130 years of fiscal deficits and currency crashes in advanced economies

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Abstract:

This paper investigates the empirical link between fiscal policy 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. While there is weak evidence that crashes depend on the magnitude of fiscal deficits per se, the effect of fiscal deficits on currency crashes is substantial if deficits are associated with banking crises or if public debt is largely foreign owned. We also uncover significant nonlinear effects at high levels of public debt and fiscal deficits as well as negative risk premia for major reserve currencies, which enjoy a lower probability of currency crashes than other currencies ceteris paribus. Our estimates yet indicate that such premia are small in size, suggesting that a currency's international status is not sufficient to shelter it from crashing once a banking crisis occurs or if public debt structure is heavily tilted towards foreign ownership.

JEL No: F30, F31, N20

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1. Introduction

The global crisis that erupted in 2007 has brought the sustainability of 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 possible 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".

There is remarkably little empirical work on the link between fiscal policy and currency crashes for advanced economies, in sharp contrast with that on emerging market economies.[1] Only a handful of studies have taken up the issue. Some have focused on 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).

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

[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; 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 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.

recent history, taking a much longer term perspective might prove particularly insightful.

The intended contribution of our paper is to investigate whether and why large fiscal deficits lead to currency crashes in mature economies, and to test empirically three main theoretical channels for such a link over the last 130 years. The paper relies on new data 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), as well as Bordo, Meissner and Stuckler (2010) on long-run macroeconomic time series, notably public debt, 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 fiscal deficits had a similar or even higher magnitude as they have 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 three key channels 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 the empirical analysis using several alternative specifications in terms of magnitude and time horizon.

The literature emphasises at least three channels through which fiscal policy may induce exchange rate crashes. A first channel – which we will refer to as the "direct fiscal channel" – 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 deficits, and the monetisation of these deficits, ultimately lead 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 view – referred to here as the "banking crisis channel" – emerged in the aftermath of the Asian crisis (Corsetti, Pesenti and Roubini, 1999; Burnside, Eichenbaum, Rebelo, 2001). According to this view, even if today's fiscal positions are sound (which was the case of most emerging Asian economies before the regional crisis that erupted in the late 1990s), *prospective* fiscal deficits and potential contingent liabilities (including 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 view is linked to the discussion on the fiscal theory of the price level, which we will refer to as the "debt structure channel" (Corsetti and Mackowiak, 2005; 2006). According to this class of models, the nature of government liabilities matters. In particular, a large share of foreign debt raises the likelihood and magnitude of a currency collapse, as sudden stops and capital flight magnify the impact of a given fiscal deficit. In addition to this, a high share of foreign debt can be expected to contribute to increase 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. 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.

The main results are as follows. First, we find that large fiscal deficits do lead to currency crashes, but that not all transmission channels matter to the same extent. We find weak evidence that the direct fiscal channel helps explain why mature economies' currencies crashed over the last century. Larger fiscal deficits are found to be associated with an increase in the probability of a currency crash, but only to a small extent. We find much stronger evidence in favour of a banking crisis channel. 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, 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 find similar evidence for the debt structure channel. Our estimates indicate that more foreign debt magnifies greatly, 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.

Moreover, we uncover significant nonlinear effects at "extreme" levels of public debt and fiscal deficits. In particular, whatever the transmission channel (be it the direct fiscal channel, the banking crisis channel or the debt structure channel), 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 a banking crisis occurs or if public debt is largely foreign, 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.

2. Estimation and hypotheses

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

2.1 Theoretical motivations

Why would large fiscal deficits lead to currency crashes? The literature has emphasised in particular three channels. A first channel – which we refer to as the "direct fiscal channel"– 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 view –which we refer to as the "banking crisis channel"– emerged in the aftermath of the Asian crisis, and was developed notably in Corsetti, Pesenti and Roubini (1999) and 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 view, which we refer to as the "debt structure channel", suggests that the structure of government liabilities matter. According to this view, a large share of foreign debt magnifies a currency crisis and 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:

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

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.[3] In addition to this, a high share of foreign debt can be expected to contribute to increase 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.[4]

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 three theoretical channels discussed above help explain whether larger fiscal deficits in advanced economies contributed to increase the probability of currency crashes over the last 130 years or so, 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 the direct fiscal (monetisation) channel,

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

for the banking crisis channel,

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

[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.

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

for the debt structure channel.

$Y_{i,t}$ 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; and Φ is the share of foreign debt in total public debt in country i in year t. 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 $\mathbf{Z_{i,t}}$ 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) and the level of foreign yields.[5] 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 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.[6]

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

[5] 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.

[6] 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.

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 direct fiscal effect) and β_3 (the coefficient of the interacted effect with banking crises or debt composition). An empirical test of whether –and why– fiscal deficits lead to currency crashes is tantamount to rejecting the following null hypotheses:

$$H_0 : \hat{\beta}_2 \geq 0 \quad \text{(direct fiscal channel)} \qquad (4)$$
$$H_0 : (\hat{\beta}_2 + \hat{\beta}_3) \geq 0 \quad \text{(banking crisis or debt structure channels)}$$

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 a banking crisis or by a risky public debt composition.

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 gauge whether there are nonlinearities, notably with regard to the levels of public debt and fiscal deficits. As our prime objective is to examine empirical regularities, we put all the information together in the baseline. However, we also test the extent to which the results are sensitive to alternative country samples, time periods and definitions of currency crashes 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[7], we follow an agnostic approach. We use alternative definitions of currency crashes based on pure statistical terms, on the one hand, and endeavour to

[7] 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".

make a more qualitative distinction between "sudden" and "protracted" ones, on the other.

Our benchmark specification focuses on "sudden" currency crashes, which we define as the annual rate of depreciation of a country's real effective exchange rate (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%); see Figure 2a.

Alternative definitions of currency crashes are considered in the robustness checks. First, we examine "more protracted" currency crashes, defined as a dummy variable which equals 1 if the depreciation of a country's real effective exchange rate over *two years* exceeds 15% and 0 otherwise (with a one-year exclusion window). We aim to capture here depreciations that are more long-lasting, albeit still infrequent (i.e. again, roughly the bottom 5th percentile of the distribution of two-year real effective exchange rate changes across the sample) and large (typically from 15% to above 60%); see Figure 3a. We further consider "even more protracted" crashes, i.e. depreciations in excess of 18% over *three years* (with a two-year exclusion window, a threshold which again leaves us with roughly the bottom 5th percentile of the distribution of three-year real effective exchange rate changes across the sample); see Figure 4a. Finally, we consider "very protracted crashes", i.e. depreciations in excess of 23% over *five years* (with a four-year exclusion window, a threshold which again leaves us with roughly the bottom 5th percentile of the distribution of five-year real effective exchange rate changes across the sample); see Figure 5a.

3. Data and stylised facts

In this section, we discuss the construction of our dataset for the period 1880-2009 and present stylised facts outlining trends in currency crashes over the past 130 years.

3.1 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 Annex I for further details as well as Table A in Annex II 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.[8] We adjust these series to take re-denominations into account.

We use consumer price indices as deflators, which we also take from GFD.[9] 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 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. 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[10], 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 account for a significant share of the international trade of the respective countries, namely about half of their post-Second

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

[9] ibid.

[10] Effective rates allow identifying 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.

World War average (but only 40% for Argentina and as much as 80% for Canada and Mexico).

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* (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 in Annex II for further details). We use similar sources to collect data on total public debt and foreign debt (see Table D in Annex II for further details). It is to be noted that public finance data can take on in some instances 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 in Annex II 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[11] 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 thereafter. The data on real GDP growth are taken from Barro and Ursúa (2008) prior to 2006 and from the WEO afterwards.

3.2 Stylised facts

Before turning to the model estimation results, it is worth discussing some of the insights gained from our century-long time series. Figure 1 shows the evolution over 1880-2009 of the real effective exchange rate of our 21 countries. A first 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 should reflect reasonably well developments that occurred previously.

Figure 2b 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.

[11] 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).

What is comforting is that many of these 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[12] stands out clearly as well as the string of currency devaluations that followed the Great Depression.[13] 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.[14] So are also the currency crashes that occurred after the first and second oil price shocks.[15] 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.

Figures 3b, 4b and 5b plot the "more protracted", "even more protracted", and "very protracted" currency crashes in our sample by country and over time (with a total of 76, 51, and 37 of such crashes, respectively).

Figure 6a and 6b shows 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 7 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. Figure 8 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 than in the G7 economies.

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[12] 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).

[13] 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.

[14] 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.

[15] 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.

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.

