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## Determinants of the Public Budget Balance: The Role of Official Capital Flows

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# Determinants of the Public Budget Balance: The Role of Official Capital Flows

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## Abstract

Central banks invest their foreign exchange reserves predominantly in government bonds. The global accumulation of reserves therefore affects the equilibrium in the market for government bonds of reserve currency countries. By means of a panel data analysis we examine the relationship between reserve currency status and public budget balance during different constellations of the international monetary system: the sterling period (1890-1935) and the dollar dominance (since World War II). We show for both periods that reserve currency status significantly lowers the public budget balance of the center countries. These novel findings are robust to a battery of sensitivity tests involving regression specification, instrumentation and data sources. By conclusion, the global accumulation of official reserve assets leads to more expansionary fiscal policies in the center countries.

**Keywords:** Reserve Currency, Official Capital Flows, Public Balance, International Monetary System, Panel Data Analysis.

**JEL Classification Numbers:** F31, F33, F41, H62, E62, C23.

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# 1 Introduction

This paper provides an empirical examination of the relationship between reserve currency status and government finances. Since central banks hold their foreign exchange reserves preferably in the form of government bonds issued by the center country of the international monetary system, the reserve-providing country faces an additional demand for its sovereign bonds. By implication, reserve currency status facilitates the financing of fiscal deficits.

The empirical importance of the relationship between public finances and reserve currency status is characterized by five stylized facts:

- 1) Central banks' international reserves have increased considerably. The annual average growth rate between 1880 (1970) and 2010 has been 7.2% (12.2%). Since this rate exceeds the US inflation rate, which averaged 2.4% between 1880 and 2010, reserves have risen in real terms. Reserves have also increased relative to the economic size of the US, which might be considered as collateral for dollar exchange reserves. US real GDP has grown at an average annual rate of 3.2% during the period of consideration.
- 2) Central banks' reserves have been increasingly held in the form of foreign assets at the expense of gold. The share of foreign exchange reserves in total reserves<sup>1</sup> has risen from 9.5% in 1899 to 95.5% in 2010 (see Figure 1).

[Figure 1 about here.]

- 3) A considerable share of foreign exchange reserves has been invested in government bonds of reserve currency countries. By way of example, in 2010 35.2% of global foreign exchange reserves were invested in US Treasuries (see Figure 1).<sup>2</sup>
- 4) These facts imply that foreign central banks are major players on the market for safe government bonds. They hold a considerable share of government debt of the center

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<sup>1</sup>Total reserves are defined as the sum of gold, convertible foreign exchange, unconditional drawing rights with the IMF (the country's reserve position in the Fund) and special drawing rights (SDRs). While historically reserves consisted of gold and foreign assets, drawing rights with the IMF arise from countries' capital shares in the IMF and SDRs were created in 1969 as a response to the "dollar shortage".

<sup>2</sup>It might be noteworthy that foreign central banks hold US agency bonds besides US Treasury securities. US agency bonds are either issued by government-sponsored enterprises (e.g. Freddie Mac, Fannie Mae and Farmer Mac) or Federal Government agencies that finance projects related to public purposes (e.g. Small Business Administration, the Federal Housing Administration). While bonds issued by federal government agencies are backed by US government alike US Treasuries, government-sponsored agency bonds are not guaranteed by US government and bear higher risks. In 2012 51% of agency bonds held abroad were in hands of foreign official institutions with the rest being held by private agents. They account for 11.3% of total US reserve assets (Treasuries plus agency bonds) held by foreign official institutions. Since agency bonds do not directly finance government expenditures, we do not include them in our empirical analysis.

countries. In 2010 35.9% of total outstanding US Treasury debt was held by foreign central banks.

5) By implication of the previous facts, a comparison of the global demand for reserves and fiscal balances shows that foreign central banks have financed a considerable part of public budget deficits in reserve currency countries. This holds for the United Kingdom when Sterling was the dominant reserve currency and for the US since the dollar has replaced the sterling after World War II. Figure 2 shows the cumulated demand for sterling reserves by foreign central banks and the cumulated sum of UK government budget balances, both relative to GDP, for two periods. Beginning in the late 1890s, a sequence of budget deficits went along with an increasing demand for sterling reserves. This positive correlation between both variables is basically absent in the interwar period when UK government budget policies were driven by the financial consequences of the preceding war. The UK ran budget surpluses in order to reduce government debt. At the same time, the dollar emerged as important alternative reserve currency such that the demand for sterling reserves was relatively stable. US government budget deficits have been positively correlated with the global demand for dollar reserves since the dollar became the dominant reserve currency (see Figure 3). While these bivariate relationships do not allow for any causal conclusions, from a financial accounting perspective, reserve currency status has facilitated the funding of government budget deficits.

[Figure 2 about here.]

[Figure 3 about here.]

The rising demand for reserve-currency government bonds generates a dilemma: Triffin (1960) points out that the objectives of providing an increasing amount of reserve assets and of fixing the real value of these assets are incompatible in a monetary system that uses national currencies as reserves. While Triffin focused on the implications for the balance of payments of the center country, the modern dilemma is a fiscal problem arising from central banks' preference for government securities (Landau, 2013; Obstfeld, 2011a, 2011b; Prasad, 2011). Obstfeld (2011b, p.10) concludes with respect to the US:

“So global reserve growth requires the ongoing issuance of gross government debt. This requires, in turn, that the government run continuing deficits, or that it issue debt to acquire assets likely to be inherently riskier than the corresponding liabilities. Just as in the classic Triffin dilemma, global reserve growth is largely driven by deficits - not national balance of payments deficits, but government deficits.”

The desire for maintaining reserve currency status may induce a country to run a conservative fiscal position in order to reassure central banks and investors that the value of reserves will not be inflated away in the future. On the other hand, center countries have to run fiscal deficits if they want to satisfy the increasing demand for safe assets.<sup>3</sup> At the same time, the increasing demand for reserve assets lowers their interest rate, which, in turn, may lower fiscal discipline. This holds under the plausible assumption that there exist no perfect substitutes for sovereign bonds of the center country.<sup>4</sup> The public budget constraint of the center is relaxed. If center country governments optimize intertemporally, their equilibrium response is to run lower public budget balances *ceteris paribus*.

