency crisis in emerging economies as the event when their exchange market pressure index is "two standard deviations or more above its country average". Gagnon (2009a, p. 163) defines currency crashes in advanced economies as an exchange rate depreciation of "at least 8 percent in year *t*, followed by a cumulative depreciation in years *t* and *t*-1 of over 20 percent, with this two-year depreciation being at least 10 percentage points greater than the depreciation over year *t*-2".

[9] Effective rates allow us to identify currency collapses less ambiguously than simple bilateral rates. Since bilateral rates are by definition relative prices, movements in the latter are indeed not interpretable in an unambiguous way. For instance, an increase in the pound sterling-US dollar exchange rate could reflect either an appreciation of the pound or a depreciation of the US dollar or perhaps even both.

[10] It is worth stressing that 10% is a very large magnitude indeed since we consider here *real effective* depreciations that occur over just one year. For instance, between August 2010 –when Chairman

Alternative definitions of currency crashes are considered in the robustness checks. We examine "more protracted", "even more protracted" and "very protracted" currency crashes, i.e. the bottom 5th percentile depreciations over two, three and five years (with a one-year, two-year and four-year exclusion window, respectively); we also consider "very abrupt" currency crashes (in excess of 18%), i.e. the bottom 2th percentile depreciations (with a one-year exclusion window).

3. Data

In this section, we discuss the construction of our dataset for the period 1880-2009 as well as a few stylised facts that can be gained from our data.

The new dataset that we construct has annual data on real effective exchange rates for 21 economies over 1880-2009, including the Group of Seven (G7) most advanced economies (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States), ten other advanced economies (Australia, Belgium, Denmark, the Netherlands, Finland, Norway, Portugal, Spain and Sweden) and four emerging market economies (Argentina, Brazil, India and Mexico). The long time span of our data is a significant improvement relative to existing datasets available from official sources, for instance the Bank for International Settlements (BIS), the International Monetary Fund (IMF) or national central banks, which generally provide data from the 1960s, 1970s or even sometimes only the 1990s. We therefore add at least 80 years of observations, which allows us to examine global exchange rate developments at times when the global economy was hit by a crisis of a dimension akin to that of 2007-09 (i.e. the Great Depression) or when public fiscal deficits and debt levels were nearly as high or even higher than they are today (e.g. during the two world wars).

Our real effective exchange rate indices are calculated in a standard fashion as geometrically weighted averages of real bilateral exchange rates (see Supplementary Appendix I for further details). To that end, we use bilateral nominal exchange rate series and consumer price indices taken from *Global Financial Data* (GFD); trade weights are calculated using data from Mitchell (1998a, 1998b and 1998c) and the IMF's Direction of Trade Statistics (see Supplementary Appendix II for a more detailed description of the sources and key characteristics of the data used to construct our effective exchange rate indices).

Figure 1 shows the evolution over 1880-2009 of the real effective exchange rate of our 21 countries. A noteworthy feature is that our long-run real effective exchange rates track rather well the standard, shorter, series available from the BIS after the 1960s and 1970s (also reported for comparison), which suggests that they

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Bernanke announced QE2–and May 2011, the US dollar lost 7% in effective terms. This was sufficient to trigger a debate about "currency wars" and capital controls by emerging economies. A depreciation of such magnitude would yet be insufficient to qualify as a currency crash under our baseline definition. Those captured here are therefore really large –and potentially disruptive– ones.

should reflect reasonably well developments that occurred previously. Figure 2 plots the "sudden" currency crashes in our sample by country and over time. There are 99 such crashes in total, with marked heterogeneity across both countries and time. For instance, Australia and Canada (two commodity exporters) have a relatively large number of crashes, while the US, Germany and Switzerland (along with Denmark) have much fewer; Japan had many crashes before 1945, a period when it was still an emerging economy, but only one thereafter.

Considering the data on public finances, we build on Reinhart and Rogoff's work on public debt (see Reinhart and Rogoff 2008a, 2009b, 2010), and hand-collect from the League of Nations' *Statistical Yearbooks,* as well as national sources, data on our 21 countries' fiscal balance positions (see Table C in Supplementary Appendix II for further details). We use similar sources to collect data on total public debt and foreign debt (see Table D in Supplementary Appendix II for further details).

The sources of the data for the control variables used in our models are reported in Table B of Supplementary Appendix II. In this respect, Figures A and B of Supplementary Appendix III show the average fiscal balance and total public debt as a share of GDP over 1880-2009 for the G7 economies, other advanced economies and emerging market economies. What comes out strongly from the figures is that fiscal deficits and debt levels in the G7 were in 2009 as high as never before, with the exception of the two world wars. Figure C of Supplementary Appendix III plots the banking crises in our sample by country and over time and suggests that, even in advanced economies, such crises were not infrequent throughout the last 130 years. The data reported here include all (systemic and non-systemic) banking crises, which are included in the baseline estimations; estimates using only the banking crises deemed systemic (about 85% of all episodes) are presented in the robustness checks. Figure D of Supplementary Appendix III shows the share of foreign debt in total public debt across the three country groups, which is found to be generally higher in our emerging market economies' sample than in the G7 economies.

4. Baseline results

We start by determining the optimal lag order j of the models. Both the z-statistics and likelihood ratio tests suggest that a specification with a second-order lag systematically outperforms specifications with first-order lags or contemporaneous values. The latter in addition would risk being endogenous to the contemporaneous occurrence of a currency crash, which would impair any causal interpretation of the results.

Another issue that deserves particular attention in our estimations is that of potential endogeneity between fiscal policy and the international monetary system's nature. One might indeed argue that adopting the gold standard was a signal that countries sent to express their commitment to pursue prudent fiscal and monetary policy (good housekeeping). Countries might in turn be rewarded through lower risk premia which ultimately allowed them to run higher fiscal deficits (see, for instance, Bordo and Rockoff, 1995). Moreover, the number of observations varies across international monetary regimes: for instance, we have only 6 currency crashes before 1913 in our sample, against 36 crashes in the interwar period and 46 crashes after 1945 (see Table B in Supplementary Appendix III for further details). We will yet show in the robustness checks that these challenges remain contained as our empirical findings are qualitatively similar for both the gold standard and the current floating era, with prospective fiscal deficits being found to be the main source of fiscal vulnerability in both periods (see the discussion in Supplementary Appendix IV).

We next consider the importance and significance of each of the main fiscal vulnerabilities in turn. A first result that comes from our benchmark regressions is that there is some evidence that a rise in actual fiscal deficits increases the probability of a currency crash in advanced economies. As can be seen from Table 1a, higher fiscal deficits increase significantly a country's probability of experiencing a "sudden" currency crash (see column 1 for results without controls and columns 2 and 3 for results with controls, including the corresponding US counterpart of the variables entered in the regressions). However, the economic significance of this effect is limited, with the elasticity of the fiscal balance with respect to the log of the odds of the currency crash probability standing at barely -0.02/-0.03 (in other words, an improvement of 1 percentage points of GDP in the fiscal balance reduces the odds of observing a currency crash by about 2%). Our finding that the impact of actual fiscal deficits on the probability of a currency crash is limited is broadly in line with the empirical literature on emerging market currency crashes (see, for instance Hemming, 2003) and industrial currency crashes. As to the latter Gagnon and Wright (2006) find that a 1 percentage point improvement in the fiscal balance to GDP ratio reduces the odds of observing a currency crash by 0.3% (i.e. still less that our own estimate).[11]

Looking beyond the results on the fiscal balance, we can consider the parsimonious model as reported in column 3. The deviation of the real effective exchange rate from its long term trend and real equity price changes are the variables that remain significant after applying our general-to-specific approach to estimation; they enter with an economically meaningful sign, with exchange rate overvaluation and domestic equity market corrections preceding a currency crash two years after.[12] These results echo similar findings in Kaminsky, Lizondo and Reinhart (1998). However, the importance of export growth is not supported by our results and, in contrast to Frankel and Rose (1996) –who analyse determinants of emerging market currency crashes– we do not find that foreign interest rates are key explanatory variables for currency crashes.

Considering prospective (rather than actual) fiscal deficits, our evidence suggest that their importance for currency crashes is much stronger, in line with

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[11] Once controlling for other factors, they even find that the coefficient for the fiscal balance to GDP ratio becomes insignificant.

[12] As a measure of fit of the baseline models, we report both their scaled resolution (as described in Galbraith and van Norden, 2011) and McKelvey and Zavoina's *R*-squared.

Kaminsky, Lizondo and Reinhart (1998) and Reinhart and Rogoff (2010). The results are shown in Table 1b. Large fiscal deficits combined with a banking crisis tend to precede a subsequent currency crash. The economic significance of the combined effect of fiscal deficits and banking crises (i.e. the sum of the estimated coefficients of the interacted variable and of the fiscal balance) is in the order of -0.20, i.e. about six to seven times larger than that previously estimated for the direct fiscal channel alone (according to the estimates, an improvement of 1 percentage points of GDP in the fiscal balance –in conjunction with a banking crisis– reduces the odds of a currency crash by about 18%). The results are robust across various specifications, i.e. without (column 1) or with controls (columns 2 and 3). The most parsimonious model is shown in column 3 and, again, exchange rate deviation from its long term trend and real equity price changes are the controls that remain after general-to-specific exclusion. The corresponding US counterpart interaction is significant, of opposite sign (quite expectedly) and of a comparable economic magnitude, suggesting that it is indeed important to control for the influence of foreign developments.

We also find some evidence in support of the view that high rollover/sudden stop risk (i.e. a higher share of foreign debt) increases the odds of a currency crash as can be seen from the results in Table 1c. Large fiscal deficits in countries where public debt is largely foreign precede a currency crash by two years. The economic significance of the combined impact of fiscal deficits and foreign debt (i.e. the sum of the estimated coefficients of the interacted variable and of the fiscal balance) is in the order of -0.18, i.e. again around six times larger than that previously estimated for the direct fiscal channel alone. The results are robust across various specifications, i.e. without (column 1) or with controls (columns 2 and 3). Our results are in line with those of Bordo and Meissner (2005) who find that higher exposure to foreign currency debt increased the probability of a currency crisis over the sample period 1972-1997 (although over their sample period 1880-1913 they can only confirm this result when public debt was mismanaged).[13] Frankel and Rose (1996)'s results on emerging economies are more mixed, and they note that most debt composition variables in their regressions are not significant (but they attribute this to potential multicollinearity among their explanatory debt composition variables). Looking at the other estimation results, we find that the corresponding US counterpart of foreign debt is significant, of opposite sign (quite expectedly) and of an even larger economic magnitude, confirming that it is important to control for the influence of foreign developments. The most parsimonious model is shown in column 3. Exchange rate deviation from its long term trend is again a control variable that remains after general to specific exclusion and with an economically meaningful sign (exchange rate overvaluation precedes a crash two years later).

The public debt to GDP ratio appears to have only a small and weakly statistically significant, if any, impact on the probability of a currency crash. As shown in the parsimonious models of Table 1d, a 1 percentage point increase in the

[13] Mismanaged in the case of Bordo and Meissner (2005) implies that countries do not match their foreign currency liabilities with foreign currency reserves or take out such debt in proportion to their export earning potential.

public debt to GDP ratio increases the odds of a currency crash by a mere 0.7%. There are few studies that have so far considered the impact of the level of public debt on the probability of a currency crash. However, insofar as high levels of public debt increase the probability of a sovereign default, several studies have documented the increased risk of currency crashes when sovereigns default (see for instance Reinhart and Rogoff, 2010). The results concerning the other variables are similar to those in the other regressions.

Finally, we test the importance of the various fiscal vulnerabilities simultaneously –rather than separately– in an encompassing model. The regression results, reported in Table 2, suggest that the impact on the probability of a currency crash of having (i) a large fiscal deficit combined with (ii) a banking crisis and (iii) a large share of foreign debt are sizeable. The coefficient of the triple interaction between these variables is indeed very much larger, at around -6, than that estimated with any of the baseline models. Note however that we lose about a third of the sample relative to the baseline specifications (due to the more limited availability of data for the foreign debt channel).

Figures 3a to 3d provide more detailed evidence on the impact of the various sources of fiscal vulnerability on the probability of a currency crash. The charts plot the conditional probability of a crash against the size of the fiscal balance as a percentage of GDP (Figure 3a), including banking crisis (prospective fiscal deficit) effects (Figure 3b), foreign debt (rollover/sudden stop risk) effects (Figure 3c) and total public debt (Figure 3d). The probabilities are calculated using the corresponding parsimonious models and under two scenarios: (i) when the control variables are set at the 5%-ile values of their historical distribution and (ii) when the control variables are set at the 95%-ile values of their historical distribution.

The charts confirm and illustrate quantitatively the results previously discussed. Considering first the direct effects only, with fiscal deficits even in excess of 50% of GDP (which happened only twice in history, in the Netherlands and Belgium during the Second World War) the probability of a currency crash reaches barely 10-20% under the two scenarios (Figure 3a). Considering now the combined effects of a fiscal deficit with a banking crisis (i.e. prospective fiscal deficits), a fiscal deficit of about 10% of GDP (i.e. close to those of some of the worst performing advanced economies after today's global crisis) now translates into a crash probability of about 30% at the mid-point of the two scenarios (Figure 3b). And considering the combined effects of a fiscal deficit with foreign debt effects (i.e. rollover/sudden stop risk), a fiscal deficit of about 10% of GDP also translates into a crash probability of about 30% at the mid-point of the two scenarios (Figure 3c). Finally, when looking at large debt to GDP ratios of e.g. around 100% of GDP (comparable with those in some of the major advanced economies after today's global crisis), we find that the probability of a currency crash depends crucially on the values taken by the other control variables (as this probability ranges between around 5 to 40%).