We next consider each of the theoretical channels in turn. A first result that comes from our benchmark regressions is that there is some evidence for the direct fiscal channel. 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 2.5%). The parsimonious model is 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 robust 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.

There is much stronger evidence for the banking crisis channel, as can be seen from 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 a foreign debt channel 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). Again, the corresponding US counterpart interaction 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).

Finally, we test the three channels 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 9a to 9c provide more detailed evidence on the impact of the various transmission channels on the probability of a "sudden" currency crash. The charts plot the conditional probability of a crash against the size of the fiscal balance as a percentage of GDP (Figure 9a), including banking crisis effects (Figure 9b) and foreign debt effects (Figure 9c). 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.[16]

The charts confirm and illustrate quantitatively the results previously discussed. Considering first 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 9a). Considering now the combined effects of a fiscal deficit with a banking crisis, 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 9b). And considering last the combined effects of a fiscal deficit with foreign debt effects, 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 9c).

Another insightful perspective provided by the baseline results is provided in figures 10a and 10c which plot a century of currency crash probabilities for the US

[16] The lower percentiles in the distributions for the control variables refer to values which would result in relatively lower crash probabilities of a currency crash as compared to the higher percentiles of the distribution.

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 the direct fiscal, banking crisis and foreign debt channels. 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).[17] 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.

Are there specific observations that have influenced the large increases in estimated crash probabilities for the US dollar over the last century? Figure 10b helps to assess this by plotting the estimated conditional probability of a sudden crash for the US currency for the parsimonious models corresponding to the direct fiscal, banking crisis and foreign debt channels together with the actual US fiscal deficit (upper left quadrant), US banking crises (upper right quadrant) and share of foreign debt in total US public debt (lower left quadrant). What comes out nicely from the chart is that the probability of a US dollar crash rises sizeably when US fiscal deficits rose in tandem markedly, e.g. at the time of the two world wars, the Great Depression and the mid-1980s (when "twin deficits" were then heavily debated). The probability of a US dollar crash also rises sizeably around the times of the main US banking crises, including those that occurred during the Great Depression, or at the time of the Savings and Loans crisis in the 1980s or of the 2008 banking crisis. The probability is somewhat disconnected from the evolution of US foreign debt, by contrast, which seems to suggest that the latter did not play a key role in explaining why the US dollar crashed in the last century.

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.

Such a specification also helps assess whether the US dollar, for instance, is different from the other 20 countries in our sample, because it is the dominant

[17] 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).

international currency. In other words, it helps 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 channels. Results for the direct channel are reported in column 1; those for the banking crisis channel in column 2; and those for the debt structure channel in column 3. What comes out clearly is that there is significant evidence of country heterogeneity for both the direct fiscal and banking crisis channels, but not for the debt structure channel. The standard deviation of the country-specific effects (reported in the shaded row of Table 3) is indeed significantly large for the first two channels, but not for the remaining one. 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 the banking and debt structure channels, than for the direct fiscal channel.

Figures 11a to 11c 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.[18] 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 largely foreign. As aforementioned, this conditional probability is estimated to reach

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

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.[19]

Do the results vary with the level of public debt? 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 12a summarises the results, with the dots in the figure indicating the estimated point elasticity of a currency crash relative to the fiscal balance (blue ones), the fiscal balance including banking crisis effects (red ones) and the fiscal balance including foreign debt effects (purple ones). What comes out from the results is that, whatever the transmission channel, 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.

Do the results also vary with the level of the fiscal deficit? To test whether there are such nonlinearities, we split our sample into separate buckets of observations, namely those for which the fiscal balance is (i) in surplus, (ii) between 0 and -6% of GDP and (iii) below -6% of GDP (i.e. roughly the bottom 5-%ile of the distribution) and then run separate regressions for each of these buckets and each of the transmission channels (using the corresponding parsimonious baseline model). Figure 12b summarises the results. What we find is that the impact of a given fiscal deficit on the probability of a currency crash is larger (i.e. the elasticity is more negative) when the deficit is very large (i.e. below -6% of GDP) for both the banking crisis and debt structure channels. At intermediate levels of fiscal deficits (i.e. between 0 and -6% of GDP) the impact is found to be insignificant for all channels. The results are similar when the fiscal balance is in surplus, barring the direct channel whose impact is estimated to be significantly negative. Taken together, the results further underscore the existence of significant nonlinear effects in the level of the fiscal balance, again possibly echoing the existence of Ricardian effects.

The remainder of the robustness checks explore the sensitiveness of our results to different country samples, time periods and definitions of currency crashes. Considering first robustness to different country samples, Table 4 reports regression results for the parsimonious baseline models, where the sample is restricted to G7 economies only (columns 1 to 3), non-G7 other advanced economies only (columns 4

[19] 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.

to 6), all advanced economies excluding Australia and Canada (columns 7 to 9), emerging economies only (columns 10 to 12) and then extended to all (advanced & emerging) economies (columns 13 to 15).

The results vary somewhat across regions. 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.[20] 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 fiscal channels 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 the direct fiscal and foreign debt channels matter, but not the banking channel (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, Table 5 reports regression results for the three channels when the sample is restricted to the three main periods characterising the international monetary system over the last century, namely the gold standard (columns 1 to 3), the Bretton Woods system (columns 4 to 6) and the current floating era (columns 7 to 9). 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 the banking crisis channel 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. One possible 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). Another one is that the number of observations on which the estimations are based (about 120-260) is small. During Bretton Woods, only the foreign debt channel seemed to matter, and again, with a much bigger (nine times) impact than estimated for the full sample (-1.60 vs. -0.18). Note that the banking channel was dropped 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 the banking channel is significant, with a magnitude broadly similar as in the full sample.

[20] 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).

Finally, Table 6 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.

6. Conclusions

To uncover the link between fiscal deficits and currency crashes in mature economies, this paper has tested three theoretical channels 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 large fiscal deficits do lead to currency crashes, but that not all transmission channels matter to the same extent. In particular, there is weak evidence that crashes depend on the magnitude of fiscal deficits per se, and much stronger evidence if those deficits are associated with a banking crisis or 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 differences over time that can be ascribed to the changing nature of the international monetary system. 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.

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 US dollar after the global crisis, although they should

obviously be interpreted with caution. Our estimates for 2009 (the last year of our sample), put the probability of a currency crash for the US dollar over 2010-2011 at around 10% or less. Prima facie, this might look surprisingly small, given that the US experienced a full-blown banking crisis in 2007-09, has now fiscal deficits in the order of 10% of GDP and public debt exceeding 90% of GDP. The estimates further suggest that the US dollar's international status is not necessarily the main mitigating factor, as the estimated negative risk premium that the US currency derives from this status does not offset the combined effects of high fiscal deficits and of a banking crisis on the probability of a currency crash.

Instead, the low probability in our models for a US dollar crash by that time mainly stem from two mitigating factors, namely that US public debt remains largely domestically held relative to other countries (although the share of foreign debt has reached historical highs in the US), and –perhaps most importantly– that the US dollar is already rather weak and significantly below its historical average, making a further collapse less likely. What our model could obviously miss, however, is the possibility of a major structural break resulting from e.g. an unprecedented loss of confidence in the US dollar, beyond those we have seen in the last 130 years. 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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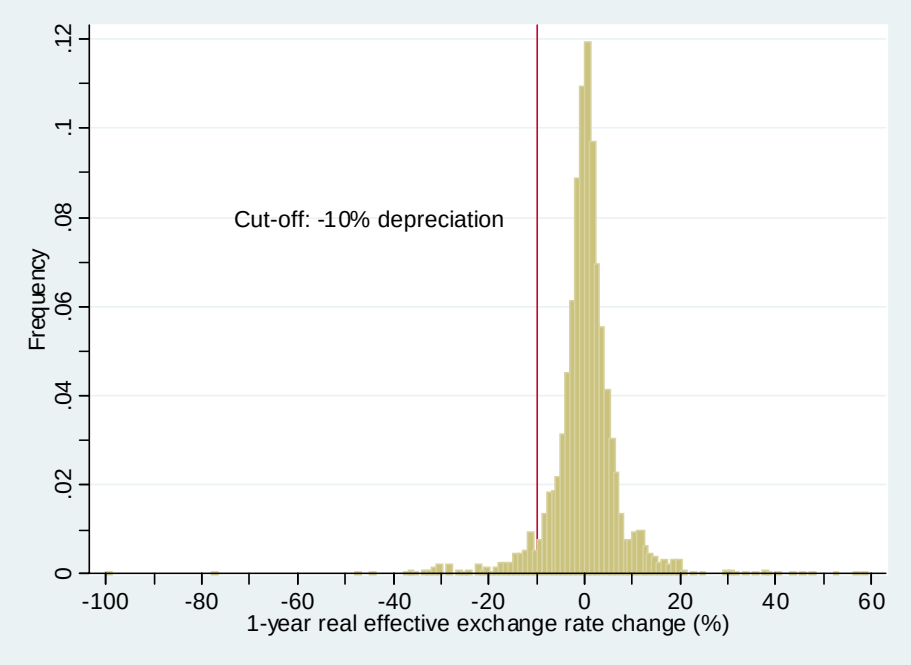
Figure 1: Real effective exchange rates in advanced and emerging market economies: 1880-2009