The research question of this paper examines whether there is a link between reserve currency status and government finances. The econometric analysis of a panel dataset covering industrialized countries over the period 1890-2009 provides evidence that reserve currency status lowers the public budget balance. Our historical dataset spans over different constellations of the international monetary system, which allows us to draw general conclusions that are de-linked from one country being at the center of the system: The relationship between reserve currency status and government finances holds for the UK when sterling was the dominant reserve currency and for the US since the dollar has replaced sterling after World War II.

This paper contributes to the preceding literature in several ways. First, we extend the literature on the determinants of the public budget balance by explicitly taking account of countries' reserve currency status. While the existing literature explains public budget balances by economic and political factors, it disregards that the supply of government bonds is not only supply-driven, but depends on private and official demand for such bonds alike. The equilibrium approach to fiscal policy pioneered by Barro (1979) focuses on economic factors that affect public finances. In this type of model, optimal tax rates are even over time. Deficits result from exceptional spending like the financing of wars and countercyclical policies. Alesina and Tabellini (1990) provide a theoretical basis for the importance of political and institutional factors for public finances. Empirical contributions by Roubini and Sachs (1989a, 1989b) show that coalition governments, left-wing parties and short terms of office are associated with larger deficits. While these findings are confirmed by Grilli et al. (1991), De Haan and Sturm (1997) and De Haan et al. (1999) do not find a robust relationship between political factors and government finances. To the best of our knowledge, the effect of reserve currency status on the public budget balance has not been investigated

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<sup>3</sup>In principle, the provision of public assets can be reconciled with a balanced public budget if the public sector purchases foreign assets.

<sup>4</sup>If home bonds and foreign reserve bonds were perfect substitutes, central banks could hold home bonds instead of foreign reserves (see Canzoneri et al., 2013).

before.<sup>5</sup>

Our second contribution concerns the dataset: The assembly of a panel dataset covering 120 years of public budget history allows us to examine the determinants of fiscal balances in the long run. Moreover, we can identify the changing influence of certain determinants over time. While existing panel studies examine more recent periods (i.e. Tujula and Wolswijk, 2007, and Woo, 2003), studies that focus on the long run using historical data are usually time-series analyses focusing on a single country (i.e. Barro, 1986 and Bohn, 1998 for the US; Barro, 1987 for the UK). The analysis of the determinants of public budget balances in a historical panel is new.

Third, this paper contributes to the literature that examines the consequences of reserve currency status. Reserve currency countries are often considered to enjoy an “exorbitant privilege” (see Gourinchas and Rey, 2007; Gourinchas et al., 2014), because they are able to issue debt in their own currency and at low interest rates. We focus on one aspect of this privilege, which has been undervalued so far: Reserve currency countries face a relaxed public budget constraint.

Finally, this paper is linked to studies examining the relationship between the key currency role of the dollar and the financing of the US public deficit (i.e. Kitchen and Chinn, 2011; Krishnamurthy and Vissing-Jorgenson, 2012). While these studies focus on how reserve status affects the interest rate, we show that besides this price effect there is also a quantity effect: Reserve status lowers the public budget balance.

This paper makes reference to a recent strand of literature investigating the scarcity of safe assets and its global implications (IMF, 2012; Dooley et al., 2004). Caballero and Farhi (2014) and Gourinchas and Jeanne (2012) provide theoretical approaches that emphasize the central role of governments and public debt in generating safe assets.

The remainder of the paper is organized as follows: The next section traces the evolution of the international monetary system since the establishment of central banks and explores the importance of government securities as central bank reserve assets. Implications of being the reserve currency provider are discussed in Section 3. Section 4 provides an empirical analysis of the effect of reserve currency status on the public budget balance. Concluding remarks are offered in Section 5.

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<sup>5</sup>Besides reserve currency status the capability to issue local-currency debt (absence of original sin) might influence the fiscal authority’s budget policy. This potential effect, however, should not bias our results because basically all countries within our sample of industrialized countries issue sovereign bonds in local currency. That is, our sample is homogeneous in this sense. Moreover, any impact would be captured by the fixed country effects.

## 2 Foreign exchange reserves in historical perspective

This section provides historical evidence of the increasing role of foreign exchange reserves in total reserves and illustrates the rise and fall of national currencies as reserve assets. It then summarizes the evidence on the asset classes in which central banks invest their foreign exchange reserves.

### 2.1 A short history of reserve currencies

#### *Sterling dominance (1880-1913)*

The classical gold standard, which emerged during the 19th century as a by-product of the foundation of central banks, gradually turned into a gold-exchange standard, where gold was supplemented by foreign assets denominated in gold-convertible currencies. In the period preceding World War I, apart from the Bank of England, most central banks held some foreign exchange reserves in addition to gold and operated under a de facto gold-exchange standard (see Bloomfield, 1963). According to the estimates of Lindert (1969), the share of foreign exchange assets in total reserves (sum of gold and foreign exchange) rose from 12.7% in 1880 to 23% in 1913. While the shares of German mark and French franc in total foreign exchange reserves both accounted for roughly 15% in 1899, the franc's share rose to 31% in 1913 at the expense of sterling. With Canada being the only country holding sizeable dollar reserves<sup>6</sup>, the dollar share in global foreign exchange holdings was below 2% in 1913.

#### *Dual reserve currency system (1920-1939)*

While the monetary system after World War I was based on the same pillars as its predecessor, the evolution of the gold-exchange standard was characterized by two main changes: First, the share of foreign exchange in total reserves grew. Second, the dollar emerged as important reserve currency and shared the role of dominant reserve currency with pound sterling during the interwar years. The changing importance of key currencies in total foreign exchange reserves is illustrated in Figure 4.

[Figure 4 about here.]

The creation of the Federal Reserve System in 1913 is an important factor that facilitated the emergence of the dollar as key currency. Moreover, after 1914 the US turned from net debtor to net creditor, while the net foreign asset position of the UK deteriorated. According to the estimates of Eichengreen and Flandreau (2009), dollar reserves accounted

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<sup>6</sup>Although small in absolute terms, the entire foreign assets of the Philippine Treasury were denominated in dollar. The Philippines were an American colony at that time.

for 18.2% of total foreign exchange reserves in 1920. In 1924, the dollar overtook sterling as most important reserve currency for the first time. In the 1930s, however, pound sterling regained its leading role.