Another insightful perspective provided by the baseline results is provided in Figures 4a and 4c which plot a century of currency crash probabilities for the US dollar and the pound sterling, i.e. the two currencies that dominate –or used to dominate– the international monetary system. These probabilities are also estimated using the parsimonious models corresponding to each of the main sources of fiscal vulnerability. The model nicely picks up all the crash episodes for the US dollar, i.e. the crash probability peaks in 1934 (exit of gold standard), 1985 (Plaza agreement) and 2003 (emergence of global imbalances).[14] The model is somewhat less successful for the pound sterling, but still picks up four (out of ten) crash episodes, namely in 1918 (end of World War I), 1942 (World War II), 1982 (global recession) and –a bit less though– in 1993 (ERM crisis). It is also interesting to observe that sterling allegedly lost pre-eminence to the US dollar as the international monetary system's main reference currency in the 1920s (see e.g. Eichengreen, 2010), a historic event which was framed by two significant currency crashes (one in the wake of World War I and the other in 1931), broadly picked up by our models.

What are the main fiscal vulnerabilities behind US dollar crash episodes over the last century? Figure 4b helps to assess this by plotting the estimated conditional probability of a sudden crash for the US currency for our four parsimonious models together with the actual US fiscal deficit (upper left quadrant), US banking crises (upper right quadrant), the share of foreign debt in total US public debt (lower left quadrant) and the share of public debt in GDP (lower right quadrant). What comes out nicely from the charts is that the 1934 crash was characterised by a rise in US fiscal deficits to over 5% of GDP, in the wake of the Great Depression, a string of banking crises, and rising public debt (in excess of 50% of GDP). The 1985 crash episode was also associated with rising fiscal deficits (again over 5% of GDP), banking crises (the Savings and Loans crisis), growing debt levels but also a higher share of foreign debt (i.e. higher rollover/sudden stop risk). This puts the downgrade of US sovereign debt in mid-2011 in interesting context (i.e. with no currency crash yet, but large deficits, growing public debt and a large share of foreign-owned public debt).

5. Robustness and extensions

Turning to the robustness of the findings, we first test to what extent there is evidence of heterogeneity in our sample of advanced economies' currencies. Table 3 reports estimation results where a logit estimator with (random) country effects in the constants is used rather than a pooled logit one. Statistically significant effects capture time-invariant, country-specific characteristics of advanced economies' currencies that are relevant to explain their probability of experiencing a crash, *after* controlling for the effect of all the other explanatory variables.

[14] It is useful to bear in mind that the probability is indeed predictive of a crash, since it is calculated using explanatory variables lagged by two years (i.e. as of 1932, 1983 and 2001). One might also argue that the 1985 crash was a "controlled" one, since the aim of the G7's Plaza agreement was precisely to let the dollar depreciate. But the "controlled" nature of the crash is dubious: the dollar's fall was such that the G7 had to undertake concerted interventions (Louvre agreement of 1987) to put a floor to it.

Such a specification also helps to assess whether the US dollar, for instance, is different from the other 20 countries in our sample, because it is the dominant international currency. In other words, it helps to assess whether the relationship as estimated on the pooled sample is the same for the dominant international currency.

We therefore interpret these effects as risk premia. For the purpose of the estimations, we take the parsimonious baseline model corresponding to each of the sources of fiscal vulnerability. Results for actual fiscal deficits are reported in column 1; those for prospective fiscal deficits in column 2; those for rollover/sudden stop risk in column 3; those for the total debt level in column 4. What comes out clearly is that there is significant evidence of country heterogeneity for all sources of vulnerabilities, except rollover/sudden stop risk. The standard deviation of the country-specific effects (reported in the shaded row of Table 3) is indeed not significantly large for the latter source. But the main message of the table remains that allowing for country effects does not change our key results: there is much stronger evidence (both in terms of statistical significance and economic magnitude) for prospective (rather than actual) fiscal deficits, and for debt composition (rather than its level) as a source of vulnerability.

Figure 5 show the estimated country effects (left quadrant), as well as the corresponding country-specific currency crash probabilities (right quadrant). Significantly positive (negative) effects can be interpreted as positive (negative) risk premia. They can be compared easily with the unconditional probability of a currency crash.[15] An interesting pattern that emerges from the charts is that safe havens currencies (including the US dollar, the German Mark and the Swiss franc) have negative risk premia, together with a few other currencies (like the Danish krone or the Dutch guilder). This suggests that –ceteris paribus and conditioning on all other explanatory variables– such currencies enjoy a lower probability of currency crash than those of other mature economies. By contrast, high-yielding or commodity currencies (e.g. the Australian dollar and the Canadian dollar) have positive risk premia. This suggests that –ceteris paribus and conditioning on all other explanatory variables– these currencies have a higher probability of currency crash than other mature economies' currencies.

The estimated premia are rather large relative to the unconditional probability of a currency crash in a given year. For instance, the country-specific crash probability for the US dollar is in the order of 2.5% per year (i.e. the US dollar crashes about once every 40 years), which is to be compared with an unconditional probability of a currency crash of about 5% per year across the sample. In other words, the internationally dominant status of the US dollar could almost halve the unconditional probability of a currency crash. However, the size of the premia remains small (i.e. in the order of a few percentage points) relative to the conditional probability of a currency crash should a banking crisis occur or if public debt is

[15] The unconditional probability is the frequency of such crashes across all countries and all years in the sample.

largely foreign. As aforementioned, this conditional probability is estimated to reach about 30% per year under plausible conditions. This therefore suggests that a currency's international status is not sufficient per se to shelter it from a collapse.[16]

Do the results vary with the level of public debt? In the theoretical literature, several studies would support the view that public deficits engender strong nonlinear effects in relation to the level of debt.[17] These studies find that raising public deficits may create Keynesian or anti-Keynesian effects, depending on the level of debt. In this context, when public debt is high, cutting deficits may reduce the default probability of the public sector and enhance confidence. To test whether such nonlinearities exist, we follow Reinhart and Rogoff (2010) and split our countries into separate groups, namely those for which the level of public debt is (i) below 60% of GDP, (ii) between 60% and 90% of GDP and (iii) above 90% of GDP. We then run separate regressions for each of these buckets and each of the transmission channels (using the corresponding parsimonious baseline model).

Figure E in Supplementary Appendix III summarises the results, with the dots in the figure indicating the estimated point elasticity of a currency crash relative to the actual fiscal balance (blue ones), the prospective fiscal balance (red ones) and the rollover/sudden stop risk effects (purple ones). What comes out from the results is that, whatever the source of vulnerability, the impact of a given fiscal deficit on the probability of a currency crash is systematically and significantly much larger (i.e. the elasticity is more negative) at very high levels of debt (i.e. above 90% of GDP) than at intermediate levels or low levels of public debt, where the impact is insignificant. This underscores the existence of significant nonlinear effects in the level of public debt, possibly reflecting Ricardian effects.[18]

Last, we also test the sensitiveness of our results to different country samples, time periods, inclusion of potential omitted variables (such as credit growth), definition of currency crashes or banking crises. The detailed results are reported in Supplementary Appendix IV to save space, but the main message that emerges from these additional robustness checks is that the gist of our findings remains unaltered.

[16] Additional estimates (not reported here to save space but available upon request) might also tend to nuance the alleged special character of the US dollar in the face of severely deteriorated public finances. When calculating indeed the conditional probability of a currency crash if fundamentals are set to (i) the sample's mean and (ii) US mean values, we obtain essentially the same crash probabilities. This suggests that US fundamentals are very similar to the average sample fundamentals and that, under similar conditions, the US dollar would crash as frequently as the average currency.

[17] In this context, see inter alia Feldstein (1982); Giavazzi and Pagano (1990); Blanchard (1990); Perotti (1999).

[18] As a further robustness check, we repeat the exercise using the public debt data of Ali Abbas et al. (2010). The results (not reported here to save space, but available upon request) confirm that the effects are stronger at very high levels of public debt both for the direct fiscal and foreign debt channels. There are also significant nonlinearities for the banking crisis channel, although the effects are found to be stronger at intermediate levels of public debt (60-90% of GDP) rather than high levels. We also find some evidence of nonlinearities in the level of fiscal deficits (not reported here to save space).

6. Conclusions

To uncover the link between fiscal deficits and currency crashes in mature economies, this paper has tested four main sources of vulnerability through which such deficits may have led to currency crashes over the last 130 years. The paper has built and exploited for this purpose a new extensive dataset constructed by the authors on real effective exchange rates and fiscal balances in 21 countries over 1880-2009.

The paper has shown that fiscal vulnerabilities do lead to currency crashes, but that not all sources matter to the same extent. In particular, there is weak evidence that crashes depend on the magnitude of actual fiscal deficits per se, and much stronger evidence that they depend on prospective deficits (i.e. associated with a banking crisis). There is also weak evidence that crashes depend on the level of public debt, but much stronger evidence on the role of its composition (i.e. of rollover/sudden stop risk if public debt is largely foreign-owned). We have also uncovered significant nonlinear effects at high levels of public debt and fiscal deficits as well as significantly negative risk premia for major reserve currencies, which enjoy a lower probability of currency crash than other currencies ceteris paribus. Our estimates yet indicate that such premia remain small in size relative to the conditional probability of a currency crash if a banking crisis occurs or if public debt is largely foreign. This suggests that a currency's international status is not necessarily sufficient to shelter it from collapse.

Using a battery of robustness checks, we have further shown that our results are strongest for G7 (i.e. the most advanced) economies, and that there are some findings that are broad-based and stretch across the various international monetary regimes we have witnessed over the last 130 years. Using alternative definitions of currency crashes, we also find that the results hold well for relatively abrupt currency collapse definitions (i.e. over one or two years), but not for those pertaining to multi-year declines (i.e. over three years or more). This suggests that the drivers of these two manifestations of currency weakness might be of a fundamentally different nature. Last we have shown that our results are unaltered when using nominal, rather than real, effective exchange rates.

Although the focus of our paper has been to help explain currency crashes over the last century, our results might also help shed light on current discussions about the future of the international monetary system, although they should obviously be interpreted with caution. It is interesting to stress again in this respect that sterling allegedly lost pre-eminence to the US dollar as the international monetary system's main reference currency in the 1920s, a historic event which was framed by two significant currency crashes (one in the wake of first world war and the other in 1931), broadly picked up by our models.