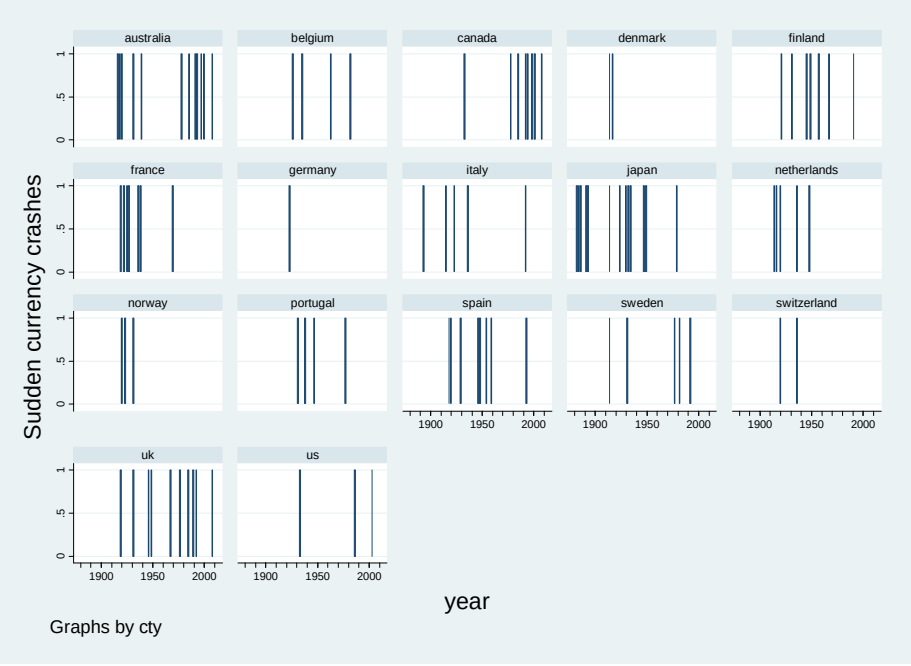
Notes: natural logarithm of index levels (an upward movement indicates an appreciation of the corresponding currency); red lines = BIS series; blue lines = authors' own series.

Figure 2a: Defining "sudden" currency crashes (baseline)
(Sample distribution of 1-year real effective exchange rate changes)



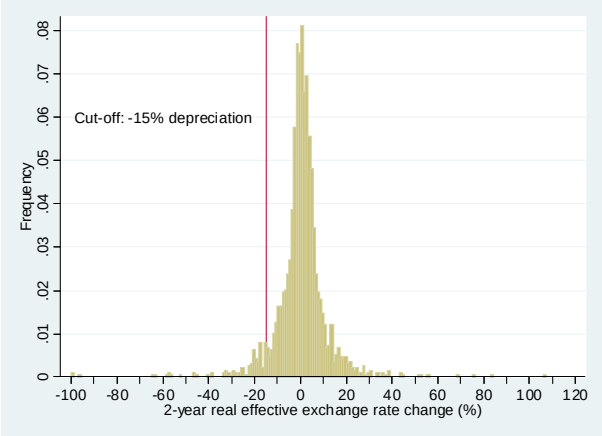
Note: red line ≈ bottom 5-%ile; only advanced economies.

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



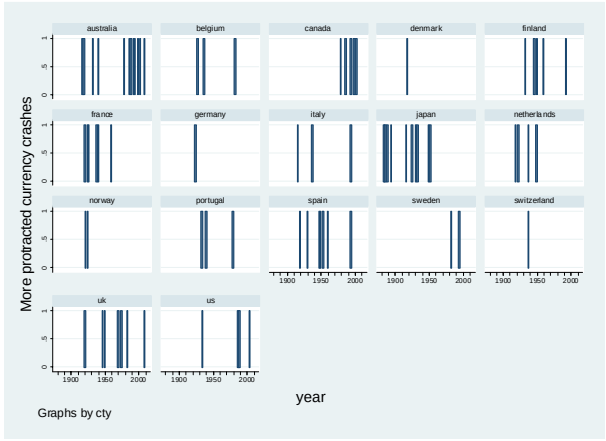
Notes: incl. 1-year exclusion window. Total # of crashes = 99.

Figure 3a: Defining "more protracted" crashes
(Sample distribution of 2-year REER changes)



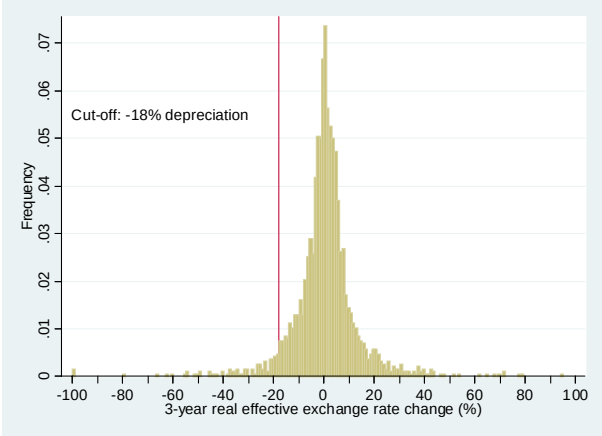
Note: red line ≈ bottom 5-%ile; only advanced economies.

Figure 3b: "More protracted" crashes: 1880-2009



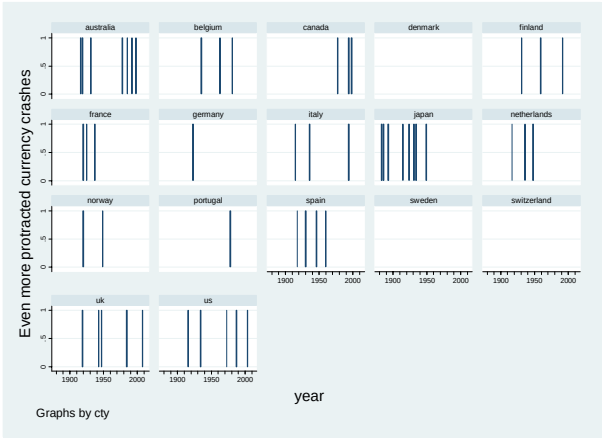
Notes: incl. 1-year exclusion window. Total # of crashes = 76.

Figure 4a: Defining "even more protracted" crashes
(Sample distribution of 3-year REER changes)



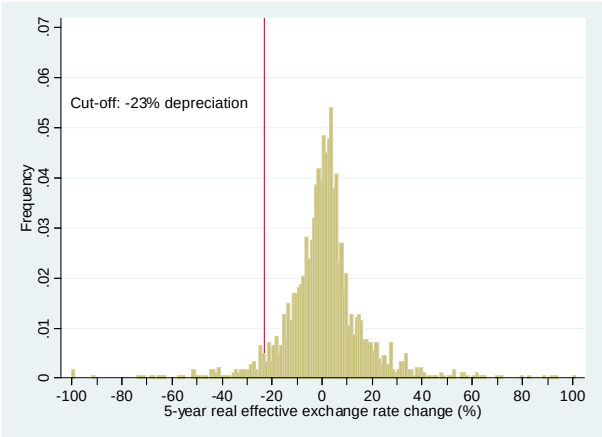
Note: red line ≈ bottom 5-%ile; only advanced economies.

Figure 4b: "Even more protracted" crashes: 1880-2009



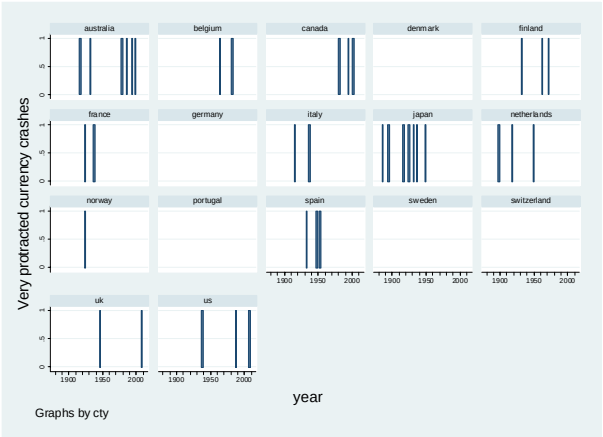
Notes: incl. 2-year exclusion window. Total # of crashes = 51.