### *Dollar dominance (since World War II)*

After World War II, the dollar consolidated its role as key currency. Its predominant role was backed by official US policy.<sup>7</sup> The gold-dollar standard collapsed in 1971 when the US revoked its commitment to exchange dollars for gold at the predefined price. Despite the dollar devaluation, its share in foreign exchange reserves did not drop. On the contrary, it reached its peak in 1975, when 75% of global foreign exchange reserves were denominated in US dollars. This share then declined gradually and reached a lower floor of 50% in 1990. Since then, dollar accounted for a relatively stable share of two thirds of total exchange reserves despite the creation of the Euro.

## **2.2 Types of reserve assets**

While individual central banks usually do not report the currency composition of their foreign exchange reserves, they provide even less information with respect to the type of assets they hold. Since reserves have to be readily available at known value in times of financial distress, the set of assets is restricted to safe short-term liquid assets.<sup>8</sup> Government bonds fulfil these conditions. Bloomfield (1963) notes that for the period up to 1913, external assets were held in the form of foreign bills, balances with foreign correspondents and foreign bonds. For the well studied case of Norway, Øksendal (2008) reports that exchange reserves were composed of British consols, French rentes and German government bonds for liquidity purposes.

Table 1 provides data on the share of government bonds in central banks' foreign assets in the interwar years for those countries where data is provided by the League of Nations. Although data availability is far from comprehensive, it shows that government bonds were an important reserve asset although their share was rather unstable. Nurske (1944, p.60) observes that countries of the sterling area<sup>9</sup> invested their foreign exchange reserves predom-

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<sup>7</sup>US tax laws were amended in 1961 (section 895) stating that foreign central banks' income from obligations of the US should be exempt from taxation.

<sup>8</sup>The Group of Ten (1965, p.21) defines reserves as "those assets of [a country's] monetary authorities that can be used, directly or through assured convertibility into other assets, to support its rate of exchange when its external payments are in deficit".

<sup>9</sup>The sterling area was formed by countries that decided to peg their exchange rate to the pound sterling after its devaluation in 1931. The group consisted of the British Commonwealth of Nations as well as independent countries, among them the Scandinavian countries, Japan and Portugal. The sterling bloc existed until World War II.



inantly in British Treasury bills.

[Table 1 about here.]

More precise statements are possible with respect to the role of UK government bonds, the gilts, and US Treasuries for the more recent period. Beginning in 1987, the UK Debt Management Office provides data on gilts held by foreign central banks. The left-hand panel of Figure 5 shows how the increasing real value of outstanding gilts is distributed between three types of creditors, namely domestic agents, foreign private agents and foreign central banks. As the right-hand panel of the figure visualizes the importance of foreign central banks is limited: Their share in total gilts outstanding does not exceed 10%. This reflects the inferior role of sterling in central banks' foreign exchange reserves during this more recent period.

[Figure 5 about here.]

By comparison, central banks are much more important on the market for US Treasuries: Since World War II the Flow of Funds data of the FED show that official foreign institutions constitute a major source of demand for US Treasury bonds. The left hand panel of Figure 6 illustrates the enormous increase in the real value of outstanding US Treasury debt since the early 1980s. This increased supply was absorbed by foreign official holders of Treasuries: Their share in total Treasury debt securities outstanding rose from 6% in 1970 to 40% in 2009 (see right hand panel of Figure 6). The declining share in recent years (35.9% in 2010) can be explained by the FED's massive purchase of US Treasuries resulting from its policy of quantitative easing. Notwithstanding, between 2000 and 2010, 49% of the increase in Treasuries was purchased by foreign official institutions. Foreign official investors hold the majority of total Treasuries in foreign hands (75% in 2010).<sup>10</sup>

[Figure 6 about here.]

### 3 Implications of reserve currency status

This section discusses the theoretical argument that the reserve-providing country faces lower interest rates and a relaxed public budget constraint.

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<sup>10</sup>In response to a data request, the Bundesbank and the Banque de France informed that they do not possess data on government securities classified by type of foreign holders.

### 3.1 Implications for interest rates

Financial markets of reserve currency countries are characterised by the unique feature that their assets are demanded by two types of foreign agents: private and official ones. First, foreign private investors devote a share of their wealth to safe assets of the reserve currency country as a result of their portfolio optimisation. Second, in contrast to non-reserve countries, foreign central banks provide loans to the reserve currency country equal to the amount of foreign exchange reserves they hold.<sup>11</sup> These loans are primarily granted to the sovereign of the reserve currency country. In a simple demand-supply framework without total crowding-out of private by official demand, the new equilibrium is characterised by a larger amount of debt and higher asset prices.

On theoretical grounds, Caballero and Krishnamurthy (2009) show that the global demand for a safe store of value rises US asset prices and lowers interest rates. Caballero et al. (2008) find that low US interest rates are the equilibrium outcome of different levels of financial development.

There is ample empirical evidence that the demand for sovereign bonds by foreign central banks substantially lowers their interest rate, which, in turn, softens the public budget constraint. This effect has been present in the UK during the sterling dominance. In this regard, Nurske (1944, p.61) notes that when sterling reserve accumulation resulted from trade with the UK, the demand for UK Treasury bills rose, which lowered their discount rate. For the more recent dollar dominance, a series of papers documents that foreign central banks' asset demand lowers US interest rates.<sup>12</sup>

These effects are intensified by the fact that the demand for safe reserve assets is relatively insensitive to their return because perfect substitutes are unavailable. For the early period of the dollar standard Aliber (1964) and Gemmill (1961) report that the share of foreign exchange in total reserves is independent of interest rates.<sup>13</sup> More recently, Krishnamurthy and Vissing-Jorgenson (2012) show that foreign central banks' investment decisions are insensitive to interest rates.

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<sup>11</sup>For the role of foreign exchange holdings and their determinants refer, among others, to Aizenman and Lee (2007), Cheung and Qian (2009) and Jeanne and Ranci ere (2011).