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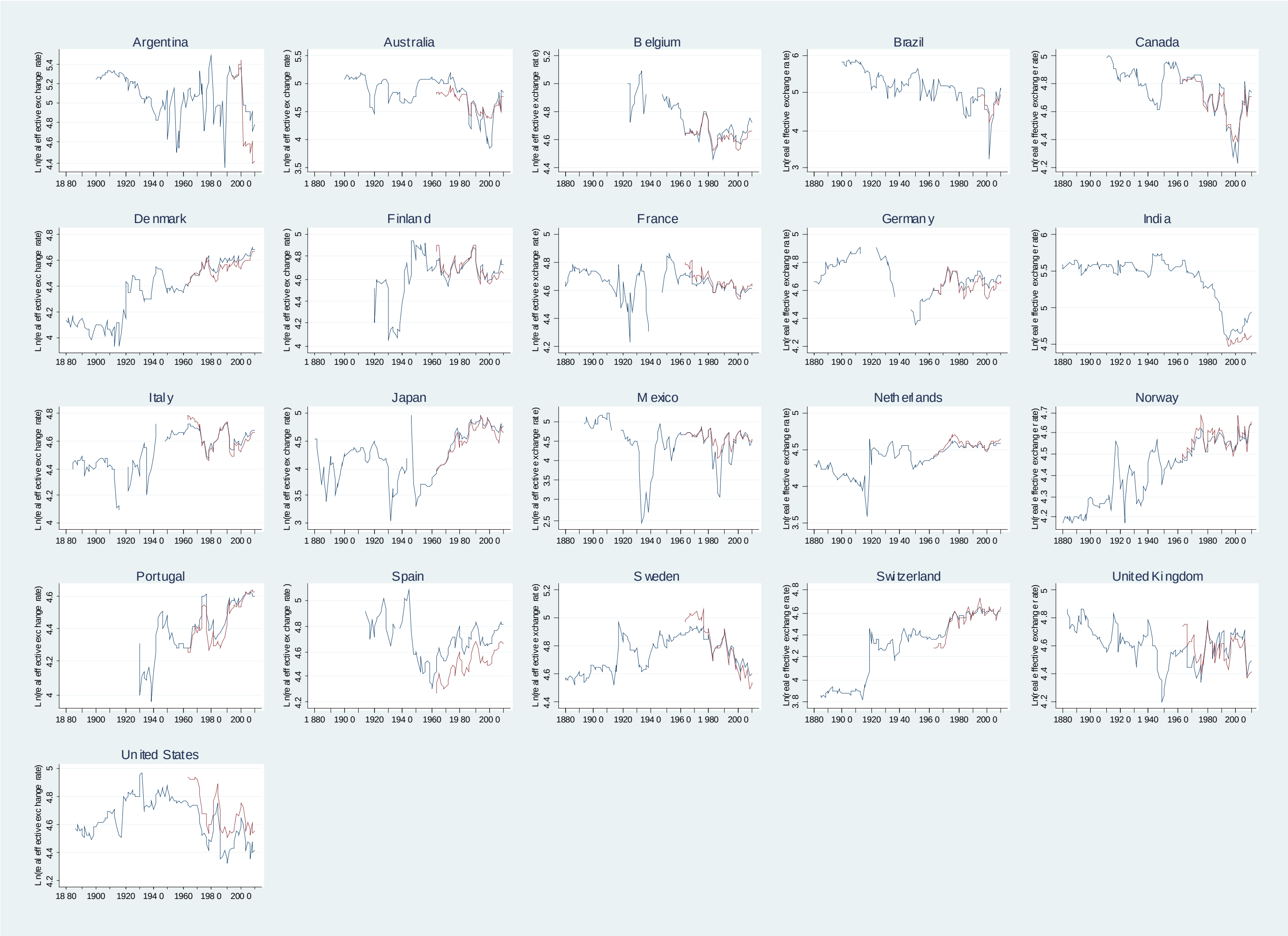
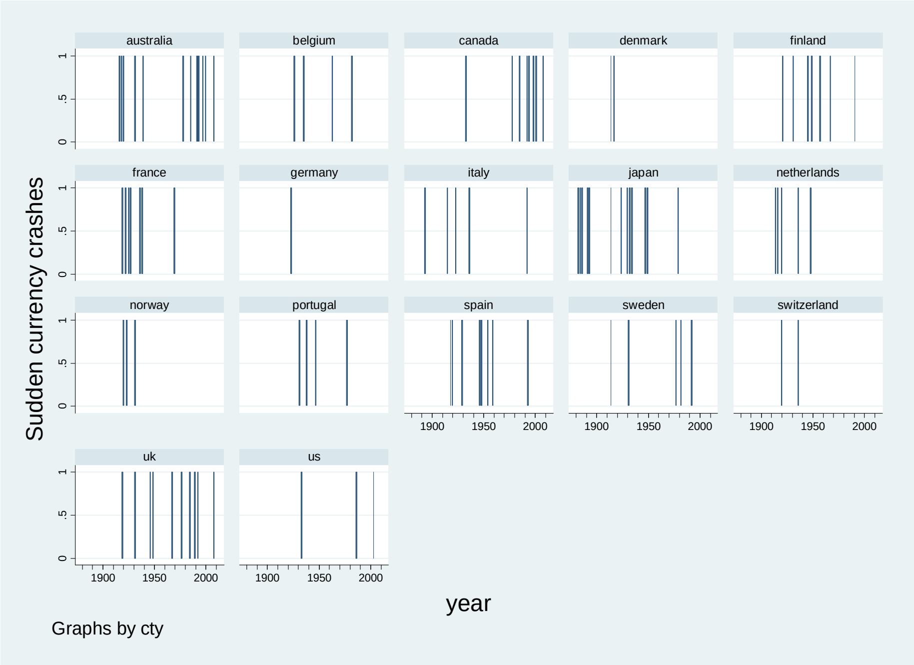
Figure 1: Real effective exchange rates in advanced and emerging market economies: 1880-2009



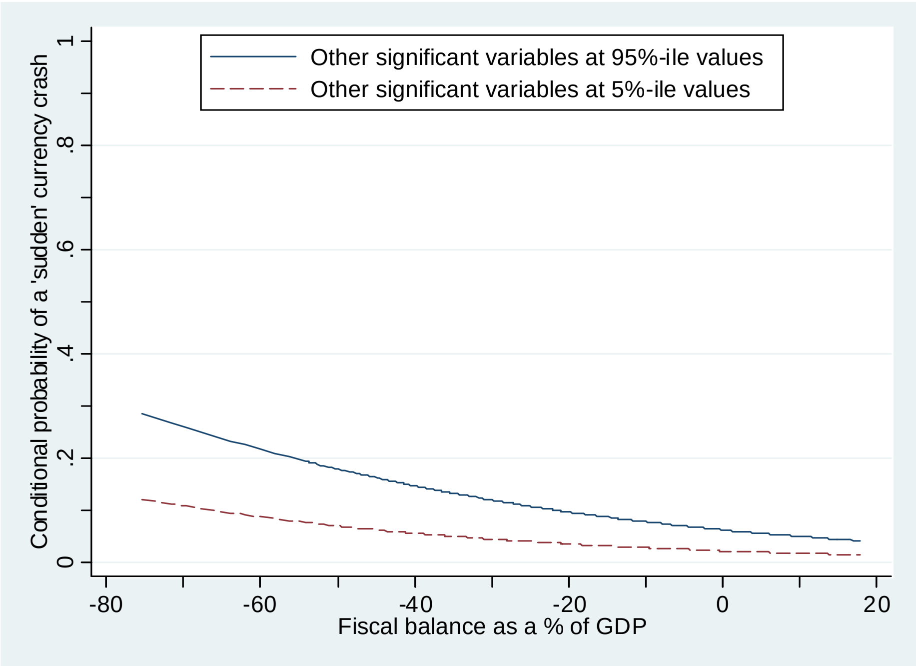
Notes: natural logarithm of index levels (an upward movement indicates an appreciation of the corresponding currency); red lines = BIS series; blue lines = authors' own series.

Figure 2: "Sudden" currency crashes: 1880-2009 (baseline)



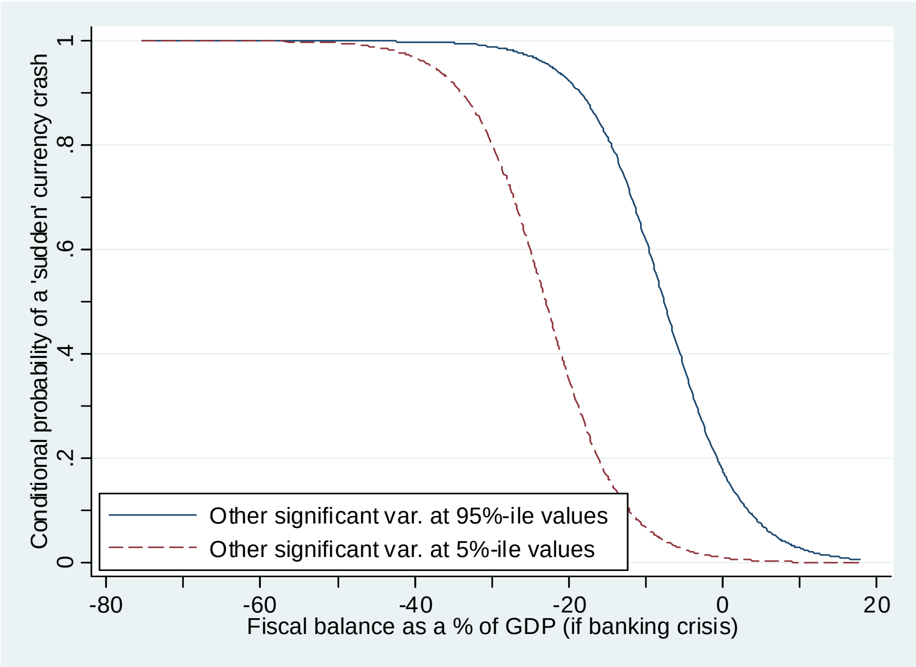
Notes: incl. 1-year exclusion window. Total # of crashes = 99.

Figure 3a: Conditional probability of a 'sudden' currency crash under two scenarios – *Actual fiscal deficits*



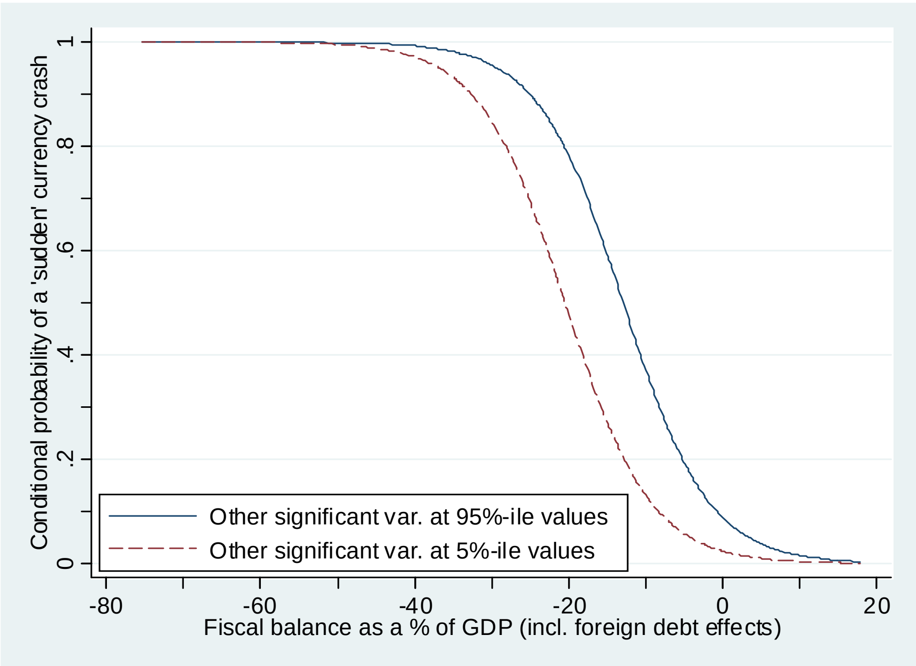
Note: Conditional probabilities calculated with parsimonious model (3) of Table 1a.

Figure 3b: Conditional probability of a 'sudden' currency crash under two scenarios – *Prospective fiscal deficits*



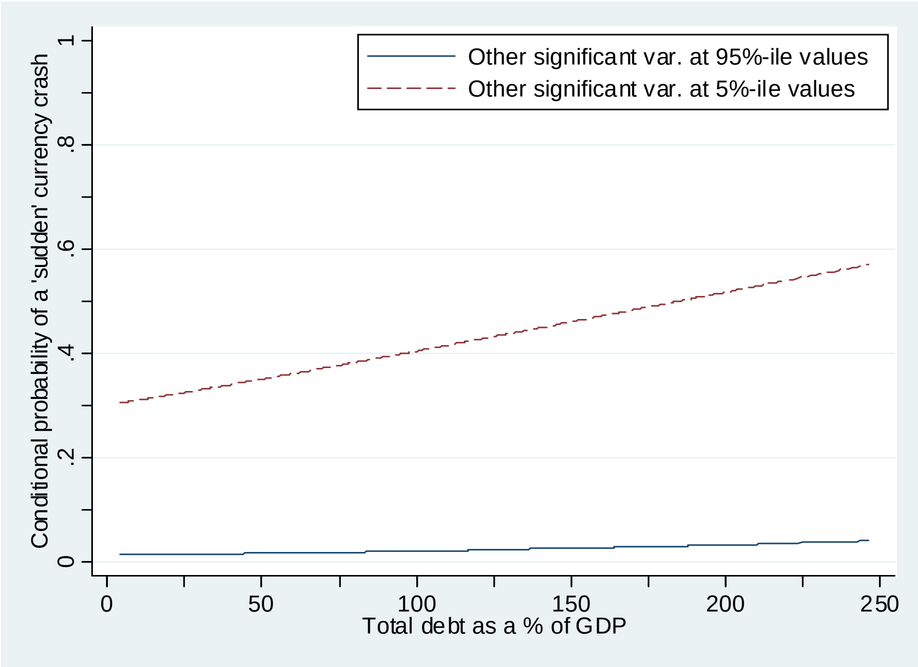
Note: Conditional probabilities calculated with parsimonious model (3) of Table 1b.

Figure 3c: Conditional probability of a 'sudden' currency crash under two scenarios – *Rollover/Sudden stop risk*



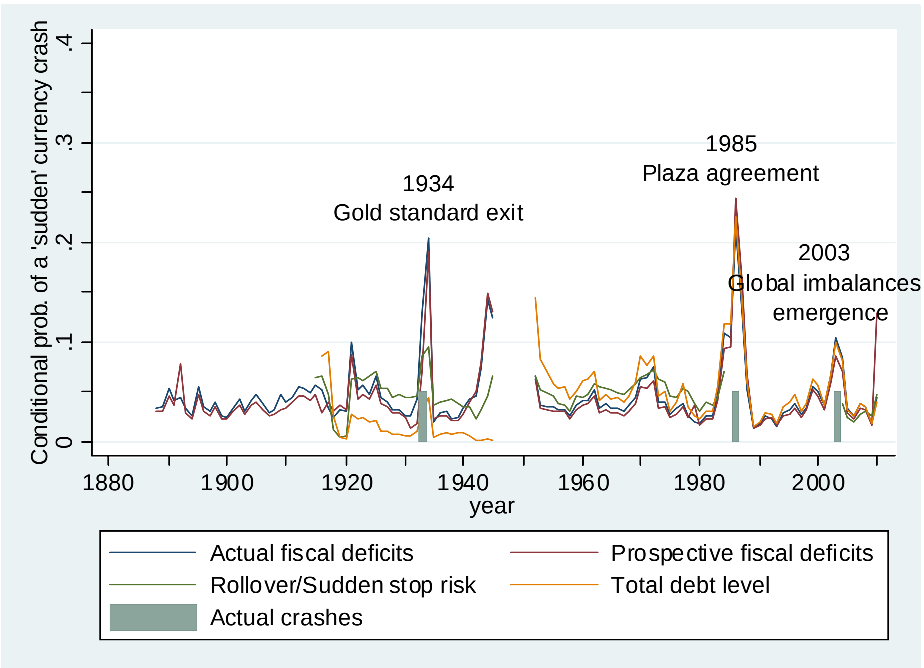
Note: Conditional probabilities calculated with parsimonious model (3) of Table 1c.