Figure 5a: Defining "very protracted" crashes
(Sample distribution of 5-year REER changes)



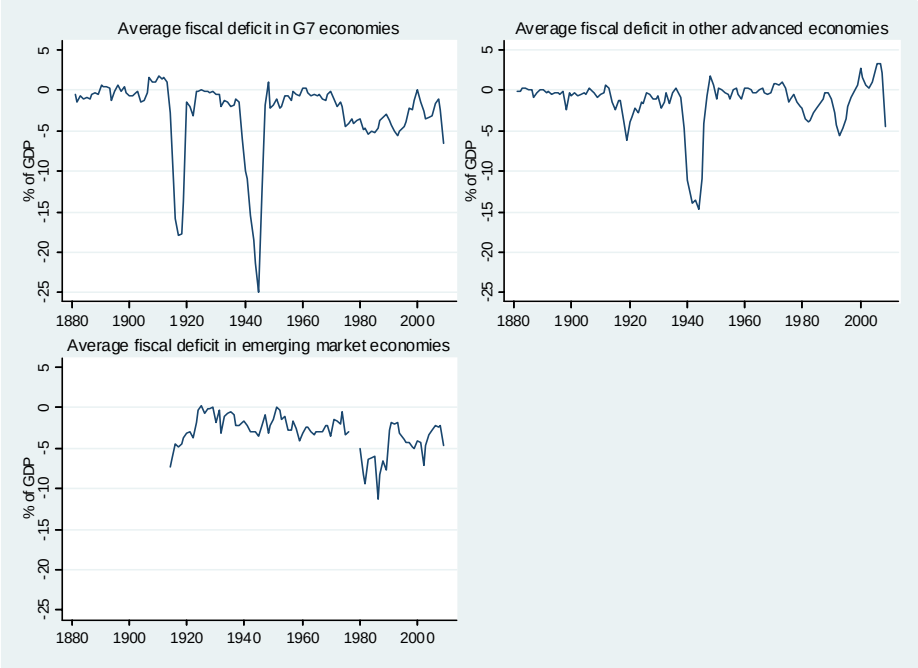
Note: red line ≈ bottom 5-%ile; only advanced economies.

Figure 5b: "Very protracted" crashes: 1880-2009



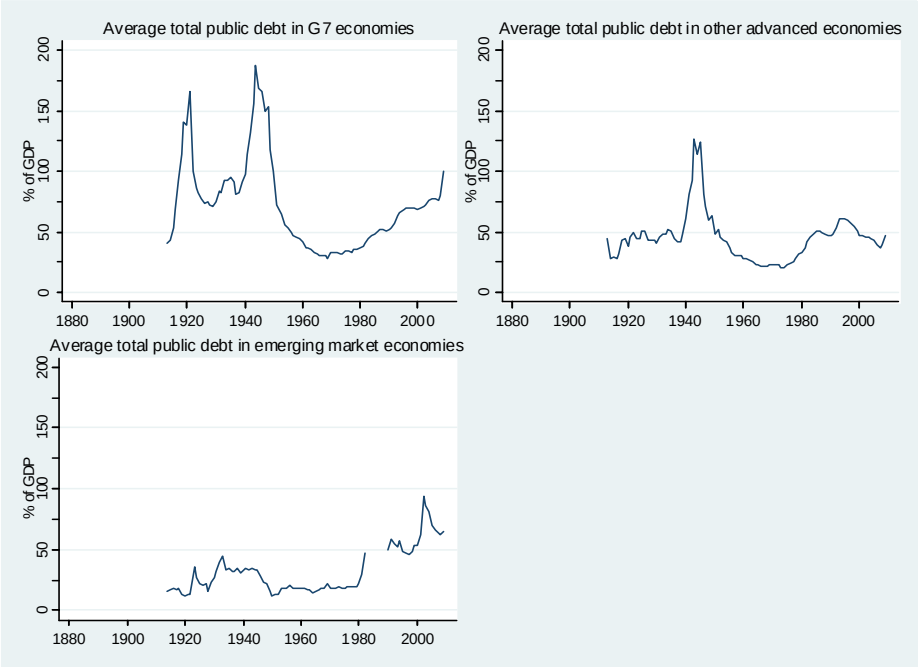
Notes: incl. 4-year exclusion window. Total # of crashes = 37.

Figure 6a: Average fiscal balance across selected country groups: 1880-2009



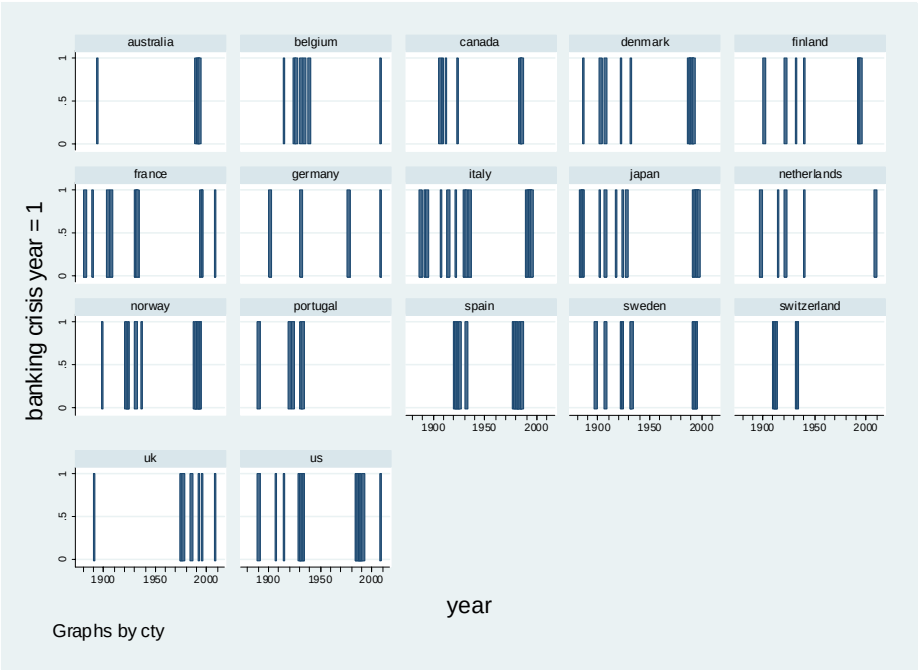
Note: the averages shown here occasionally mask that some observations may be missing for some individual countries in certain years.

Figure 6b: Average total public debt across selected country groups: 1880-2009



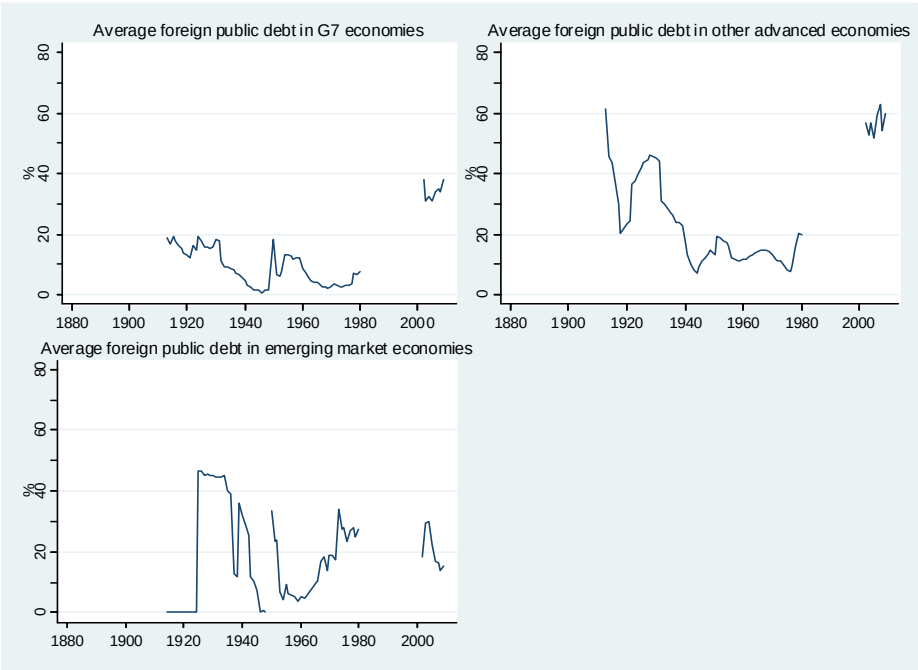
Note: the averages shown here occasionally mask that some observations may be missing for some individual countries in certain years.