<sup>12</sup>Refer to Kaminska and Zinna (2014), Krishnamurthy and Vissing-Jorgensen (2012), Warnock and Warnock (2009), Kitchen and Chinn (2011) and Beltran et al. (2013).

<sup>13</sup>“The general conclusion from recent empirical investigations is that foreign official institutions do not shift funds from dollar assets into gold, or into reserve assets denominated in other currencies, in response to changes in interest rates” (Aliber, 1964, p.448).

## 3.2 Implications for the public budget

Lower interest rates, in turn, relax the fiscal constraint and are compatible with lower public budget balances. First, the current public balance required by the intertemporal budget constraint at a given level of debt is the smaller, the lower interest rates are (see Appendix G for a formal analysis). Second, given limited substitutability between safe reserve assets and assets in the rest of the world, the optimal government response to lower interest rates is an increase in present consumption.

In addition to this indirect transmission channel through lower interest rates, reserve currency status might induce a direct effect: At any given interest rate, governments may run lower budget balances, that is, the supply curve for sovereign bonds shifts upwards. This shift might be explained by various considerations: First, reserve currency status might be linked to the ability to issue sovereign bonds denominated in domestic currency.<sup>14</sup> This allows government to steer the real value of its debt burden: Government may inflate away the real value of debt. Exchange rate risk of outstanding debt is eliminated. That is, reduced risk shifts the supply curve upwards. Second, reserve currency countries might want to accommodate the demand for reserves: To fulfil their role, reserve currency countries have to supply the demanded amounts of reserve assets. Third, governments might internalize that foreign central banks are long-term investors. There exists no roll-over risk because central banks hold their stock of reserves relatively constant and alternative assets are unavailable. In the event that foreign central banks sell reserve assets this is mostly a response to downward pressures on the exchange rate and capital outflows. That is, periods of decreasing global reserves coincide with private investors pulling out of the affected economies and looking for safe assets. Hence, private investors will be happy to absorb reserve currency assets released by foreign central banks.

# 4 Regression analysis

## 4.1 Data

To study the effect of reserve currency status on the public budget balance we assembled a new annual dataset covering 24 industrialized countries over the years 1890-2009. The limitation on industrialized countries is due to data availability and to the attempt to form a relatively homogeneous country group, which warrants pooling. For each variable we use one main data source, which provides data from the start of the series until 2009 (International Financial Statistics start in 1948 at the earliest, for World Development Indicators the longest

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<sup>14</sup>It has to be noted that this ability is not restricted to reserve currency countries.

series date back to 1960). These series are complemented by alternative sources that provide historical data: The most important are Bordo et al. (2001), Lindert (1969) and Mitchell (2007). The definitions of the variables and their data sources are listed in Appendix A. Appendix B enumerates the countries of our sample.

At the core of our dataset are yearly data of central banks' international reserves and their composition (gold vs. foreign exchange). In contrast to the main dataset, which contains country-specific data for our 24 sample countries, foreign exchange reserves are measured as the sum of reserves aggregated over all countries where data is available. For reserve currency countries matters the reserve demand emanating from the rest of the world. In particular, our data on foreign exchange include the reserve stocks of emerging and developing countries, where the major part of reserve accumulation has taken place since the East Asian financial crisis. Beginning with their first release in 1948, we use the IMF world series on foreign exchange. For the period 1890-1913 world reserves are calculated as the aggregate of 35 countries (see Lindert, 1969). Aggregate reserves in the interwar period are the sum over 21 countries as provided in the Statistical Yearbooks of the League of Nations (see Bordo and Eichengreen, 2001).

Currency shares in these foreign exchange reserves shed light on the dynamics of reserve currency status. These shares are based on various sources, which are listed in Appendix C. Data on currency shares are not available at the global level; they rather reflect reserve choices of a selected number of central banks reporting them.<sup>15</sup> For the European reserve currencies we face the problem that since the introduction of the Euro we have been unable to monitor in which national sovereign bonds Euro reserves are invested. Given that the share of the Euro in total reserves in 1999, the year after its introduction, basically makes up for the combined shares of German mark, French franc and Dutch guilder before 1999, we take the relative importance of these three currencies in 1998, hold them constant and take these shares to divide the effect of the Euro between these three countries. That is, we assume that foreign central banks invest their Euro reserves in French, German and Dutch sovereign bonds; on the other hand, this simplification implies that sovereign bonds of the remaining countries of the Euro area are not part of global reserve portfolios.

We then calculate the disaggregated demand for foreign exchange reserves denominated in individual reserve currencies. The procedure, which is the same for all reserve currencies, is illustrated by way of example for sterling reserves: Changes in total reserves and changes in their composition result from valuation changes (exogenous) and active reserve policy (endogenous). Since only purchases and sales of reserves affect the bonds market of the

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<sup>15</sup>While some central banks report the annual change in the holdings of foreign exchange reserves listed by currency of denomination, others do not provide this breakdown.

center country, we try to isolate reserve changes due to active reserve policy. To this end, the total level of foreign exchange reserves is first converted into sterling and then multiplied by the sterling share in total foreign exchange reserves. The difference in sterling reserves between two years is our measure of sterling demand. While this method filters out the effect of exchange rate changes, we are unable to separate the effect of changes in the market value of reserve assets from active reserve policy at this stage of the analysis.<sup>16</sup>

This demand for assets of the major reserve currencies is illustrated in Figure 7.<sup>17</sup> It highlights several facts: First, the demand for reserve assets is highly volatile. Second, annual reserve changes amounting to 1% of reserve country GDP are rather the rule than the exception. This is an economically significant value. Third, changes in reserves provided measured relative to national GDP have been small in France, but large in the US and Germany. Fourth, the time series illustrate the fall of the sterling and the rise of the dollar as reserve currencies. While demand for sterling is often negative, dollar assets were sold on a net basis only on few occasions. Since 1983 the demand for dollar reserves has been positive in any year.

[Figure 7 about here.]

Table 2 provides data on the demand for reserves relative to GDP of the issuing countries. The largest relative demand for reserve assets has been recorded in Germany and the US since 1995. Before 1970 the demand for reserve assets was economically less significant relative to GDP.

[Table 2 about here.]