Figure 3d: Conditional probability of a 'sudden' currency crash under two scenarios – *Total debt level*



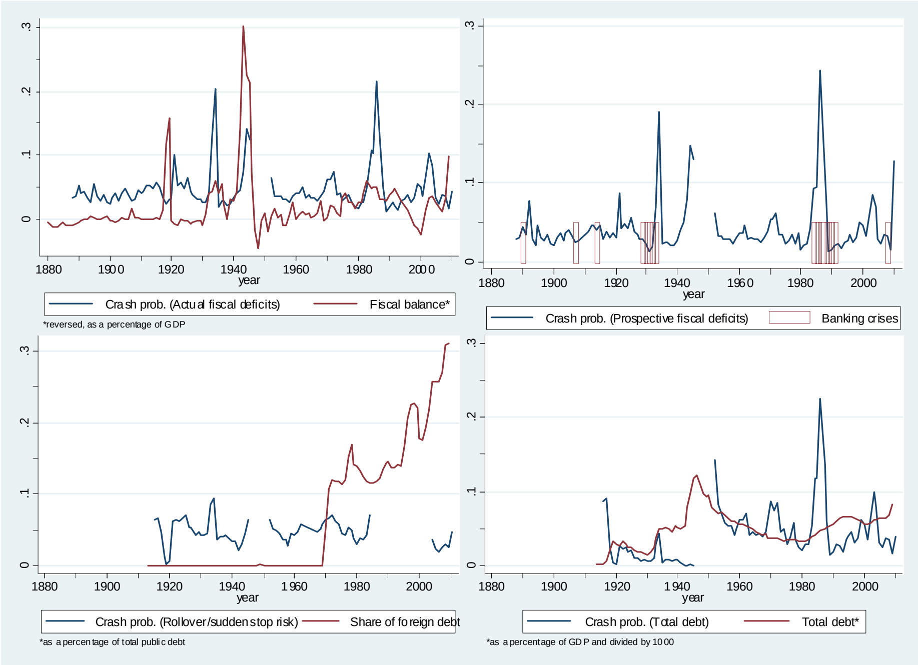
Note: Conditional probabilities calculated with parsimonious model (3) of Table 1d.

Figure 4a: A century of crash probabilities for the US dollar by main sources of fiscal vulnerability



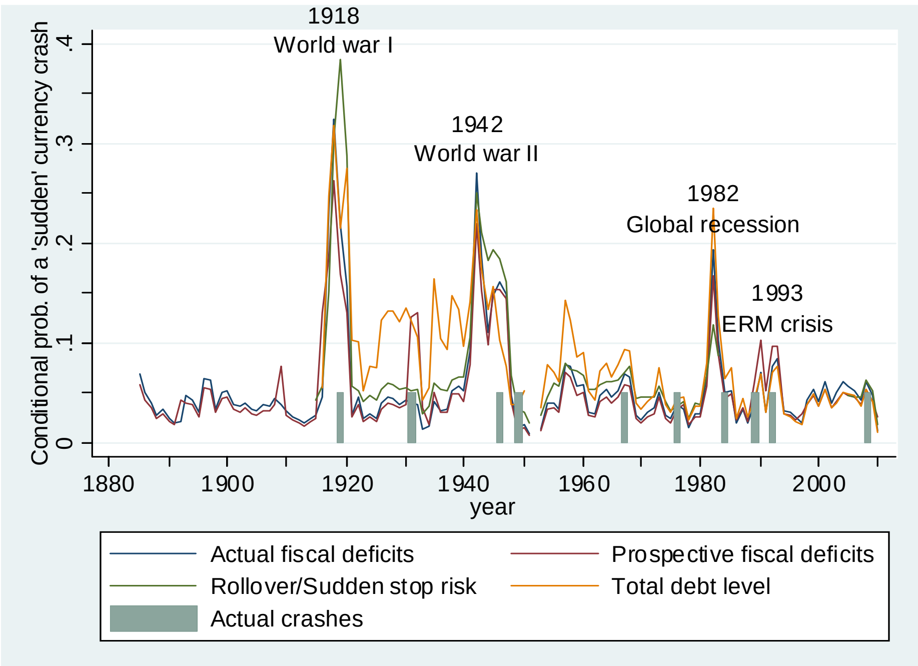
Note: Conditional probabilities calculated with parsimonious models (3) of Tables 1a, 1b, 1c and 1d.

Figure 4b: Sources of fiscal vulnerability underlying the estimated crash probabilities/episodes for the US dollar



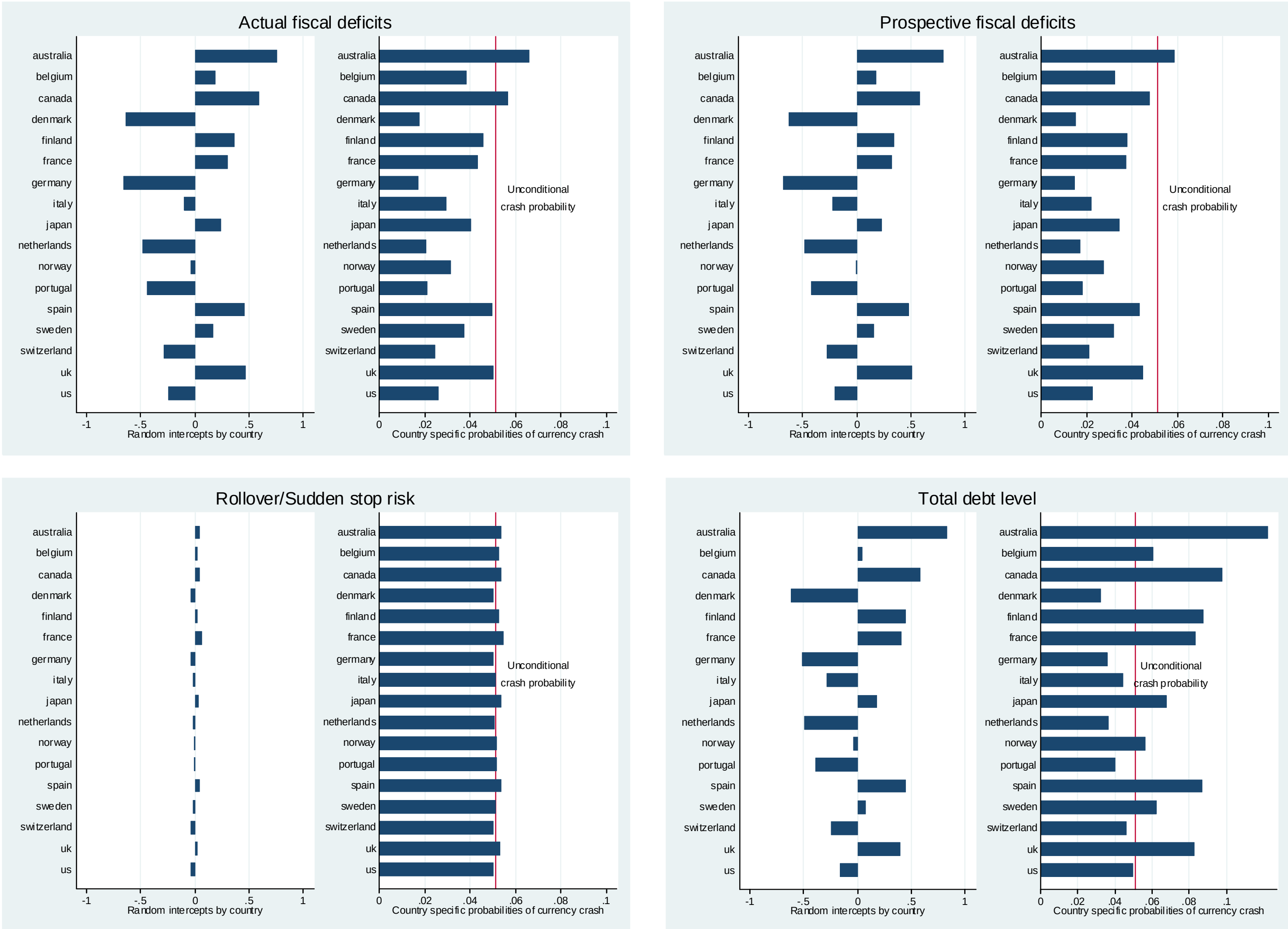
Note: Conditional probabilities calculated with parsimonious models (3) of Tables 1a, 1b, 1c and 1d.

Figure 4c: A century of crash probabilities for the pound sterling by main sources of fiscal vulnerability



Note: Conditional probabilities calculated with parsimonious models (3) of Tables 1a, 1b, 1c and 1d.

Figure 5: Heterogeneity in currency risk premia (country effects) by main sources of fiscal vulnerability



Note: Random effects estimated using specification (1), (2), (3) and (4) of Table (3), respectively

Table 1a: Benchmark estimates – *Actual fiscal deficits*

	(1)	(2)	(3)
Fiscal balance	-0.032***	-0.052**	-0.024**
	(0.012)	(0.022)	(0.011)
Fiscal balance$^{(us)}$	-0.025	-0.058**	-0.017
	(0.017)	(0.023)	(0.011)
Exchange rate deviation		0.080***	0.066***
		(0.027)	(0.023)
Trade balance		-0.002	
		(0.023)	
Trade balance$^{(us)}$		0.048	
		(0.055)	
Real equity prices		-0.013*	-0.011**
		(0.008)	(0.005)
Real equity prices$^{(us)}$		0.015	0.006
		(0.010)	(0.008)
Real growth		-0.041	
		(0.036)	
Real growth$^{(us)}$		0.010	
		(0.038)	
Foreign yields		-0.019	
		(0.050)	
Real export growth		0.004	
		(0.007)	
Real export growth$^{(us)}$		0.006	
		(0.008)	
World war dummy		-2.506***	
		(0.912)	
Sovereign default dummy		-0.867	
		(1.134)	
Real commodity prices		-1.106**	
		(0.557)	
Constant	-3.091***	-1.395*	-3.255***
	(0.166)	(0.838)	(0.219)
Observations	1,775	1,452	1,591
McKelvey and Zavoina's R^2	0.017	0.082	0.115
log likelihood	-345.9	-249.0	-289.6
χ^2	19.97	724.90	53.99
p-value	0.000	0.000	0.000
Scaled resolution	0.010	0.068	0.051

Note: Benchmark estimates of Eq. (1) focusing on actual fiscal deficits as the main source of fiscal vulnerability and the definition of a 'sudden' currency crash used as dependent variable. The shaded specification is the final parsimonious model estimated using the general-to-specific approach described in section 2. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 1b: Benchmark estimates – *Prospective fiscal deficits*

	(1)	(2)	(3)
Fiscal balance × banking crisis	-0.206***	-0.155*	-0.181*
	(0.063)	(0.095)	(0.094)
Fiscal balance	-0.025*	-0.040*	-0.021*
	(0.014)	(0.024)	(0.012)
Banking crisis	-0.401	-0.366	-0.531
	(0.513)	(0.679)	(0.619)
Fiscal balance$^{(us)}$ × banking crisis$^{(us)}$	0.267***	0.173	0.239***
	(0.068)	(0.129)	(0.066)
Fiscal balance$^{(us)}$	-0.035*	-0.053**	-0.024**
	(0.019)	(0.024)	(0.012)
Banking crisis$^{(us)}$	1.310***	1.259**	1.332***
	(0.274)	(0.545)	(0.305)
Exchange rate deviation		0.080***	0.064***
		(0.027)	(0.023)
Trade balance		-0.004	
		(0.024)	
Trade balance$^{(us)}$		0.058	
		(0.070)	
Real equity prices		-0.011	-0.010*
		(0.008)	(0.006)
Real equity prices$^{(us)}$		0.014	0.007
		(0.011)	(0.008)
Real growth		-0.039	
		(0.036)	
Real growth$^{(us)}$		0.030	
		(0.040)	
Foreign yields		-0.036	
		(0.060)	
Real export growth		0.005	
		(0.007)	
Real export growth$^{(us)}$		0.005	
		(0.007)	
World war dummy		-2.312**	
		(0.952)	
Sovereign default dummy		-0.832	
		(1.103)	
Real commodity prices		-0.809	
		(0.684)	
Constant	-3.253***	-2.048*	-3.409***
	(0.171)	(1.111)	(0.215)
Observations	1,775	1,452	1,591
McKelvey and Zavoina's R^2	0.055	0.098	0.137
log likelihood	-337.2	-244.8	-284.0
χ^2	71.51		116.30
p-value	0.000		0.000
Scaled resolution	0.026	0.077	0.059