Figure 7: Banking crises in mature economies: 1880-2009



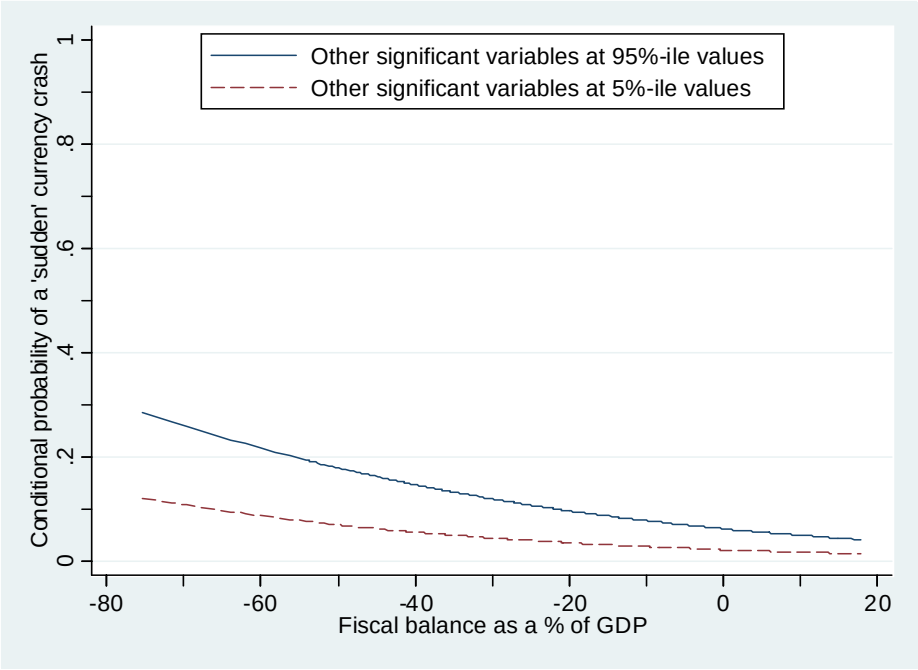
Source: Reinhart (2010).

Figure 8: Share of foreign debt in total public debt across selected country groups: 1880-2009



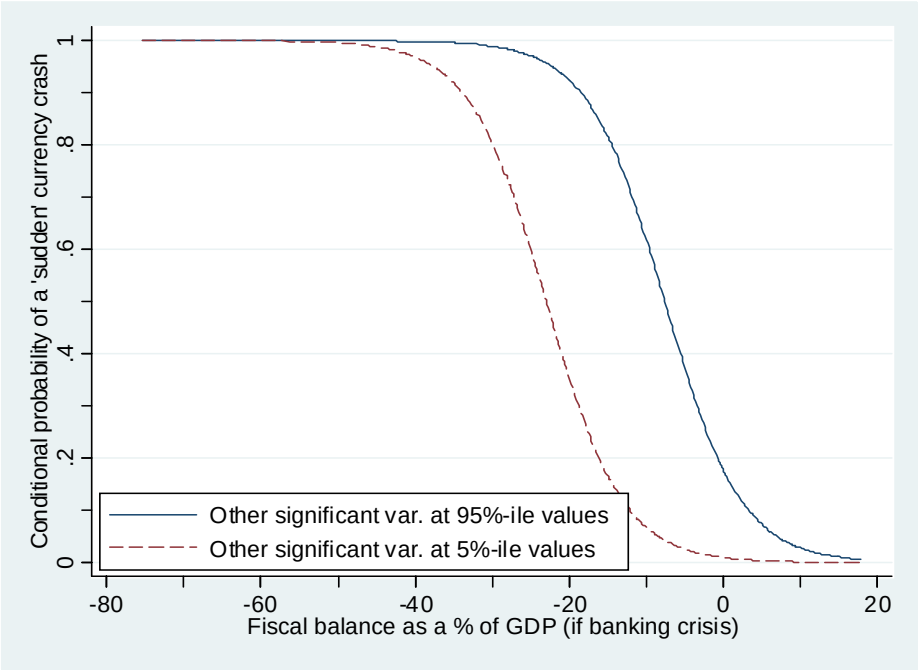
Note: the averages shown here occasionally mask that some observations may be missing for some individual countries in certain years.

Figure 9a: Conditional probability of a 'sudden' currency crash under two scenarios – *Direct fiscal channel*



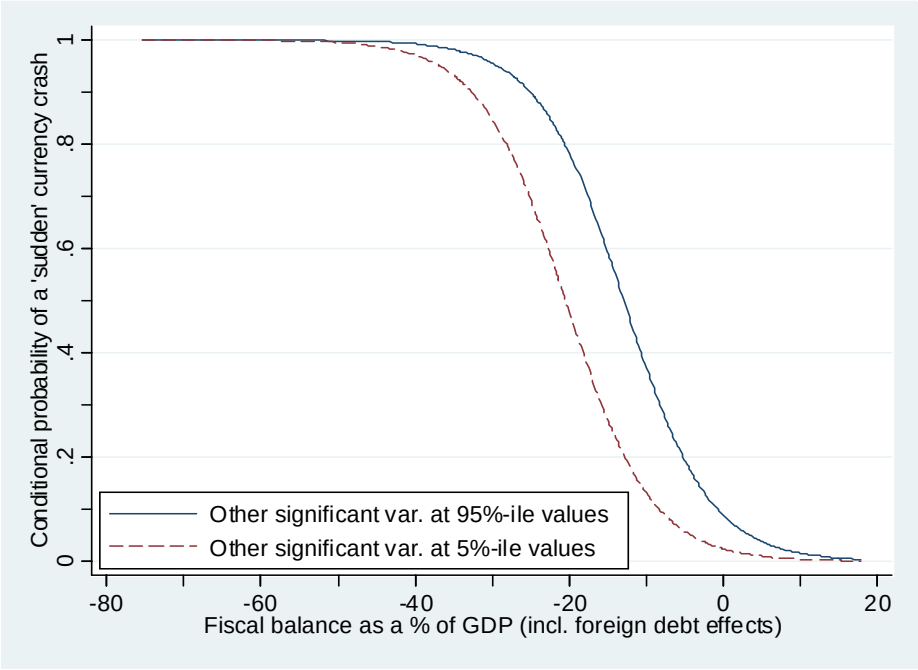
Note: Conditional probabilities calculated with parsimonious model (3) of Table 1a.

Figure 9b: Conditional probability of a 'sudden' currency crash under two scenarios – *Banking crisis channel*



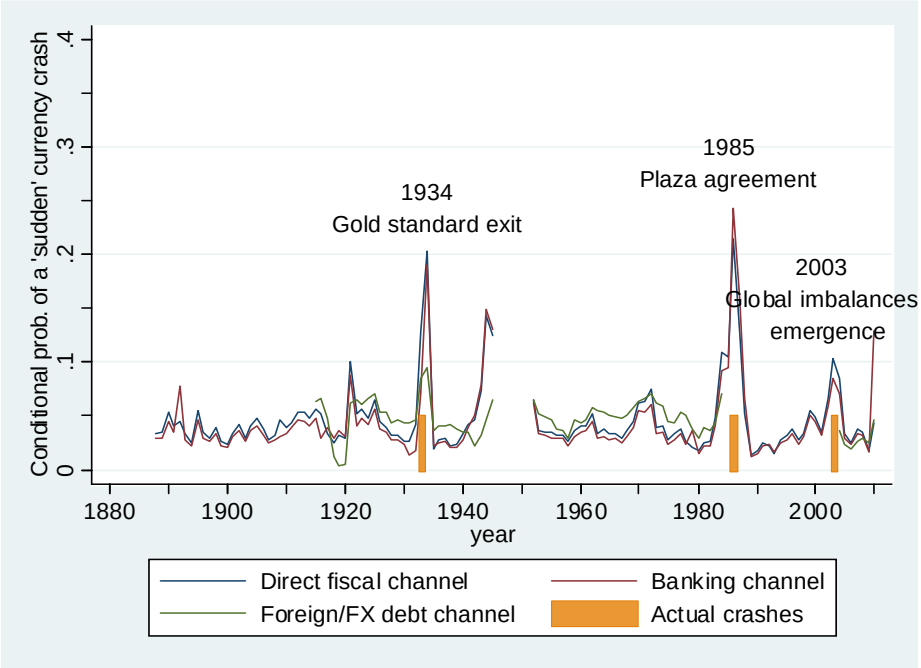
Note: Conditional probabilities calculated with parsimonious model (3) of Table 1b.