Since foreign exchange reserves are not entirely invested in government bonds, our measure of reserve demand provides an upper bound for the demand of government bonds.<sup>18</sup> Given the lack of more precise data, we rely on this proxy variable in our main analysis. Beginning in 1948, the FED's Flow of Funds dataset provides data on the amount of US Treasuries held by foreign official institutions, which we use in the analysis covering the more recent period. Accordingly, for the UK its Debt Management Office compiles data on UK sovereign bonds held by foreign central banks since 1987. These two sources are vital

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<sup>16</sup>Table 7 and the robustness analysis in Section 4.4 provide approaches that isolate active reserve policies of central banks.

<sup>17</sup>The analysis of this chapter focuses on those reserve currencies that represent a remarkable share in total reserves over a substantially long time period within our historical dataset. That is, we do not show the effects of, among others, the Japanese yen, the Dutch guilder and the Swiss franc.

<sup>18</sup>Arslanalp and Tsuda (2014) assume that 80% of foreign exchange reserves are invested in sovereign bonds.

to check our results because they allow us to replace our proxy by real data on the foreign official demand for sovereign bonds, which, in addition, are not disturbed by valuation or exchange rate changes. Both sources report the face value of outstanding bonds.

The dependent variable of our regression analysis is the government budget balance expressed as a ratio of GDP in decimal terms. The choice of control variables follows the seminal papers of Roubini and Sachs (1989a, 1989b), De Haan and Sturm (1997) and Woo (2003). In particular, the following determinants of government surpluses/deficits are considered:

*Inflation:* Inflation erodes the real value of taxes if there is a collection lag. Moreover, if tax law specifies a value expressed in national currency, inflation decreases its real value. In contrast, in the presence of progressive tax rate schedules government income benefits from higher inflation rates. The overall effect has to be determined empirically.

*Growth of GDP:* If government spending is used as an anticyclical instrument to smooth the business cycle, deficits emerge when GDP growth is temporarily low. In periods of relatively high GDP growth, governments may reduce their spending and amount surpluses in their budget balance. The built-in stabilizer of fixed tax rates works in the same direction: Whereas tax income is high during booms, it decreases during recessions.

*Demographic structure:* Economies with relatively old societies spend a larger share of income for social welfare like pensions and health. The dependency ratio of persons over 65 years (relative to its world average) is expected to negatively affect government finances.

*Wars:* The involvement of a country's armed forces in wars and peacekeeping operations generates costs, which are often transitory and unforeseen. Smooth tax rates imply that these exceptional expenditures generate deficits, which are subsequently financed over long time periods. Because historical data on military expenditures is not available, in our long-run analysis we use a dummy variable for wars, which takes on the value one during World War I and World War II.

*Democracy:* Countries with reliable institutions and a sound legal and political system are expected to attract private foreign capital flows, which facilitates the financing of government budget deficits. This effect works in addition to the impact of reserve currency status.

*Financial deepening:* The development of the domestic financial market is crucial for a government's ability to finance a budget deficit. In developed markets, governments can more easily cover a deficit by the issuance of bonds and depend less on inflationary finance.

*Interest rate:* Interest rates on sovereign bonds determine the cost of debt financing. High interest rates limit spending of indebted countries. Since high interest rates imply that a present deficit has to be balanced by larger future surpluses, it is less favourable to substitute future consumption by present consumption. Optimising governments are

expected to run higher budget balances. On the other hand, high rates increase interest payments on outstanding liabilities with variable interest rates, which lowers the budget balance.

The inclusion of interest rates as a determinant of public budget balances poses one major caveat: Interest rates are endogenous. They are determined by the level of government debt and the contemporaneous deficit (see Laubach, 2009). To circumvent the econometric problem of endogeneity, we use an instrumental variable approach in the regressions including interest rates.

*Level of government debt:* The inherited level of debt exerts opposing effects on the government budget balance: First, higher levels of debt increase interest payments for a given interest rate and thereby lower the government budget balance.<sup>19</sup> Second, debt levels might act as automatic stabilizers where highly indebted countries run more restrictive fiscal policies in order not to endanger government finances.

Summary statistics of all variables are reported in Appendix D. To check the time-series behaviour of our variables we test for possible non-stationarity. For each variable we perform two panel data unit root tests. The upper panel of Table 3 shows the results of a Fisher-type test and the Im-Pesaran-Shin test. The variables of the global demand for reserves are not in panel structure, but are time-series variables. We therefore apply two time-series unit root tests (augmented Dickey-Fuller and Phillips-Perron test) on the global demand for reserves individually for each reserve currency (see bottom panel of Table 3). The hypothesis of a unit root is rejected for most variables. Exceptions are financial centers, the interest rate, government debt and the relative dependency ratio. The dummy variable for financial centers has a unit root because it remains one for the remaining period after financial center status has been identified (no reversion). Interest rates are instrumented in most regressions by the world policy rate, for which non-stationarity seems to be less of a problem. Since government debt is only included in few regressions it does not affect our main results. Finally, with respect to the relative dependency ratio we checked whether its omission substantially affects our main results, which, however, is not the case.

[Table 3 about here.]

We are aware that the global economy went through major changes during the 120 years considered. The process of financial integration, the move to more flexible exchange rates after the breakdown of the Bretton Woods system, the rising importance of emerging markets and China in particular as reserve holders and the introduction of the Euro are only some examples. We account for these effects by the inclusion of time effects in our regressions.

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<sup>19</sup>In the historical dataset we are unable to distinguish between general and primary budget balances.

We do not model these changes explicitly because we suspect that they do not change the fundamental determinants of the public budget balance. However, since we use the aggregate demand for reserves as a regressor we control implicitly for shifts in the structure of the international monetary system that are reflected in changes in reserve demand.