Note: Benchmark estimates of Eq. (2) focusing on prospective fiscal deficits (arising from a banking crisis) as the main source of fiscal vulnerability and the definition of a 'sudden' currency crash used as dependent variable. The shaded specification is the final parsimonious model estimated using the general-to-specific approach described in section 2. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 1c: Benchmark estimates – *Rollover/Sudden stop risk*

	(1)	(2)	(3)
Fiscal balance × foreign debt	-0.170**	-0.175	-0.181**
	(0.079)	(0.182)	(0.090)
Fiscal balance	-0.023*	-0.047	-0.012
	(0.012)	(0.039)	(0.013)
Foreign debt	0.003	-0.006	0.001
	(0.006)	(0.005)	(0.005)
Fiscal balance$^{(us)}$ × foreign debt$^{(us)}$	0.448*	0.132	0.371*
	(0.256)	(0.220)	(0.215)
Fiscal balance$^{(us)}$	-0.022	-0.043	-0.017
	(0.020)	(0.026)	(0.013)
Foreign debt$^{(us)}$	-0.006	-0.003	-0.008
	(0.020)	(0.022)	(0.020)
Exchange rate deviation		0.062*	0.040**
		(0.033)	(0.020)
Trade balance		0.007	
		(0.022)	
Trade balance$^{(us)}$		0.007	
		(0.053)	
Real equity prices		-0.012	
		(0.011)	
Real equity prices$^{(us)}$		0.019*	
		(0.010)	
Real growth		-0.064*	
		(0.038)	
Real growth$^{(us)}$		0.010	
		(0.039)	
Foreign yields		-0.025	
		(0.059)	
Real export growth		0.005	
		(0.008)	
Real export growth$^{(us)}$		0.007	
		(0.010)	
World war dummy		-2.374**	
		(0.926)	
Sovereign default dummy		-1.045	
		(1.117)	
Real commodity prices		-1.233***	
		(0.442)	
Constant	-2.875***	-0.816	-2.901***
	(0.198)	(0.812)	(0.211)
Observations	1,107	1,001	1,102
McKelvey and Zavoina's R^2	0.043	0.082	0.077
log likelihood	-248.7	-187.6	-239.8
χ^2	73.39		99.12
p-value	0.000	0.000	0.000
Scaled resolution	0.014	0.020	0.015

Note: Benchmark estimates of Eq. (3) focusing on rollover/sudden stop risk (proxied by the share of foreign debt in total public debt) as the main source of fiscal vulnerability and the definition of a 'sudden' currency crash used as dependent variable. The shaded specification is the final parsimonious model estimated using the general-to-specific approach described in section 2. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** p < 0.01; ** p <0.05; * p <0.1.

Table 1d: Benchmark estimates – *Total debt level*

	(1)	(2)	(3)
Fiscal balance × total debt	0.016	0.022	0.016
	(0.011)	(0.019)	(0.013)
Fiscal balance	-0.047**	-0.052*	-0.023
	(0.021)	(0.031)	(0.017)
Total debt	0.005	0.005	0.007**
	(0.004)	(0.004)	(0.003)
Fiscal balance$^{(us)}$ × total debt$^{(us)}$	0.071	0.070	0.087
	(0.057)	(0.100)	(0.068)
Fiscal balance$^{(us)}$	-0.089**	-0.098	-0.094*
	(0.039)	(0.077)	(0.048)
Total debt$^{(us)}$	-0.012	-0.005	-0.009
	(0.009)	(0.008)	(0.009)
Exchange rate deviation		0.082***	0.065***
		(0.028)	(0.025)
Trade balance		-0.001	
		(0.023)	
Trade balance$^{(us)}$		0.028	
		(0.067)	
Real equity prices		-0.014	-0.011**
		(0.009)	(0.006)
Real equity prices$^{(us)}$		0.018*	0.009
		(0.010)	(0.008)
Real growth		-0.044	
		(0.041)	
Real growth$^{(us)}$		0.000	
		(0.040)	
Foreign yields		-0.022	
		(0.051)	
Real export growth		0.007	
		(0.008)	
Real export growth$^{(us)}$		0.004	
		(0.009)	
World war dummy		-1.702**	
		(0.801)	
Sovereign default dummy		-1.011	
		(1.131)	
Real commodity prices		-0.972**	
		(0.489)	
Constant	-2.772***	-1.587**	-3.147***
	(0.455)	(0.660)	(0.586)
Observations	1,446	1,343	1,416
McKelvey and Zavoina's R^2	0.0747	0.0924	0.157
log likelihood	-301.5	-236.2	-270.2
χ^2	39.29		105.6
p-value	0.000	0.000	0.000

Note: Benchmark estimates of Eq. (4) focusing on the total debt level as the main source of fiscal vulnerability and the definition of a ‘sudden’ currency crash used as dependent variable. The shaded specification is the final parsimonious model estimated using the general-to-specific approach described in section 2. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 2: Encompassing model with all main sources of fiscal vulnerability

	(1)	(2)	(3)
Fiscal balance × banking crisis × foreign debt	-5.056*	-10.971**	-6.559*
	(3.417)	(5.474)	(4.081)
Fiscal balance × banking crisis	-0.248*	0.152	-0.195
	(0.152)	(0.269)	(0.303)
Fiscal balance × foreign debt	-0.108	-0.121	-0.138
	(0.103)	(0.179)	(0.114)
Banking crisis × foreign debt	-0.254*	-0.464**	-0.299*
	(0.159)	(0.224)	(0.175)
Fiscal balance	-0.029	-0.027	0.011
	(0.020)	(0.043)	(0.026)
Foreign debt	0.006	-0.005	0.003
	(0.006)	(0.006)	(0.005)
Banking crisis	0.032	0.758	0.153
	(1.052)	(0.746)	(1.259)
Total debt	0.005*	0.007*	0.007**
	(0.003)	(0.004)	(0.004)
Exchange rate deviation		0.083**	0.056***
		(0.035)	(0.022)
Trade balance		0.027	
		(0.024)	
Trade balance$^{(us)}$		0.019	
		(0.057)	
Real equity prices		-0.018	
		(0.012)	
Real equity prices$^{(us)}$		0.018	
		(0.012)	
Real growth		-0.040	
		(0.047)	
Real growth$^{(us)}$		0.018	
		(0.034)	
Foreign yields		-0.026	
		(0.056)	
Real export growth		0.007	
		(0.007)	
Real export growth$^{(us)}$		0.005	
		(0.008)	
World war dummy		-1.694**	0.713*
		(0.853)	(0.398)
Sovereign default dummy		-1.067	
		(1.199)	
Real commodity prices		-1.272**	
		(0.537)	
Constant	-3.281***	-1.184	-3.480***
	(0.273)	(0.860)	(0.280)
Observations	1,119	1,011	1,114
McKelvey and Zavoina's R^2	0.633	0.131	0.718
log likelihood	-243.4	-180.6	-231.4

Note: Pooled logit estimates with all main sources of fiscal vulnerability tested at the same time and the definition of a ‘sudden’ currency crash used as dependent variable. The shaded specification is the final parsimonious model estimated using the general-to-specific approach described in section 2. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 3: Robustness – *Country effect estimates*

	(1)	(2)	(3)	(4)
	Actual fiscal deficits	Prospective fiscal deficits	Rollover / Sudden stop risk	Total debt level
Fiscal balance	-0.023	-0.021	-0.012	-0.015
	(0.018)	(0.019)	(0.020)	(0.030)
Fiscal balance × banking crisis		-0.198*		
		(0.110)		
Banking crisis		-0.542		
		(0.588)		
Fiscal balance$^{(us)}$	-0.019	-0.026	-0.017	-0.028
	(0.022)	(0.022)	(0.023)	(0.036)
Fiscal balance$^{(us)}$ × banking crisis$^{(us)}$		0.240*		
		(0.124)		
Banking crisis$^{(us)}$		1.341***		
		(0.413)		
Exchange rate deviation	0.057***	0.056***	0.040***	0.054***
	(0.015)	(0.014)	(0.015)	(0.014)
Real equity prices	-0.014*	-0.012		-0.012
	(0.007)	(0.008)		(0.007)
Real equity prices$^{(us)}$	0.007	0.008		0.009
	(0.008)	(0.008)		(0.008)
Fiscal balance × short-term debt				
Fiscal balance$^{(us)}$ × short-term debt$^{(us)}$				
Fiscal balance × foreign debt			-0.180*	
			(0.116)	
Foreign debt			0.001	
			(0.006)	
Fiscal balance$^{(us)}$ × foreign debt$^{(us)}$			0.376	
			(0.612)	
Foreign debt$^{(us)}$			-0.007	
			(0.020)	
Fiscal balance × total debt				0.103
				(0.116)
Total debt				0.005*
				(0.003)
Total debt$^{(us)}$				-0.018***
				(0.007)
Constant	-3.406***	-3.572***	-2.909***	-2.791***
	(0.226)	(0.243)	(0.217)	(0.418)
R.E. std. dev.	0.579***	0.587***	0.129	0.574***
	(0.224)	(0.224)	(0.431)	(0.226)
Observations	1,591	1,591	1,102	1,416
Number of groups	17	17	17	17
log likelihood	-286.8	-281.0	-239.8	-266.6
χ^2	28.34	41.11	20.53	35.14
p-value	0.000	0.000	0.000	0.000

Note: Random effects panel logit estimates for all main sources of fiscal vulnerability using the 'sudden' currency crash as dependent variable as well as the respective parsimonious models of Tables 1a, 1b, 1c and 1d. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Supplementary appendices

Appendix I: Additional information on the construction of our real effective exchange rates series

We calculate real effective exchange rate indices in a standard fashion as geometrically weighted averages of real bilateral exchange rates.[19] The index *I* at time *t* for currency *k* is defined therefore as:

$$I_t^k = I_{t-1}^k \times \prod_{j=1}^{N(t)} \left(\left[\frac{p_t^k}{p_t^j} \right] e_t^{k,j} \Big/ \left[\frac{p_{t-1}^k}{p_{t-1}^j} \right] e_{t-1}^{k,j} \right)^{w_t^{k,j}}$$

where $e^{k,j}$ is the nominal bilateral exchange rate (i.e. the number of foreign currency units *j* per unit of currency *k*); p^k and p^j are the deflators for currencies *k* and *j*, respectively; $w^{k,j}$ is the weight of currency *j* in currency *k*'s index; $N(t)$ is the number of foreign currencies included in the index at time *t*; and $\Sigma_j w_t^{k,j} = 1$.

The weights are based on annual data on international trade and remain constant within a calendar year. They are calculated as the share of country *k*'s bilateral merchandise trade with country *j* (exports and imports) in its total merchandise trade:

$$w_t^{k,j} = \frac{X_t^{k,j} + M_t^{k,j}}{\sum_{j=1}^{N(t)} (X_t^{k,j} + M_t^{k,j})}$$

[19] See e.g. Loretan (2005) and Buldorini et al. (2002). Under geometric averaging, a proportionately equal appreciation and depreciation of a currency has the same numerical effect (though of opposite sign) on the index. In an arithmetically averaged exchange rate index, such changes would result in an upward bias in the index.

Appendix II: Data – Sources and main characteristics

Our real effective exchange rate indices are calculated in a standard fashion as geometrically weighted averages of real bilateral exchange rates (see Table A hereafter for the sources and key characteristics of the data used to construct our indices). To that end, bilateral nominal exchange rate series were taken from *Global Financial Data* (GFD) which itself compiles data from a large array of primary and secondary sources, including official publications by national central banks, statistical institutes, international organisations, economic historians, as well as newspapers' archives, etc.[20] We adjust these series to take re-denominations into account.

We use consumer price indices as deflators, which we also take from GFD. Arguably, internationally traded goods might be better proxied by producer price indices than by consumer prices, but data over the last century are not as widely available for the former as for the latter. The weights are based on annual data on international trade. They are calculated as the share of country *k*'s bilateral merchandise trade with country *j* (exports and imports) in its total merchandise trade. In this respect, we use the data compiled in Mitchell (1998a, 1998b and 1998c) for the period 1880-1947 and the IMF's Direction of Trade Statistics (DOTS) data for the period 1948-2010. Note that we do not aim to adjust these weights for third-market competitiveness effects nor for effects due to differences in price levels (rather than price changes; see e.g. Thomas, Marquez and Fahle, 2008). This would indeed stretch far beyond the scope of our paper, as we aim here to use effective rates rather than simple bilateral rates only with a view to identifying currency crashes with greater assurance, and leave these aspects for possible future research.

Depending on data availability (bilateral trade data are available only for a limited number of trade partners from Mitchell), our real effective exchange rates typically include 5 to 6 trade partners in their respective basket (only 3 partners can be used for the Australian dollar index, and as many as 8 can be used for the German mark and the pound sterling indices). These yet account for a significant share of the international trade of the respective countries, namely about half of their post-Second World War average (but only 40% for Argentina and as much as 80% for Canada and Mexico).

When looking at Figures 1 and 2, what is comforting is that many of our currency crashes can be linked to well-known historical events. For instance, the collapse of many European currencies in the wake of the First World War[21] stands out clearly as well as the string of currency devaluations that followed the Great

[20] Full details on the data sources are not reported here to save space but are available from the authors upon request.

[21] These included the Deutsche Mark in 1923 due to Germany's hyperinflation crisis and that of the Belgian Franc, the French Franc, the Italian Lira and the Spanish peseta when the late "Latin Monetary Union" broke-up in the mid-1920s (see Bordo and James, 2008).