Figure 9c: Conditional probability of a 'sudden' currency crash under two scenarios – *Debt structure channel*



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

Figure 10a: A century of crash probabilities for the US dollar

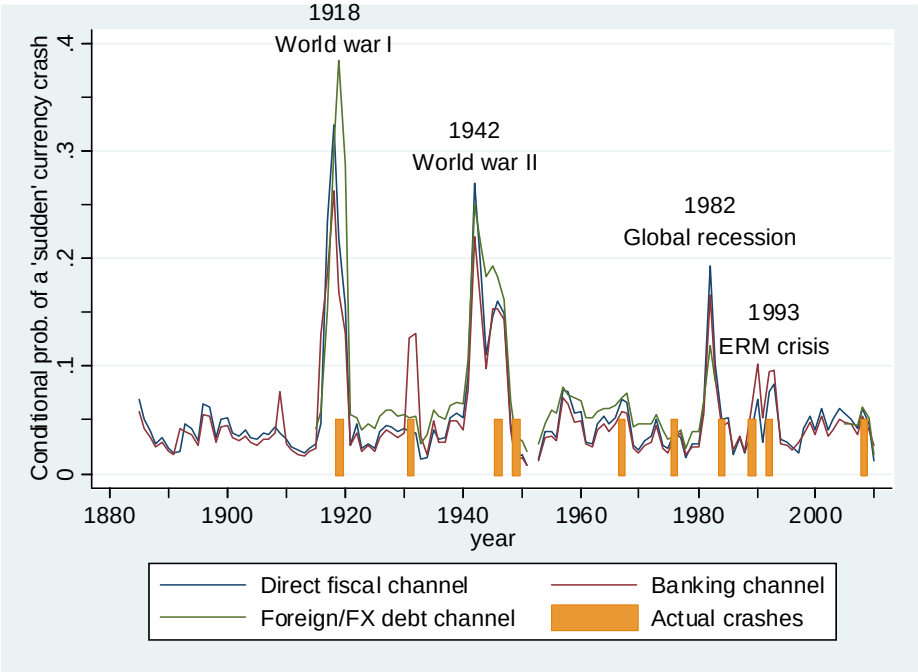


Note: Conditional probabilities calculated with parsimonious models (3) of Tables 1a, 1b and 1c.

Figure 10b: Estimated crash probabilities for the US dollar and selected explanatory variables for the US

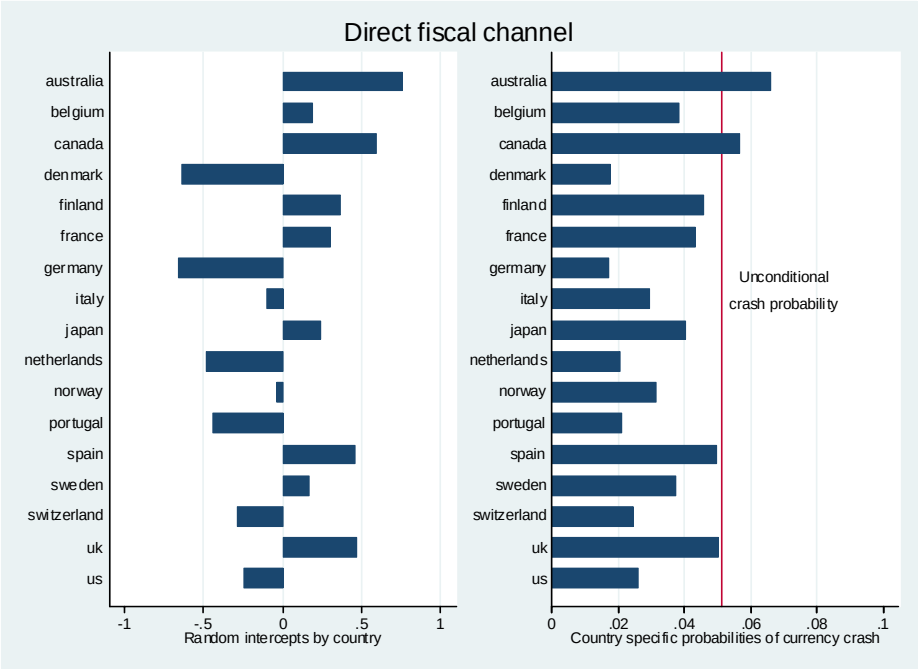
Note: Conditional probabilities calculated with parsimonious models (3) of Tables 1a, 1b and 1c.

Figure 10c: A century of crash probabilities for the pound sterling



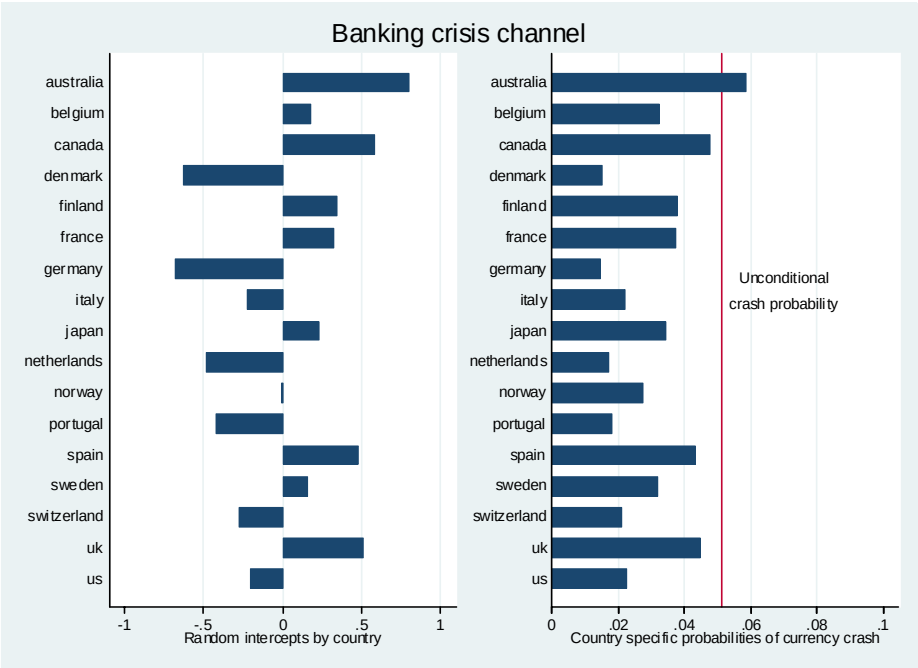
Note: Conditional probabilities calculated with parsimonious models (3) of Tables 1a, 1b and 1c.

Figure 11a: Country effects and conditional country-specific probabilities of a 'sudden' currency crash



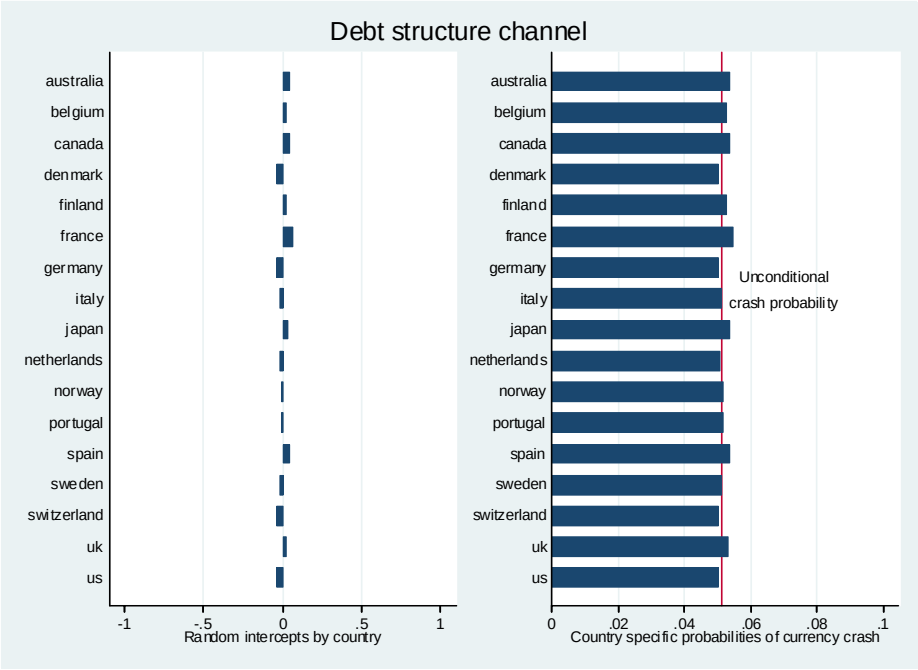
Note: Random effects estimated using specification (1) of Table (3).