## 4.2 Panel data analysis

This section tests whether the accumulation of reserve currency bonds in the rest of the world affects the government budget balance of reserve-providing countries. To this end, we regress the government budget balance relative to GDP on a set of standard determinants. To this setting, we add the demand for reserve-currency assets as an additional control variable. Thanks to easy financing, reserve currency countries might react differently to changes in the control variables. The panel data approach has the merit to assume constant impact coefficients across countries, which allows to isolate the effect of reserve status in the reserve demand variable. In particular, we estimate the following fixed-effects specification

$$\left(\frac{GovBudget}{GDP}\right)_{it} = \beta X_{it} + \gamma \left(\frac{\Delta IR^d}{GDP}\right)_{it} + c_i + d_t + \epsilon_{it} \quad (1)$$

where  $GovBudget/GDP$  is the ratio of the government budget balance to GDP,  $X$  is a vector of control variables,  $\Delta IR^d$  measures the change in the demand for reserve assets of country  $i$  by foreign central banks<sup>20</sup>,  $c$  is a fixed country effect,  $d$  a fixed time effect and  $\epsilon$  is the error term.  $i$  denotes a specific country and  $t$  represents the time period. The slope parameters, represented by the vectors  $\beta$  and  $\gamma$ , are assumed to be constant across countries and time. We use the fixed effects estimator with a cluster-robust variance estimator.<sup>21</sup> This country-level robust estimator of the VCE is consistent in the presence of heteroskedasticity and autocorrelation.

To control for the endogeneity of interest rates, we use an instrumental variable approach. We provide results for two different instruments: the lagged value of interest rates on government bonds and the world policy rate. Since interest rates may be characterized by autocorrelation, the world policy rate is our preferred instrument. Between 1890 and 1935 the world policy rate is defined as the policy rate set by the Bank of England; beginning in 1948 we use the policy rate of the US FED as world policy rate. The switch from the UK to the US as source country of the world policy rate accounts of the changing dominance of these countries in international finance. It is empirically required because data on US policy rates has only been available after the FED was founded in 1913. To deal with the

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<sup>20</sup> $\Delta IR^d$  is zero for all countries besides those enjoying reserve currency status.

<sup>21</sup>The Hausman test rejects a random effects specification.



endogeneity of the world policy rate in the center countries, the German policy rate is used as world policy rate for the UK until 1935 and for the US starting in 1948. It is reasonable to assume that the exclusion criterion holds for this instrument: The world policy rate is neither linked to the government budget of individual countries nor to the other domestic determinants. By way of example, when GDP is affected by a negative shock, domestic policy rates will be low while the world policy rate is unaffected except that the shock is global.

We use two different estimators, the instrumental variable two-stage least squares (IV-2SLS) and the two-step efficient generalized methods of moments (GMM) estimators.<sup>22</sup> In the first step, both estimators create instruments by regressing interest rates on the instrumental variable. These instruments are then used to replace interest rates in the second-step regression.

#### 4.2.1 Results spanning 120 years of history

The results for the entire time period (1890-2009) are presented in Table 4. While column 1 presents a parsimonious model only accounting for fundamental determinants of the budget balance (inflation, GDP growth and demographics), we add political and financial variables in subsequent columns.

[Table 4 about here.]

Regarding our control variables, the following effects are found: Wars significantly decrease the budget balance. Countries with deep financial markets are characterized by lower budget balances. While not significant across all specifications, real GDP growth affects the public budget balance in the hypothesized direction: Real GDP growth increases the fiscal balance, which can be interpreted as evidence of countercyclical government spending. There is weak evidence that democratic governments are associated with larger government balances.

Columns 8 to 10 are estimated by IV-2SLS. Interest rates are instrumented by their lagged level (column 8) and by the world policy rate (columns 9 and 10). As expected, higher interest rates and the existing level of government debt decrease the current government budget balance. That is, the cost effect of higher interest payments dominates the disciplining effect.

Across all specifications, the government balances of the UK and the US are significantly affected by the demand for sterling and dollar reserve assets, respectively. If the rest of

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<sup>22</sup>Results are reported for 2SLS; those obtained with GMM can be provided upon request.

the world accumulates dollar reserves equivalent to 1% of US GDP, the US government budget balance decreases by 0.7-1.3 percentage points relative to GDP. For the UK, these numbers are comparable in magnitude. An increase in global sterling reserves by 1% of UK GDP lowers the UK government budget balance relative to GDP by 0.8-1.3 percentage points. While these results are in line with our hypothesis that reserve demand lowers the government budget balance, the magnitude of the effect may be perceived as large at first sight. Coefficients larger than one imply that the negative effect on public balances is stronger than what is directly financed by the official demand for reserve assets. The magnitude of the effect becomes plausible if one takes into account that central banks' choice of safe assets has a signalling effect for private investors: Private agents follow central banks' investment strategy and shift their portfolio share dedicated to safe assets to those assets chosen by central banks' reserve managers. Hence, there is a multiplier effect: The official demand for reserve assets attracts an additional private demand for government bonds. Foreign central banks do not crowd-out private investors on the market for government bonds.

Apart from sterling and dollar demand, we also include the change in globally held franc and mark reserves (see columns 3, 7-10). With respect to these secondary reserve currencies, we do not find significant effects.

While this analysis over an extended time period benefits from the amount of information included, it may be plagued by structural breaks. We therefore proceed by splitting our sample into two sub-periods, namely the period before and after World War II.

#### **4.2.2 UK during sterling dominance**

We replicate our fixed-effects regressions of Table 4 for the period from 1890 to 1935. The results in Table 5 show that most of the standard control variables do not significantly affect government balances. We find some evidence that older societies are characterized by lower government balances. During wars government budget balances are significantly lower. The demands for dollar and sterling reserve assets are significant across all specifications: For the UK, sterling demand lowers the government budget balance albeit its effect is economically somewhat smaller compared to the entire period. An increase in global sterling reserves by 1% of UK GDP lowers its government balance by 0.5-1.2 percentage points. The demand for dollar assets significantly increases the US government balance. This unexpected result may have various explanations: First, before World War I, the dollar's role in foreign exchange reserves was marginal. More importantly, relative to US GDP, dollar reserve demand was relatively low during this period (see Table 2). Hence, its effect on the government balance was economically small. Second, before World War II the US has actively promoted the rise of the dollar as reserve currency. When central banks for the first time began to invest

in dollar assets, the US realised its potential to become a global reserve currency. Fiscal authorities responded by more restrictive policies - the positive coefficient in the regressions - to demonstrate the US commitment for sustainable public finances and a stable value of the dollar. This is consistent with the observation that the US accumulated gold during that period and thereby emphasised that dollar assets are backed by gold.