Depression.[22] The host of large-scale devaluations and exchange rate readjustments that marked the immediate aftermath of the Second World War (1945-1949) stand out also visibly, along with the collapse of the Bretton Woods system in 1971.[23] So are also the currency crashes that occurred after the first and second oil price shocks.[24] The charts also capture rather well the Louvre episode of 1987 of major US dollar weakening, the ERM crises of 1992-1995, when massive speculative attacks forced large scale devaluations and depreciations of the pound sterling, the Italian lira, the Spanish peseta and the Swedish krona. Closer to us in time, the weakening of the US dollar prior to the global crisis of 2008-2009 shows up noticeably, as does the massive depreciation of the pound sterling subsequent to the bursting of the UK's real estate bubble in late-2007 and those of currencies previously involved in carry trades, such as the Australian dollar, or linked to commodity prices, such as the Canadian dollar.

Considering now the data on public finances, we build on Reinhart and Rogoff's work on public debt (see Reinhart and Rogoff 2008a, 2009b, 2010), and hand-collect from the League of Nations' *Statistical Yearbooks* (all issues between 1926 and 1944), the United Nations' *Statistical Yearbooks* (selected issues between 1950 and 1982), as well as national sources, data on our 21 countries' fiscal balance positions (see Table C hereafter for further details). We use similar sources to collect data on total public debt and foreign debt (see Table D hereafter for further details). It is to be noted in some instances that public finance data can take on different values in League of Nations publications than in the underlying national sources, and still different values in national scholars' subsequent reconstruction of the historical series. We have strived therefore to cross-check the data with those of Reinhart (2010) and to maximise estimation consistency by pooling the data in the baseline estimates.

As regards the other variables (see Table B hereafter for further details), we use Reinhart (2010) as our source for the dating of banking crises as well as for sovereign defaults. We take consumer price indices (used throughout as deflators), nominal equity prices, nominal long term bond yields[25] and global commodity prices from GFD. We use Mitchell (1998a, 1998b, 1998c) for the data on nominal GDP, nominal exports in local currency and the trade balance before 1945 as well as the IMF's Direction of Trade Statistics and the IMF's World Economic Outlook

[22] We capture indeed rather well the devaluations in 1931 of the pound sterling and the currencies pegged to the latter (Australian dollar, Danish krone, Finnish markka, Japanese yen, Norwegian kroner, Portuguese escudo and Swedish krona); the abandoning of the gold standard by the US dollar in 1933/4, as well as the devaluations of the "gold bloc" currencies (French franc, Italian lira and Swiss franc) three years later.

[23] This collapse involved the devaluation of the US dollar, the Australian dollar, the Canadian dollar, the Italian Lira and the pound sterling, as well as the revaluations of the German mark and the Japanese yen.

[24] For instance, the pound sterling crisis of 1976 (when the United Kingdom requested an IMF loan) and the tensions in the European monetary "Snake" (e.g. for the Swedish krona) are noticeably apparent from the charts.

[25] We use the 10-year benchmark government bond yield in most cases; when the latter is unavailable throughout the whole of our sample period, we take shorter maturity bonds (including the 7-year government bond yield for Japan; the 5-year government bond yield for the UK and Finland; the 1-year government note yield for Mexico over parts of the sample).

thereafter. The data on real GDP growth are taken from Barro and Ursúa (2008) prior to 2006 and from the WEO afterwards.

Table A: *Real effective exchange rate data*

(G7 economies)

Currency	No. of trade partners in the real effective exchange rate index	Share of partners in corresponding country's total trade *(%)*	Data availability
Canadian dollar	4 (Germany, Japan, UK and US)	79.1	January 1910-January 2010
French franc	6 (Belgium, Germany, Italy, Spain, UK and US)	50.5	January 1877-January 2010 (the series excludes the Belgian franc and the Spanish peseta before January 1920 due to data unavailability; data between May 1940 and April 1948 are excluded as they are distorted by the high instability of the (post) second world war)
German Deutsche mark	8 (Austria, Belgium, France, Italy, Netherlands, Sweden, UK and US)	57.1	January 1880-January 2010 (the series excludes the Belgian franc before January 1920 due to data unavailability; data between December 1913 and December 1923 as well as between November 1937 and January 1948 could not be calculated due to missing trade data and the high instability of the German economy in the early 1920s)
Italian lira	6 (Austria, France, Germany, Switzerland, UK and US)	49.5	December 1884-January 2010 (data between July 1918 and October 1922 as well as between December 1942 and January 1948 are not reported or could not be calculated due to the high instability of the Italian economy in the aftermath of the first world war and to missing trade data during the second world war)
Japanese yen	6 (Australia, France, Germany, India, UK and US)	40.3	January 1880-January 2010 (the series excludes the Australian dollar before December 1910 due to data unavailability; data between September 1945 and January 1946 are excluded as they are distorted by the high instability of the (post) second world war)
UK pound sterling	8 (Argentina, Australia, Canada, France, Germany, India, the Netherlands and US)	41.9	February 1883-January 2010 (the series excludes the Australian and Canadian dollars before December 1910 due to data unavailability)
US dollar	6 (Canada, France, Germany, Japan, Mexico and UK)	49.6	December 1886-January 2010 (the series excludes the Canadian dollar before December 1910 due to data unavailability)

(Other advanced economies)

Currency	No. of trade partners in the real effective exchange rate index	Share of partners in corresponding country's total trade *(%)*	Data availability
Australian dollar	3 (Japan, UK and US)	47.3	December 1901-January 2010
Belgian franc	7 (Argentina, France, Germany, India, Netherlands, UK and US)	66.4	December 1920-January 2010
Danish kroner	6 (France, Germany, Norway, Sweden, UK and US)	62.4	January 1920-January 2010
Dutch guilder	4 (Belgium, Germany, UK and US)	53.9	December 1880-January 2010
Finnish markka	4 (Germany, Sweden, UK and US)	41.7	January 1920-January 2010
Norwegian kroner	7 (Denmark, France, Germany, Netherlands, Sweden, UK and US)	68.5	January 1880-January 2010
Portuguese escudo	5 (France, Germany, Spain, UK and US)	50.7	January 1930-January 2010
Spanish peseta	5 (Argentina, France, Germany, UK and US)	45.6	January 1915-January 2010
Swedish krona	7 (Denmark, France, Germany, Netherlands, Norway, UK and US)	59.1	January 1880-January 2010
Swiss franc	6 (Austria, France, Germany, Italy, UK and US)	61.8	January 1885-January 2010

(Emerging market economies)

Currency	No. of trade partners in the real effective exchange rate index	Share of partners in corresponding country's total trade *(%)*	Data availability
Argentinean peso	4 (Brazil, Germany, UK and US)	40.6	January 1883-January 2010
Brazilian real	4 (France, Germany, UK and US)	41.9	January 1901-January 2010
Indian rupee	6 (Australia, Canada, Germany, Japan, UK and US)	44.7	January 1880-January 2010 (the series excludes the Australian and Canadian dollars before December 1910 due to data unavailability)
Mexican peso	5 (France, Germany, Japan, UK and US)	80.2	January 1895-January 2010

Note: Table A summarises the key characteristics of the data used to construct our real effective exchange rate indices. The source of the data on nominal bilateral exchange rates and their deflators are reported in Appendix III. The source of the data used to calculate trade weights is Mitchell (1998a, 1998b and 1998c) for the period 1880-1947 and the IMF's Direction of Trade Statistics (DOTS) database for the period 1948-2010. The share of the trade partners in the corresponding country's total trade reported in the third column pertains to the period 1948-2010.

Table B: *Other macroeconomic time series*

Series	Source
Banking crises	Reinhart (2010) (with own updates for 2008/9)
Consumer price indices	Global Financial Data
Global commodity prices	The Economist (Global financial data)
Nominal equity prices	Global Financial Data
Nominal export growth in local currency	Mitchell (1998) pre-1945; IMF DOTS post-1945
Nominal GDP in local currency	Mitchell (1998) pre-1993; IMF WEO post-1993
Nominal long term bond yields	Global Financial Data
Real effective exchange rate deviation from trend	Own calculations based on a 15-year moving average centred trend
Real GDP growth	Barro and Ursúa (2008) pre-2006; IMF WEO post-2006
Sovereign defaults	Reinhart (2010)
Trade balance	Mitchell (1998) pre-1945; IMF DOTS post-1945

Table C: *Fiscal balance data*

Country	*Period*	*Source*	*Concept*
Argentina	1935-1969	League of Nations/United Nations	Central government
	1980-2009	IMF World Economic Outlook	Central government
Australia	1880-1924	Mitchell	Central government
	1925-1973	League of Nations/United Nations	Central government
	1974-2009	Reserve Bank Australia	Central government
Belgium	1919-1923	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
Brazil	1914-1935	Mitchell	
	1936-1974	League of Nations/United Nations	Central government
	1980-2009	IMF World Economic Outlook	General government
Canada	1880-1922	Mitchell	Central government
	1923-1961	League of Nations/United Nations	Federal government
	1962-2009	Department of Finance, Canada	Federal government
Denmark	1880-1923	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
Finland	1882-1923	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
France	1880-1923	Mitchell	Central government
	1925-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
Germany	1880-1913	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Federal government
	1960-2009	Eurostat	General government
India	1949-1974	United Nations	Central government
	1980-2009	IMF World Economic Outlook	Central government
Italy	1880-1923	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
Japan	1885-1923	Mitchell	Central government
	1924-1969	League of Nations/United Nations	Central government
	1970-2008	Cabinet Office	Central government
Mexico	1925-1937	Mitchell	Central government
	1938-1967	League of Nations/United Nations	Central government
	1980-2009	IMF World Economic Outlook	General government
Netherlands	1914-1923	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
Norway	1880-1923	Mitchell	Central government
	1924-1977	League of Nations/United Nations	Central government
	1978-2008	Norges Bank	General government
Portugal	1950-1959	United Nations	Central government
	1960-2009	Eurostat	General government
Spain	1901-1923	Mitchell	Central government
	1924-1969	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government
Sweden	1880-1923	Mitchell	Central government
	1924-1969	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government
Switzerland	1913-1924	Mitchell	Central government
	1925-1979	League of Nations/United Nations	Central government
	1980-2009	Federal Finance Administration	Central government
United Kigdom	1880-1923	Mitchell	Central government
	1924-1959	League of Nations/United Nations	Central government
	1960-2009	Eurostat	General government
United States	1880-1922	Mitchell	Central government
	1922-1929	League of Nations	Federal government
	1930-2009	Office of Management and Budget	Federal government