Figure 11b: Country effects and conditional country-specific probabilities of a 'sudden' currency crash



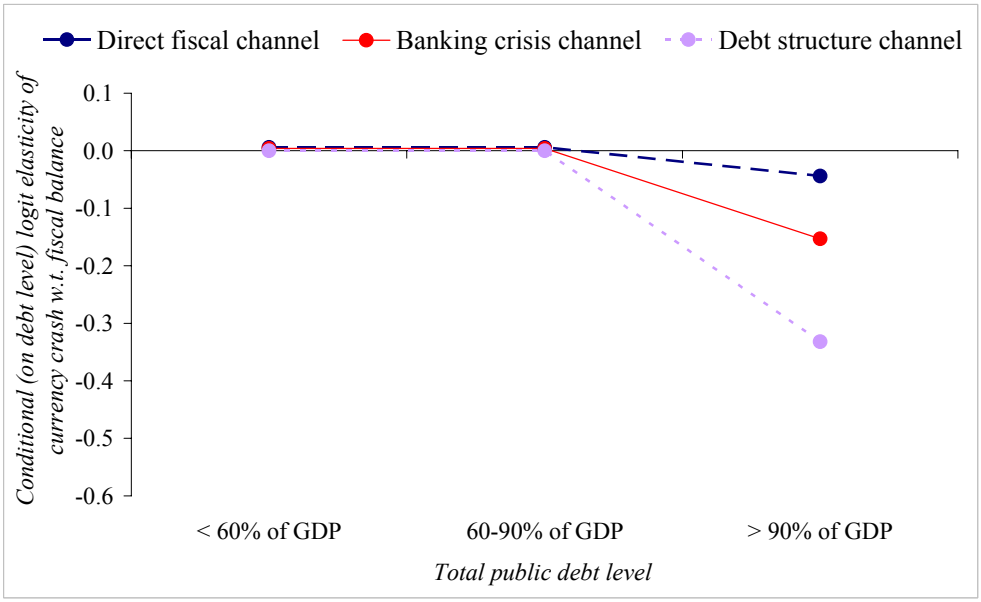
Note: Random effects estimated using specification (2) of Table (3).

Figure 11c: Country effects and conditional country-specific probabilities of a 'sudden' currency crash



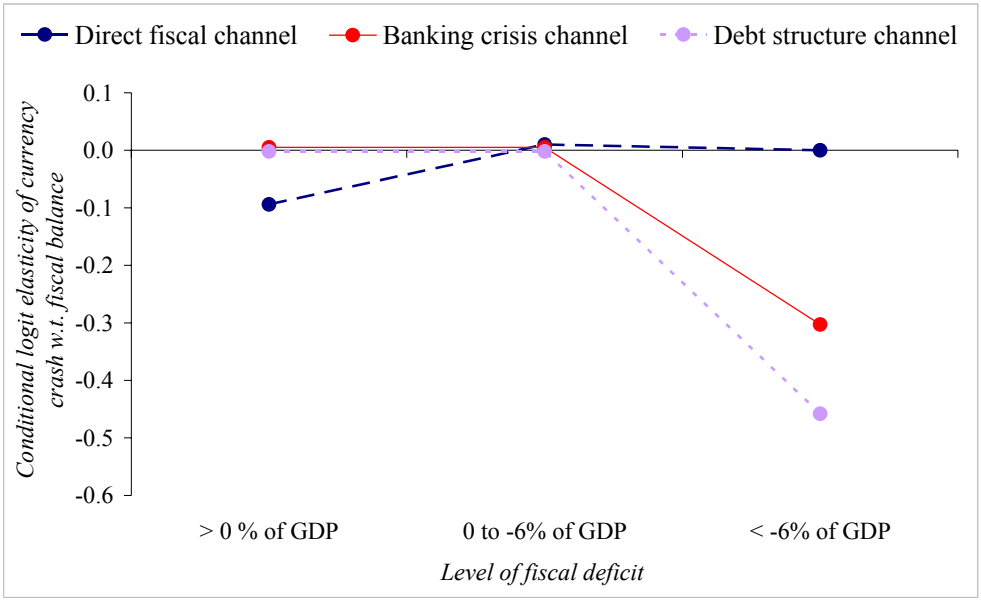
Note: Random effects estimated using specifications (3) of Table (3).

Figure 12a: 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 (i) fiscal balance (blue dots), (ii) fiscal balance incl. banking crisis effects (red dots) and (iii) fiscal balance incl. foreign debt effects (purple dots) obtained with the corresponding parsimonious models (3) of Tables 1a, 1b and 1c, respectively.

Figure 12b: Nonlinearities in the level of the fiscal balance



Note: Conditional (on the fiscal deficit level) elasticity of the probability of a currency crash with respect to (i) fiscal balance (blue dots), (ii) fiscal balance incl. banking crisis effects (red dots) and (iii) fiscal balance incl. foreign debt effects (purple dots) obtained with the corresponding parsimonious models (3) of Tables 1a, 1b and 1c, respectively.

Table 1a: Benchmark estimates – *Direct fiscal channel*

	(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

Note: Benchmark estimates of Eq. (1) for the direct fiscal channel 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. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 1b: Benchmark estimates – *Banking crisis channel*

	(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

Note: Benchmark estimates of Eq. (2) for the banking crisis channel 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. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 1c: Benchmark estimates – *Debt structure channel*

	(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

Note: Benchmark estimates of Eq. (3) for the debt structure channel 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. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 2: Encompassing model with all three channels

	(1)	(2)	(3)
Fiscal balance × banking crisis × foreign debt	-4.677	-10.519**	-6.011*
	(3.318)	(5.333)	(3.854)
Fiscal balance × banking crisis	-0.267*	0.111	-0.202
	(0.149)	(0.285)	(0.286)
Fiscal balance × foreign debt	-0.172**	-0.160	-0.181*
	(0.085)	(0.190)	(0.096)
Banking crisis × foreign debt	-0.239	-0.449**	-0.278*
	(0.155)	(0.215)	(0.166)
Fiscal balance	-0.024***	-0.034	0.003
	(0.009)	(0.042)	(0.015)
Foreign debt	0.003	-0.006	0.001
	(0.006)	(0.006)	(0.005)
Banking crisis	-0.092	0.619	0.055
	(1.004)	(0.727)	(1.146)
Exchange rate deviation		0.077**	0.051**
		(0.035)	(0.022)
Trade balance		0.018	
		(0.028)	
Trade balance$^{(us)}$		0.036	
		(0.053)	
Real equity prices		-0.014	
		(0.010)	
Real equity prices$^{(us)}$		0.016	
		(0.011)	
Real growth		-0.055	
		(0.046)	
Real growth$^{(us)}$		0.017	
		(0.039)	
Foreign yields		-0.037	
		(0.066)	
Real export growth		0.006	
		(0.007)	
Real export growth$^{(us)}$		0.010	
		(0.009)	
World war dummy		-1.861**	0.697*
		(0.904)	(0.395)
Sovereign default dummy		-1.058	
		(1.266)	
Real commodity prices		-1.614***	
		(0.590)	
Constant	-2.946***	-0.157	-3.053***
	(0.218)	(0.949)	(0.234)
Observations	1,132	1,020	1,127
McKelvey and Zavoina's R^2	0.608	0.119	0.689
log likelihood	-249.6	-186.1	-238.9

Note: Pooled logit estimates for the direct fiscal channel, banking crisis channel and the debt structure channel 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. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 3: Robustness – *Country effect estimates*

	(1)	(2)	(3)
	Direct fiscal channel	Banking crisis channel	Debt structure channel
Fiscal balance	-0.023	-0.021	-0.012
	(0.018)	(0.019)	(0.020)
Fiscal balance × banking crisis		-0.198*	
		(0.110)	
Banking crisis		-0.542	
		(0.588)	
Fiscal balance$^{(us)}$	-0.019	-0.026	-0.017
	(0.022)	(0.022)	(0.023)
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***
	(0.015)	(0.014)	(0.015)
Real equity prices	-0.014*	-0.012	
	(0.007)	(0.008)	
Real equity prices$^{(us)}$	0.007	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)
Constant	-3.406***	-3.572***	-2.909***
	(0.226)	(0.243)	(0.217)
R.E. std. dev.	0.579***	0.587***	0.129
	(0.224)	(0.224)	(0.431)
Observations	1,591	1,591	1,102
Number of groups	17	17	17
log likelihood	-286.8	-281.0	-239.8
χ^2	28.34	41.11	20.53
p-value	0.000	0.000	0.000