[Table 5 about here.]

### 4.2.3 US during dollar dominance

*Historical dataset: 1950-2009*

For the dollar dominance since World War II (see Table 6) real GDP growth has a robust positive effect on the government balance as long as interest rates are not controlled for confirming the tax- and consumption-smoothing hypothesis. Interest rates and government debt decrease the government balance significantly. For both the UK and the US the demand for reserve assets significantly lowers the respective government budget balances. This effect holds for the French franc in two out of five specifications, while the demand for mark reserves has the expected sign, but is only significant in one out of five specifications.

[Table 6 about here.]

*Enriched dataset: 1970-2009*

For the more recent period beginning in 1970, data availability allows us to use a richer dataset. In particular, besides the variables used before, we have data on the rate of unemployment, external shocks, military expenditures, government orientation and market capitalization.

*Unemployment rate:* If the rate of unemployment is high, government spending is high due to social assistance transfers. At the same time, low economic activity depresses tax revenue. Therefore, the unemployment rate is expected to negatively affect the government budget balance.

*External shocks:* Negative external shocks might be accommodated by an increase in government spending. The growth rate of the terms of trade multiplied by trade openness is used as a proxy for external shocks.

*Relative income:* Real per capita GDP relative to the world average is introduced to control for the stage of development. Relatively poor countries are more likely to have inefficient tax and spending systems. As a result, government budget deficits might arise.

*Military expenditure:* To refine our measure of military costs, we rely on data on military expenditures (relative to GDP) provided by the World Development Indicators since 1988.

To identify periods of abnormally high or low military expenditures, we calculate the deviation of military expenditures from their country-specific mean and use this variable instead of the dummy variable for wars in our empirical analysis.

*Civil liberties/Democracy:* We replace the measure of democracy by a finer index of civil liberties, based on measures for personal freedom, human rights, rule of law and economic rights, to proxy for country risk.

*Left-wing government:* Left-wing governments are ideologically in favour of a higher degree of public intervention. According to the partisan approach, they focus on economic growth and low unemployment while low inflation rates are a less important objective. Therefore, left-wing governments might be more prone to increase expenditures and to generate deficits than right-wing governments.

*Market capitalization:* An alternative measure of financial depth is provided by the size of the stock market relative to GDP. Large stock markets offer investment opportunities for foreign capital. This might be beneficial for the market for government bonds.

*Financial center:* We control for financial centers by the inclusion of a dummy variable. Countries whose gross positions of external assets and liabilities relative to GDP are both larger than their respective mean plus their standard deviation in the cross section, are considered to be financial centers.<sup>23</sup> Interestingly, the US is not identified as a financial center. To capture a broader notion of financial center, we additionally include countries listed as top ten in the Global Financial Centers Index, which evaluates the competitiveness of financial center cities. In particular, Hong Kong, Japan, Switzerland, the UK and the US are coded as financial centers over the entire period.<sup>24</sup>

Besides these additional control variables, consideration of the more recent period has the virtue that we can make use of more precise data on the global demand for reserve assets. More precisely, for the US (beginning in 1948) and the UK (beginning in 1987) we have data on sovereign bonds held by foreign central banks. The Federal Reserve provides data on US Treasuries held by non-US official institutions in its Flow of Funds data. Analogously, the Office of National Statistics publishes data on UK central government liabilities held by foreign central banks. We use the change in these variables as the demand for the respective reserve currencies.

Summary statistics of the set of variables used for regressions starting in 1970 may be found in Appendix E; unit root tests are described in Table 3. The regression results are

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<sup>23</sup>By way of example, in 2005 the following countries are identified as financial centers: Belgium, Hong Kong, Ireland, the Netherlands, Singapore, Switzerland and the United Kingdom.

<sup>24</sup>While being in the top ten, Singapore's financial development is more recent. We therefore rely on the definition based on gross foreign assets and liabilities, according to which it has been a financial center since 1998.

presented in columns (1) to (6) of Table 7.<sup>25</sup> For the following variables we find significant and robust results: Real GDP growth increases the balance, while it is negatively correlated with the rate of unemployment. Financial centers, characterized by easy access to private external financial resources, run lower government balances. Interest rates and government debt negatively affect the fiscal balance.

The global demand for official reserves lowers the public budget balance of the dominant reserve-providing countries. Across all specifications, we find significant negative effects for the US and the UK. While the magnitude of the effect in the US is comparable to that found in Tables 4 and 6, the estimated impact on the UK balances is now larger ranging between 1.2 and 3.4 sterling per unit of sterling reserve assets. There is some evidence that the demand for official franc reserves lowers the French government balance. This shows that France only recently began to use the reserve status to finance additional government spending.

[Table 7 about here.]

In sum, the demand for reserve assets affects public balances of the dominant reserve currencies. When reserves are accumulated by the rest of the world, public budget balances of the US and the UK decrease. They increase when global reserve holdings are reduced.

### 4.3 Accounting for endogeneity

Estimation of equation (1) raises standard identification concerns typically associated with demand-supply relationships. One might suspect that the global demand for reserves is not only demand-driven. The change in global reserves might be endogenous, that is, it might be a function of the supply of safe assets in reserve currency countries.<sup>26</sup>

The literature on the demand for reserves (see, among others, Aizenman and Lee, 2007; Jeanne and Ranci ere, 2011; Obstfeld et al., 2010) identifies domestic variables (e.g. trade openness, financial openness, external debt, potential for capital flight) as well as policy variables (capital controls, exchange rate regime) as determinants of reserve demand. These are all unrelated to deficit financing in reserve currency countries. According to this view, reserve demand is exogenous for the reserve currency country.

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<sup>25</sup>The results for the period 1970-2009 using the enriched dataset but based on our standard measure of global reserve demand confirm our finding of a significant and negative effect of reserve demand on budget balances of reserve currency countries. For space constraints, they are not reported here, but may be obtained upon request.

<sup>26</sup>Endogeneity is present between global reserve demand and the current account balance of reserve currency countries (Steiner, 2014). It is, however, less evident whether this endogeneity also translates to the public budget balance of reserve currency countries.