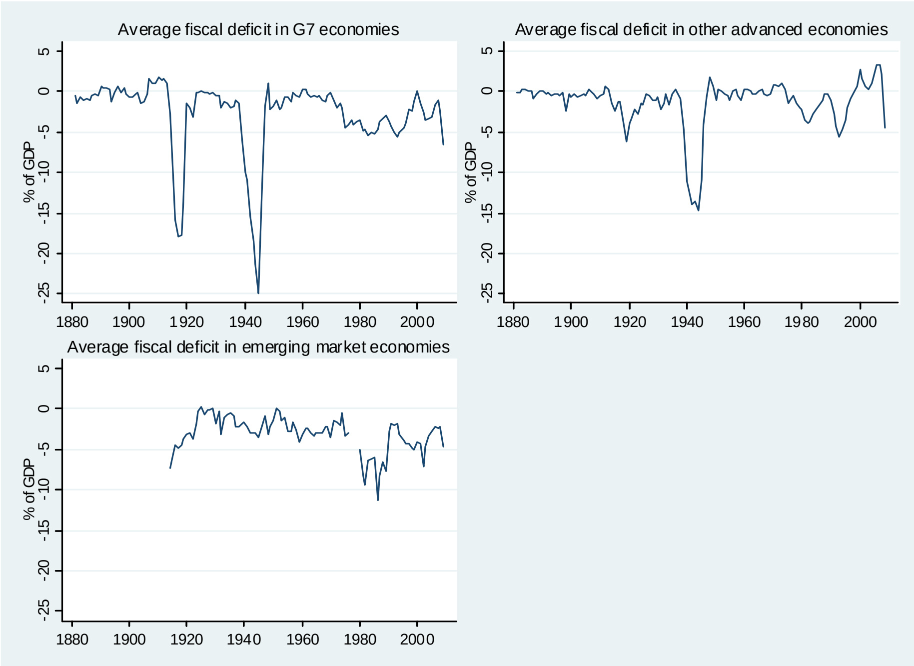
Table D: *Public debt data*

Country	Total public debt: Period	Total public debt: Source	Total public debt: Concept	Foreign debt: Period	Foreign debt: Source	Foreign debt: Concept
Argentina	1935-1980	League of Nations/United Nations	Central government	1935-1964	League of Nations/United Nations	Central government
	1995-2009	IMF World Economic Outlook	Central government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Australia	1913-1969	League of Nations/United Nations	Central government	1913-1978	League of Nations/United Nations	Central government
	1970-2009	Reserve Bank Australia	Central government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Belgium	1913-1968	League of Nations/United Nations	Central government	1913-1982	League of Nations/United Nations	Central government
	1969-2009	Eurostat	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Brazil	1914-1980	League of Nations/United Nations	Central government	1914-1981	League of Nations/United Nations	Central government
	1996-2009	IMF World Economic Outlook	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Canada	1913-1960	League of Nations/United Nations	Federal government	1913-1982	League of Nations/United Nations	Federal government
	1961-2009	Statistics Canada	Federal government	1983-2001[1]	Statistics Canada	Federal government
				2002-2009	BIS-IMF-OECD-WB external debt hub	General government
Denmark	1914-1970	League of Nations/United Nations	Central government	1913-1974	League of Nations/United Nations	Central government
	1971-2009	Eurostat	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Finland	1914-1969	League of Nations/United Nations	Central government	1914-1982	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
France	1914-1969	League of Nations/United Nations	Central government	1914-1969	League of Nations/United Nations	Central government
	1977-2009	Eurostat	General government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
Germany	1913-1969	League of Nations/United Nations	Federal government	1913-1982	League of Nations/United Nations	Federal government
	1970-2009	Eurostat	General government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
India	1951-1982	United Nations	Central government	1951-1982	United Nations	Central government
	1991-2009	IMF World Economic Outlook	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Italy	1913-1969	League of Nations/United Nations	Central government	1913-1983	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
Japan	1913-1961	League of Nations/United Nations	Central government	1913-1982	League of Nations/United Nations	Central government
	1962-2008	Bank of Japan	Federal government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
Mexico	1925-1979	League of Nations/United Nations	Central government	1925-1979	League of Nations/United Nations	Central government
	1990-2009	IMF World Economic Outlook	General government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
Netherlands	1914-1974	League of Nations/United Nations	Central government	1914-1978	League of Nations/United Nations	Central government
	1975-2009	Eurostat	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Norway	1914-1977	League of Nations/United Nations	Central government	1913-1983	League of Nations/United Nations	Central government
	1978-2008	Statistisk Sentralbyra	General government			
Portugal	1950-1972	United Nations	Central government	1950-1974	League of Nations/United Nations	General government
	1973-2009	Eurostat	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Spain	1914-1969	League of Nations/United Nations	Central government	1914-1981	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
Sweden	1914-1969	League of Nations/United Nations	Central government	1914-1982	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
Switzerland	1914-1979	League of Nations/United Nations	Central government	1914-1977	League of Nations/United Nations	Central government
	1980-2009	Federal Finance Administration	Central government	2002-2009	BIS-IMF-OECD-WB external debt hub	General government
United Kigdom	1914-1969	League of Nations/United Nations	Central government	1914-1978	League of Nations/United Nations	Central government
	1970-2009	Eurostat	General government	2003-2009	BIS-IMF-OECD-WB external debt hub	General government
United States	1914-1938	League of Nations	Federal government	1914-1969	League of Nations/United Nations	Federal government
	1939-2009	Office of Management and Budget	Federal government	1970-2001[2]	US Treasury	Federal government
				2002-2009	BIS-IMF-OECD-WB external debt hub	General government

[1] Federal debt held by non-residents.
[2] US Treasuries held by non-residents.

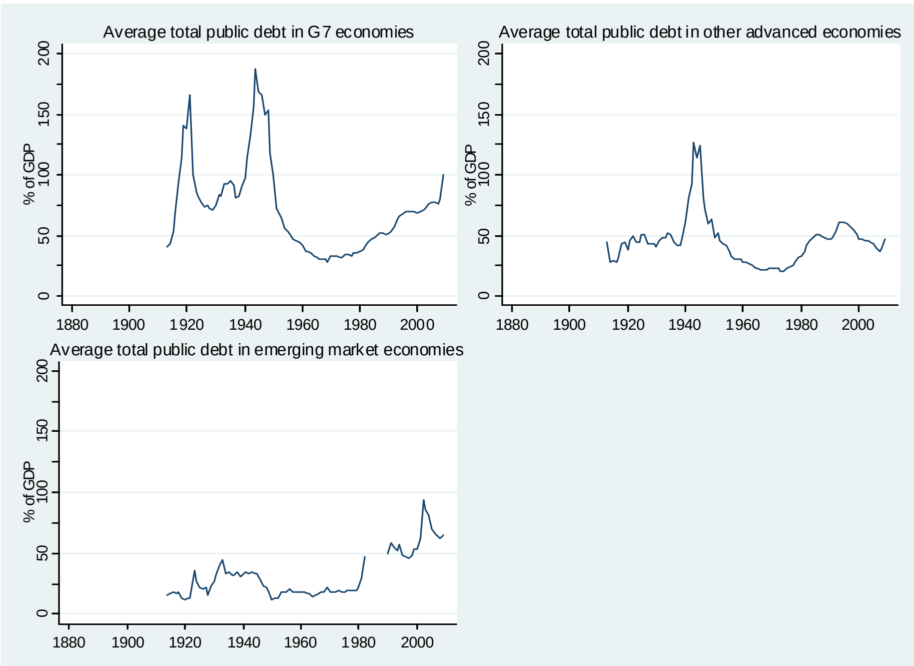
Appendix III: Additional charts and tables

Figure A: Average fiscal balance across selected country groups: 1880-2009



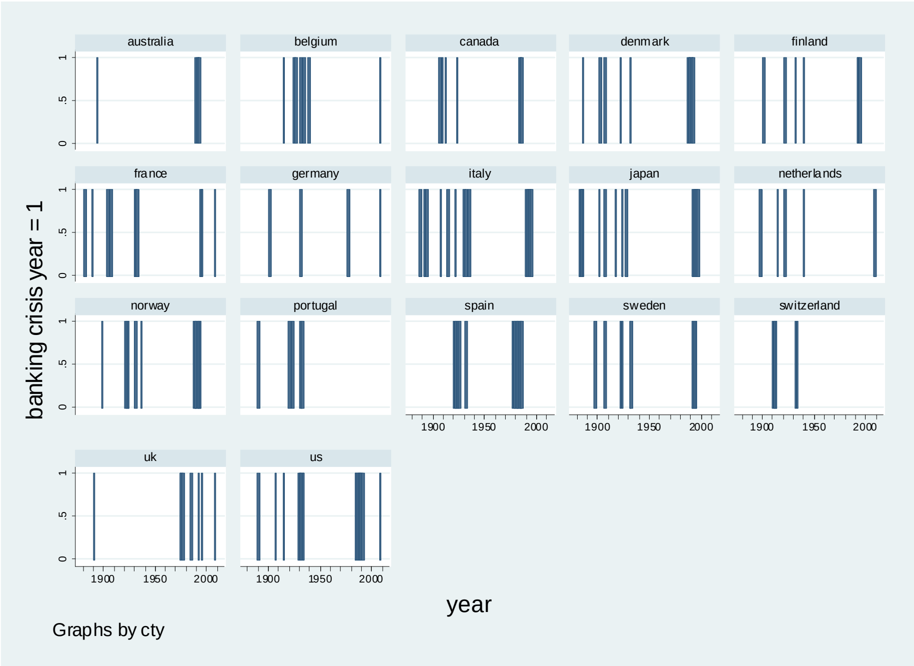
Note: the averages shown here occasionally mask that some observations may be missing for some individual countries in certain years.

Figure B: Average total public debt across selected country groups: 1880-2009



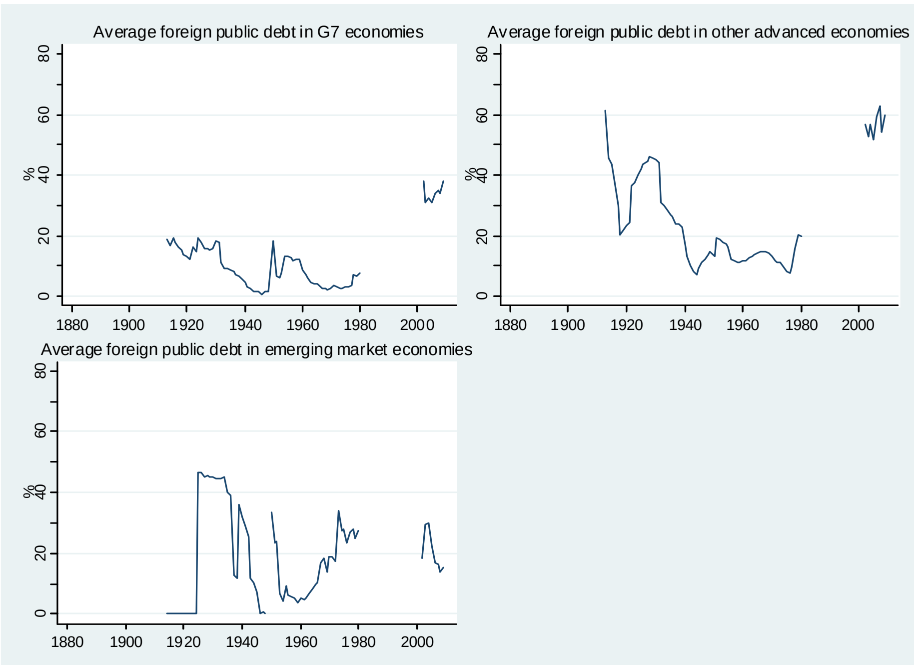
Note: the averages shown here occasionally mask that some observations may be missing for some individual countries in certain years.

Figure C: Banking crises in mature economies: 1880-2009



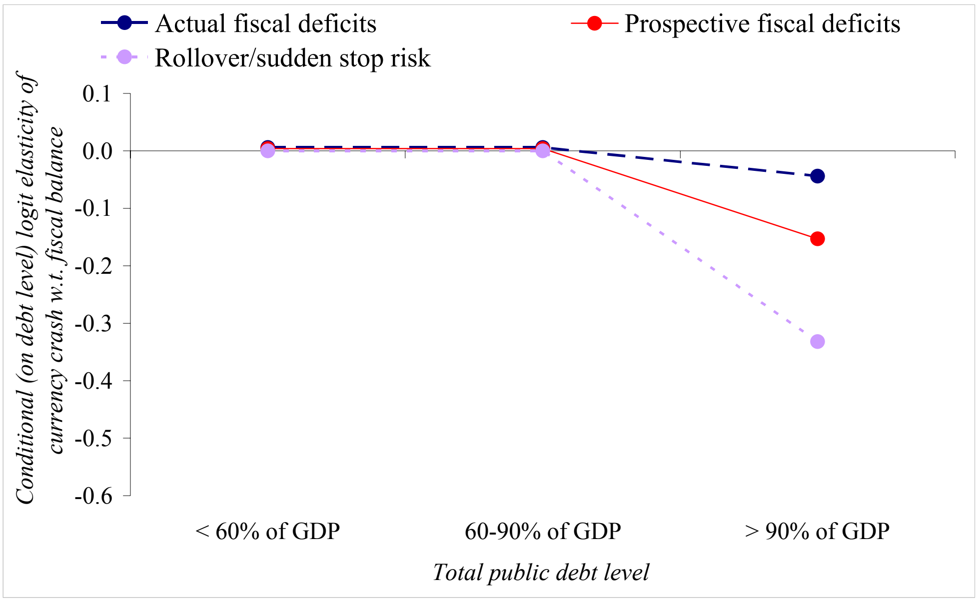
Source: Reinhart (2010). *Note*: The data reported here include all (systemic and non-systemic) banking crises, which are included in the baseline estimations; estimates using only the banking crises deemed systemic (about 85% of all episodes) are presented in the robustness checks.

Figure D: Share of foreign debt in total public debt across selected country groups: 1880-2009



Note: the averages shown here occasionally mask that some observations may be missing for some individual countries in certain years. There are only four countries in the group of emerging economies. Data for all four economies are available only after 1950; the jump in the series in the 1920s is due to the fact that Mexico starts to report data along with Brazil (the only country to report data up to the 1920s).

Figure E: Nonlinearities in the level of public debt



Note: Conditional (on the level of public debt) elasticity of the probability of a currency crash with respect to three sources of fiscal vulnerability, namely: (i) actual fiscal deficits (blue dots), (ii) prospective fiscal deficits (red dots) and (iii) rollover/sudden stop risk (purple dots) obtained with the corresponding parsimonious models (3) of Tables 1a, 1b and 1c, respectively.

Table A: Mapping between theory and estimation

Fiscal vulnerability	Key theoretical paper(s)	Key proxy variable	Control variables
Actual fiscal deficits	Krugman (1979); Flood and Garber (1984)	Fiscal balance/GDP	(systemic/non-systemic) banking crises; consumer price indices; global commodity prices; trade balance/GDP; real equity prices; real export growth; long term bond yields; real effective exchange rate deviation from trend; real GDP growth; credit growth; sovereign defaults + their US counterparts
Prospective fiscal deficits	Corsetti, Pesenti and Roubini (1999); Burnside, Eichenbaum, Rebelo (2001)	Fiscal balance/GDP; banking crisis dummy; interacted effect	
Rollover/sudden stop risk	Calvo (2006); Corsetti and Mackowiak (2005) and (2006)	Fiscal balance/GDP; share of foreign public debt/total public debt; interacted effect	
Total debt level	Benigno and Missale (2004)	Fiscal balance/GDP; share of total public debt/GDP; interacted effect	

Table B: *Descriptive statistics on key sources of fiscal vulnerability* (pre-1913; interwar period; floating era)

	Obs.	Mean	St. dev.	Min.	Max.
Pre-1913 (6 crashes)					
Fiscal balance/GDP	394	-0.1	2.6	-8.1	17.7
Banking crises	578	0.1	0.2	0.0	1.0
Share of foreign debt/Total debt	10	35.9	38.0	0.0	94.2
Total debt/GDP	7	42.3	26.9	9.8	76.6
Interwar period (36 crashes)					
Fiscal balance/GDP	321	-1.8	5.0	-37.6	14.3
Banking crises	357	0.1	0.3	0.0	1.0
Share of foreign debt/Total debt	331	24.8	24.8	0.0	100.0
Total debt/GDP	331	66.7	64.3	3.7	580.5
Post-1945 (46 crashes)					
Fiscal balance/GDP	1,057	-1.5	3.8	-24.3	18.9
Banking crises	1,105	0.1	0.2	0.0	1.0
Share of foreign debt/Total debt	726	17.0	20.0	0.0	96.8
Total debt/GDP	1,047	46.6	36.8	10.0	300.5

Source: authors' calculations. *Note*: in percent (with the exception of banking crises: dummy variable).