Note: Random effects panel logit estimates for the direct fiscal, banking crisis and the debt structure channels, using the 'sudden' currency crash as dependent variable 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. Standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 4: Robustness – *Estimates restricted to selected regional groupings*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	G7 economies only			Non-G7 other advanced economies only			All advanced economies excl. Canada & Australia			Emerging economies only			All (advanced & emerging) economies		
Fiscal balance	-0.033*	-0.031*	-0.023	-0.009	-0.006	-0.014	-0.025*	-0.022	-0.008	0.032	-0.017	-0.060	-0.029***	-0.030***	-0.017
	(0.018)	(0.018)	(0.022)	(0.020)	(0.017)	(0.010)	(0.013)	(0.014)	(0.013)	(0.049)	(0.061)	(0.227)	(0.011)	(0.011)	(0.013)
Fiscal balance × banking crisis		-0.240***			-0.092			-0.259***			0.342			-0.059	
		(0.063)			(0.232)			(0.064)			(0.298)			(0.120)	
Banking crisis		-0.688			-0.405			-1.241*			0.721			-0.294	
		(0.712)			(0.890)			(0.665)			(0.999)			(0.526)	
Fiscal balance$^{(us)}$	-0.004	-0.006	0.013	-0.019	-0.029**	-0.019	-0.016	-0.021	-0.022*	0.065***	0.075*	0.076	-0.008	-0.013	0.002
	(0.022)	(0.022)	(0.029)	(0.012)	(0.015)	(0.013)	(0.012)	(0.013)	(0.012)	(0.022)	(0.040)	(0.070)	(0.012)	(0.014)	(0.016)
Fiscal balance$^{(us)}$ × banking crisis$^{(us)}$		0.192**			0.288**			0.222**			0.601**			0.213***	
		(0.080)			(0.112)			(0.095)			(0.297)			(0.070)	
Banking crisis$^{(us)}$		0.970**			1.641***			1.217***			2.787**			1.288***	
		(0.494)			(0.409)			(0.414)			(1.093)			(0.302)	
Exchange rate deviation	0.047	0.046	0.014	0.076***	0.075***	0.058***	0.075**	0.074**	0.033	0.025***	0.027***	0.016*	0.043***	0.041***	0.037***
	(0.049)	(0.048)	(0.031)	(0.026)	(0.026)	(0.022)	(0.035)	(0.035)	(0.026)	(0.009)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
Real equity prices	-0.010	-0.007		-0.013**	-0.011*		-0.012**	-0.012*		0.002	0.002		-0.007	-0.006	
	(0.009)	(0.011)		(0.006)	(0.006)		(0.006)	(0.006)		(0.003)	(0.003)		(0.004)	(0.004)	
Real equity prices$^{(us)}$	-0.006	-0.007		0.018*	0.019**		0.001	0.001		0.019***	0.029***		0.006	0.009	
	(0.013)	(0.012)		(0.010)	(0.010)		(0.009)	(0.009)		(0.006)	(0.009)		(0.007)	(0.007)	
Fiscal balance × Foreign debt			-0.153			-0.146			-0.237**			1.065			-0.153*
			(0.146)			(0.120)			(0.105)			(1.259)			(0.087)
Foreign debt			0.011			0.000			-0.004			-0.002			-0.001
			(0.008)			(0.007)			(0.005)			(0.006)			(0.005)
Fiscal balance$^{(us)}$ × Foreign debt$^{(us)}$			0.247			-2.505**			0.648*			5.554*			0.412
			(0.381)			(1.024)			(0.371)			(2.834)			(0.297)
Foreign debt$^{(us)}$			-0.004			-0.104***			-0.037*			0.126*			-0.005
			(0.029)			(0.040)			(0.023)			(0.069)			(0.017)
Constant	-3.141***	-3.251***	-2.889***	-3.384***	-3.574***	-2.959***	-3.458***	-3.556***	-2.780***	-2.032***	-2.307***	-1.771***	-3.068***	-3.211***	-2.675***
	(0.301)	(0.296)	(0.311)	(0.335)	(0.329)	(0.274)	(0.243)	(0.259)	(0.219)	(0.259)	(0.247)	(0.592)	(0.180)	(0.179)	(0.219)
Observations	725	725	469	866	866	633	1,394	1,394	938	180	180	167	1,771	1,771	1,269
McKelvey and Zavoina's R^2	0.078	0.107	0.054	0.158	0.176	0.136	0.125	0.158	0.141	0.277	0.406	0.252	0.129	0.140	0.086
log likelihood	-137.6	-135.0	-108.3	-150.1	-146.2	-129.0	-220.5	-216.2	-186.7	-60.86	-58.59	-57.32	-358.4	-353.4	-305.5
χ^2	30.17			49.26			62.63	299.1	94.39				43.86	119.8	62.85
p-value	0.000	0.000	0.000	0.000	0.000	0.000	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 the direct fiscal, banking crisis and debt structure channels, using the 'sudden' currency crash as dependent variable as well as the respective parsimonious models of Tables 1a, 1b and 1c and where the sample is restricted to selected regional groupings. All models include the corresponding US counterpart of the variables entered in the regressions. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 5: Robustness – *Estimates restricted to selected historical periods*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Gold standard			Bretton Woods			Floating era		
Fiscal balance	-0.150	-0.167	-0.111***	-0.034		0.046	-0.019	0.008	-0.083
	(0.107)	(0.179)	(0.035)	(0.039)		(0.038)	(0.035)	(0.037)	(0.092)
Fiscal balance × banking crisis		-0.634***						-0.137*	
		(0.213)						(0.081)	
Banking crisis		-0.982						0.004	
		(1.209)						(0.606)	
Fiscal balance$^{(us)}$	-0.416***	-0.940***	-0.260*	-0.021		-0.010	-0.151**	-0.160***	-0.793**
	(0.127)	(0.254)	(0.150)	(0.059)		(0.025)	(0.065)	(0.062)	(0.373)
Fiscal balance$^{(us)}$ × banking crisis$^{(us)}$		1.425***						0.395*	
		(0.537)						(0.223)	
Banking crisis$^{(us)}$		2.393*						1.682*	
		(1.236)						(0.876)	
Exchange rate deviation	0.128**	0.168***	0.123**	0.104*		0.106***	0.112***	0.110***	0.104***
	(0.057)	(0.054)	(0.058)	(0.053)		(0.038)	(0.036)	(0.035)	(0.028)
Real equity prices	-0.018	-0.002		-0.004			-0.017**	-0.015**	
	(0.014)	(0.034)		(0.011)			(0.007)	(0.007)	
Real equity prices$^{(us)}$	0.044*	0.043**		-0.034			0.026	0.026	
	(0.023)	(0.017)		(0.032)			(0.030)	(0.029)	
Fiscal balance × Foreign debt			-0.059			-1.607**			-0.324
			(0.241)			(0.713)			(0.318)
Foreign debt			-0.008			0.004			-0.005
			(0.015)			(0.022)			(0.008)
Fiscal balance$^{(us)}$ × Foreign debt$^{(us)}$			-5.377***						4.785**
			(1.778)						(2.067)
Foreign debt$^{(us)}$			0.038						0.073*
			(0.047)						(0.039)
Constant	-4.678***	-5.588***	-3.373***	-3.645***		-3.781***	-3.964***	-4.057***	-4.693***
	(0.319)	(0.668)	(0.752)	(0.471)		(0.564)	(0.549)	(0.529)	(0.813)
Observations	265	265	124	372		342	659	659	306
McKelvey and Zavoina's R^2	0.364	0.553	0.382	0.192		0.123	0.261	0.268	0.297
log likelihood	-31.63	-24.16	-30.20	-44.49		-45.59	-104.2	-102.8	-53.48
χ^2	173.9	614.6		81.91		91.97	53.54	206.4	32.25
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 the direct fiscal, banking crisis and debt structure channels, using the 'sudden' currency crash as dependent variable as well as the respective parsimonious models of Tables 1a, 1b and 1c and where the sample is restricted to selected historical periods. All models include the corresponding US counterpart of the variables entered in the regressions. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 6: 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 the direct fiscal, banking crisis and debt structure channels, 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. Robust standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

ANNEX

Annex 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.[21] 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:

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

[21] 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.

Annex II: Data – Sources and main characteristics

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*

	Total public debt			Foreign debt		
Country	*Period*	*Source*	*Concept*	*Period*	*Source*	*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.