Table C: Robustness – *Alternative currency crash definitions*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	"More protracted" crash definition			"Even more protracted" crash			"Very protracted" crash definition		
Fiscal balance	-0.029**	-0.028**	-0.015	-0.049***	-0.049***	-0.039**	-0.032**	-0.031**	-0.040**
	(0.013)	(0.014)	(0.018)	(0.009)	(0.010)	(0.016)	(0.015)	(0.014)	(0.017)
Fiscal balance × banking crisis		-0.143*			-0.110			-0.159	
		(0.081)			(0.101)			(0.117)	
Banking crisis		0.121			-0.033			-0.271	
		(0.518)			(0.767)			(0.655)	
Fiscal balance$^{(us)}$	0.013	0.011	0.019	-0.006	-0.012	0.008	0.010	-0.006	0.019
	(0.020)	(0.021)	(0.023)	(0.014)	(0.012)	(0.019)	(0.029)	(0.025)	(0.048)
Fiscal balance$^{(us)}$ × banking crisis$^{(us)}$		-0.023			0.248**			0.664***	
		(0.102)			(0.111)			(0.205)	
Banking crisis$^{(us)}$		0.361			0.897			1.513***	
		(0.556)			(0.600)			(0.485)	
Exchange rate deviation	0.132***	0.132***	0.122***	0.095***	0.094***	0.066**	0.075***	0.073***	0.037**
	(0.023)	(0.022)	(0.016)	(0.028)	(0.028)	(0.029)	(0.027)	(0.028)	(0.018)
Real equity prices	-0.009	-0.007		-0.007	-0.005		-0.009	-0.004	
	(0.007)	(0.008)		(0.011)	(0.012)		(0.012)	(0.012)	
Real equity prices$^{(us)}$	0.014	0.013		-0.001	-0.000		0.029**	0.027**	
	(0.010)	(0.010)		(0.012)	(0.013)		(0.013)	(0.011)	
Fiscal balance × Foreign debt			-0.089			-0.064			0.156
			(0.163)			(0.186)			(0.198)
Foreign debt			-0.002			0.001			0.006
			(0.006)			(0.011)			(0.007)
Fiscal balance$^{(us)}$ × Foreign debt$^{(us)}$			0.249			-0.167			0.169
			(0.237)			(0.240)			(0.618)
Foreign debt$^{(us)}$			-0.017			-0.019			0.001
			(0.027)			(0.025)			(0.028)
Constant	-3.867***	-4.001***	-3.391***	-4.080***	-4.173***	-3.582***	-4.296***	-4.399***	-3.784***
	(0.283)	(0.284)	(0.266)	(0.253)	(0.231)	(0.290)	(0.225)	(0.276)	(0.314)
Observations	1,592	1,592	1,103	1,585	1,585	1,097	1,562	1,562	1,080
McKelvey and Zavoina's R^2	0.304	0.311	0.302	0.198	0.207	0.134	0.176	0.222	0.053
log likelihood	-215.9	-213.1	-179.2	-173.5	-171.9	-153.2	-142.0	-137.0	-130.6
χ^2	78.62	221.10	271.40	75.76	104.10	111.50	30.85	217.9	28.77
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Estimates of Eq. (1), (2) and (3) for vulnerabilities arising from actual fiscal deficits, prospective fiscal deficits and rollover/sudden stop risk using the four alternative definitions of a currency crash presented in section 2 as well as the respective parsimonious models of Tables 1a, 1b and 1c. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table D: Robustness – *Using nominal (rather than real) effective exchange rates to define currency crashes*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Standard threshold (5th %ile i.e. >10% depreciation)				Higher threshold (2.5th %ile i.e. >18% depreciation)			
Fiscal balance	0.001	0.006	0.027	0.046	0.012	0.019	0.006	0.074*
	(0.024)	(0.026)	(0.026)	(0.031)	(0.030)	(0.036)	(0.033)	(0.043)
Fiscal balance × banking crisis		-0.185**				-0.217**		
		(0.092)				(0.094)		
Banking crisis		-0.411				-0.109		
		(0.597)				(0.643)		
Fiscal balance$^{(us)}$	-0.032*	-0.044***	-0.024	-0.031	-0.062**	-0.082***	-0.069***	-0.047
	(0.018)	(0.016)	(0.024)	(0.026)	(0.025)	(0.022)	(0.020)	(0.034)
Fiscal balance$^{(us)}$ × banking crisis$^{(us)}$		0.439***				0.587***		
		(0.125)				(0.191)		
Banking crisis$^{(us)}$		1.548***				2.261***		
		(0.319)				(0.545)		
Exchange rate deviation	0.056**	0.054**	0.056**	0.048**	0.108***	0.107***		0.097***
	(0.022)	(0.021)	(0.022)	(0.021)	(0.021)	(0.020)		(0.028)
Real equity prices	-0.002	0.001	-0.002		0.018	0.024*	-0.005	
	(0.009)	(0.010)	(0.009)		(0.013)	(0.012)	(0.013)	
Real equity prices$^{(us)}$	-0.015	-0.013	-0.015		-0.024*	-0.021	-0.011	
	(0.010)	(0.010)	(0.010)		(0.013)	(0.013)	(0.011)	
Total debt			0.007***				0.007**	
			(0.002)				(0.003)	
Total debt$^{(us)}$			0.001				-0.006	
			(0.004)				(0.010)	
Fiscal balance × foreign debt				-0.281***				-0.278**
				(0.100)				(0.126)
Foreign debt				-0.007				-0.002
				(0.005)				(0.008)
Fiscal balance$^{(us)}$ × foreign debt$^{(us)}$				0.115				-0.169
				(0.254)				(0.353)
Foreign debt$^{(us)}$				-0.032				-0.066
				(0.021)				(0.043)
Constant	-3.458***	-3.596***	-3.702***	-2.987***	-4.511***	-4.875***	-4.122***	-3.943***
	(0.179)	(0.218)	(0.339)	(0.210)	(0.219)	(0.324)	(0.418)	(0.285)
Observations	1,566	1,566	1,412	1,099	1,566	1,566	1,428	1,099
McKelvey and Zavoina's R^2	0.0898	0.120	0.104	0.108	0.235	0.284	0.0820	0.275
log likelihood	-235.2	-228.7	-227.4	-185.8	-130.5	-122.0	-149.0	-106.7
χ^2	18.75	67.49	26.30	63.13	63.96	458.1	42.79	80.77
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Estimates of Eq. (1), (2), (3) and (4) for all main sources of fiscal vulnerability using *nominal* effective exchange rates to define currency crash episodes as well as two distinct thresholds to define currency crashes: (i) our standard 5th percentile threshold (i.e. an annual depreciation in excess of 10%) and (ii) a higher 2.5th percentile threshold (i.e. an annual depreciation in excess of 18%), together with the respective parsimonious models of Tables 1a, 1b, 1c and 1d. All models include the corresponding US counterpart of the variables entered in the regressions. All regressors enter with a two-year lag. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

<u>Appendix IV</u>: Additional robustness tests

Our results vary somewhat across regions.[26] They are very close to the baseline results for the most advanced (G7) economies, whose currencies account for the lion's share of foreign exchange market transactions, as well as when the sample is restricted to all advanced economies, but excluding Canada and Australia.[27] This is comforting because the latter are the two currencies with by far the largest number of crashes, probably because they are tightly dependent on volatile commodity prices. As regards non-G7 advanced economies and emerging economies, it appears that none of the sources of fiscal vulnerability seem to matter, while other variables seem to explain currency crashes (notably our proxy for exchange rate overvaluation). It is worth to bear in mind however that our sample for emerging economies is small, as we have roughly only 200 observations and four countries. Finally, looking at the results for all (advanced and emerging) economies, we find that actual fiscal deficits and rollover/sudden stop risk matter, but not prospective fiscal deficits (possibly due to the inclusion here of the emerging economies in the sample).

Turning now to the sensitivity of the results to different time periods, we run regression results when the sample is restricted to the three main periods characterising the international monetary system over the last century, namely the gold standard, the Bretton Woods system and the current floating era.[28] Our findings suggest that results vary over time and that the nature of the international monetary system matters. Under the gold standard, the results suggest that prospective deficits mattered the most by far: the elasticity to that channel is 3 times larger than that estimated for the full sample (around -0.63 vs. -0.20).

This might come prima facie as a surprise, since the gold standard should have severely constrained the ability of governments to monetise fiscal deficits that swell in the wake of a banking crisis (the key trigger of a currency crash under this channel), given that money supply was exogenously determined by in- and outflows of gold (note, however, that the relevance of banking crises was also noted by Kugler and Straumann (2010) for the peripheral countries in the gold standard). As previously noted, one possible explanation was that joining the gold standard acted as a seal of approval (of good housekeeping by fiscally prudent countries) which yet helped relax borrowing constraints, ultimately. A related explanation is that fiscal deficits were at least partly monetised under the gold standard (as they largely were during the First World War, when many countries exited temporarily the standard). A third one is that the number of observations on which the estimations are based (about 120-260) is small. During Bretton Woods, only the rollover/sudden stop risk seemed to matter, and again, with a much bigger (nine times) impact than estimated for the full sample (-1.60 vs. -0.18). Prospective fiscal deficits were dropped as a source of vulnerability

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[26] The results are not reported here to save space but are available upon request.
[27] However, the foreign debt channel loses significance when the sample is restricted to G7 economies only (possibly due to a loss of efficiency in the estimation, as a third of the sample is then lost due to data availability).
[28] The results are not reported here to save space but are available upon request.

from the estimations because there were no reported banking crises between 1945 and 1971. Under the current floating era, there is neither evidence for a direct fiscal channel nor for a foreign debt channel, but prospective fiscal deficits are a significant source of vulnerability, with a magnitude broadly similar as in the full sample. The latter finding indicates that although the exchange rate regime (in part determined through the international monetary system) and fiscal policy may have been co-determined, some findings are broad-based and stretch across the various international monetary regimes that we have witnessed over the last 130 years, alleviating concerns relating to endogeneity.

Table C of Supplementary Appendix III reports regression results using alternative definitions of currency crashes. The results prove most robust when using the definition of a "more protracted crash" (columns 1 to 3), as the direct fiscal and banking channels remain significant, with a similar magnitude as in the baseline estimates, while the foreign debt channel turns insignificant. The results are less robust with the other two definitions i.e. those of an "even more protracted crash" (columns 4 to 6) and of a "very protracted crash" (columns 7 to 9). Only the direct fiscal channel remains then significant, while the banking crisis and foreign debt channels then become insignificant. This suggests that our findings hold more for relatively abrupt currency collapses (i.e. over one or two years) than for multi-year declines (i.e. over three years), thereby suggesting that the drivers of these two manifestations of currency weakness might be of a fundamentally different nature.

As a further robustness check, we add credit growth as a possibly omitted variable in the parsimonious model regressions, since credit growth has proved to be a very good predictor of financial crises (defined as major banking crises) over the last century (see Schularick and Taylor, forthcoming). Our results remain broadly unchanged both in terms of statistical significance and economic magnitude of the different sources of vulnerability (with the exception of sudden stop/rollover risk which then loses statistical significance). We also restrict the estimations to systemic banking crises only, which make the results even stronger (in the sense that the estimated interacted effect between fiscal and banking crises becomes 25% larger in terms of economic magnitude and is still significant).[29]

As a last robustness check, we examine how the results are affected when using nominal effective exchange rates to define currency crash episodes, rather than real effective exchange rates as in the baseline estimations. Our results remain broadly unaltered, with no significant evidence for actual fiscal deficits as a source of vulnerability, strong evidence for prospective fiscal deficits and rollover/sudden stop risk, a very limited impact in magnitude (albeit significant) of the total debt level (see Table D of Supplementary Appendix III, columns 1 to 4). The results are also

[29] In so doing, we use the classification of systemic banking crisis episodes of Reinhart (2010). We have also cross-checked these episodes with those available from Laeven and Valencia (2008) who provide information for the post-1970 period. Both dataset are highly correlated (0.74 at the 1% level of confidence). It is however worth noting that the Laeven and Valencia (2008) public data only indicate the starting date of the banking crisis (unlike those of Reinhart which also reports how long the crisis lasted).

unchanged when using a higher cut-off to define a currency crash, namely the bottom 2th percentile depreciation over one year (with a one-year exclusion window), i.e. a depreciation in excess of 18% (rather than 10%; see Table D of Supplementary Appendix III, columns 5 to 8).