A public deficit might induce foreign reserve demand if the deficit lowers the reserve country's current account and if the foreign country intends to prevent a nominal exchange rate adjustment.<sup>27</sup> If the reserve country's current account turns negative, this puts downward pressures on the reserve country's currency, which might be alleviated if the rest of the world accumulates reserves.

To assure that our results are not spurious, we present in the following different strategies to instrument the demand for reserves:

(1) *Instrumentation by imports*: The traditional rule of thumb that was used to assess reserve adequacy until the early 2000s measured reserves relative to imports (see, for example, Aizenman and Pinto, 2005). Reserves equal to three to four months of imports were regarded as an adequate level. Imports may therefore be considered the most important determinant of the demand for reserves, especially in our historical perspective. For our analysis, we calculate global imports as the sum of imports across our dataset of 24 countries. To account for the changing importance of individual reserve currencies we multiply world imports with the share of country  $i$ 's assets in total foreign exchange reserves and use this measure as an instrument for the global demand for reserve assets of country  $i$ .

(2) *Instrumentation by commodity prices*: Commodity exporting countries run larger current account balances when commodity prices are high. Surpluses are eventually used to accumulate reserve assets.<sup>28</sup> Therefore, periods of high commodity prices are assumed to go along with periods of intensive global demand for reserves. We instrument the global demand for reserves by two commodity prices: First, we use the commodity price index introduced by Grilli and Yang (1998). This index is a trade-weighted average of 24 real primary commodity prices including nonfood agricultural commodities, food agricultural commodities and metals. Second, since energy commodities are not part of the Grilli-Yang-Index we use the price of crude oil in constant US\$ as second instrument.

(3) *Estimation of individual country's reserve demand*: The idea is to get a measure of the demand for reserves that is based on domestic variables only. To this end, we estimate a traditional demand for reserves specification in the spirit of Aizenman and Lee (2007) and IMF (2011b). This is, we calculate the demand for reserves by country  $i$  based on fundamentals of country  $i$ , which is assumed to be exogenous from policies in reserve-providing countries. In particular, we run a fixed effects panel regression where

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<sup>27</sup>The evidence with respect to the twin deficit hypothesis, however, is mixed. Deficits might even increase the current account balance (see Kim and Roubini, 2008).

<sup>28</sup>In the more recent past, commodity exports started to manage these resources in sovereign wealth funds.

we regress the level of reserves relative to GDP on real GDP per capita, trade openness, a measure of trade volatility, an index of economic globalisation, a dummy for the exchange rate regime and on external debt, total and short-term, relative to GDP. In addition, year dummies are included. The dataset contains 92 countries over the period 1970-2009. The R squared amounts to 0.24. The predicted value of individual countries' demand for foreign exchange is then aggregated to compute the global demand for reserves. After multiplying this global reserve demand with the share of reserve currencies and calculating the difference between two consecutive years, we get the demand for dollar and sterling reserves in a given year.

The results for reserve demand instrumented by imports are presented in columns (1) to (3) of Table 8, those for instrumentation by commodity prices and the oil price in columns (4) to (6). Regressions span the entire period from 1890 to 2009. Given that we do not have individual instruments for each reserve currency country, we are unable to proceed with our strategy to construct distinct reserve demand variables for each reserve currency. Consequently, we summarise the global reserve demand in one variable called  $\Delta$  *global reserves (US and UK)*. This variable equals the demand for dollar reserves for the US and the demand for sterling reserves for the UK and takes on the value zero otherwise. We do no longer consider the effects on secondary reserve currencies given that these mostly turned out to be insignificant.

By and large, instrumentation confirms the validity of the results presented for the entire period (1890-2009) in Table 4: Inflation, wars and developed financial markets are associated with a lower government budget balance. High interest rates and the level of government debt exert a negative effect on the budget balance. The global demand for reserve assets significantly decreases the government budget balances of the US and the UK. Instrumentation by commodity and oil prices leads to stronger negative effects on the budget balance.

[Table 8 about here.]

The findings for reserve demand instrumented by the predicted global demand for reserves derived from individual demand-for-reserves equations may be found in columns (7) to (12) of Table 7. Results are available for the period 1970-2009. Significant effects are in line with those previously found for this more recent period. Again, the government budget balances of the US and the UK are significantly lowered by the demand for reserves across all specifications. New is the discovery of a large negative effect of the demand for official franc reserves on the French government balance.

## 4.4 Robustness

In this section we check whether our results are robust with respect to alternative specifications and to different data sources for our main variables. Due to limited space, we do not attach results; these may be obtained upon request.

*Means over 5-year-periods:* We replicate our analysis over the entire time period (1890-2009) from Table 4 using 5-year averages of the data. This allows to abstract from cyclical shifts in the government budget balance and to concentrate on structural effects. The negative effect of global reserve demand on national budget balances is confirmed.

*Alternative data on reserve demand:* In its Annual Report, the IMF provides data on the change in official holdings of foreign exchange by currency, which are broken down in quantity and price changes. This allows us to separate reserve changes due to valuation changes (price effect) from the reserve demand from active reserve policies (quantity change). We measure the change in the global demand for reserves by these quantity changes divided by GDP. The negative effect of reserves on the US and UK government budget balance is confirmed.

*Alternative data on public deficits:* Data on public budget balances are known to be imprecise, subject to revisions and may be manipulated for political reasons. This might be even more true for historical data. We therefore repeat our analysis using alternative data sources for historical values of our dependent variable: these are Accominotti et al. (2011) and Abbas et al. (2011). The latter, however, has the disadvantage that they report data on public debt levels only such that we have to proxy the budget balance by the change in the debt level. The main results are robust to these changes.

*Time-series analysis for US and UK:* As an alternative approach, we show in Appendix F in a time-series analysis for the US and the UK that reserve currency status is an important determinant of their government budget balance as evidenced by a substantial increase in R-squared thanks to the inclusion of the global reserve demand.

## 4.5 Contributions to the US government budget balance

To further assess the economic importance of the various determinants of the government budget balance, we calculate their individual contributions on the budget balance based on our regression estimates (i.e.  $\hat{\beta}X_{it}, \hat{\gamma}_i \left( \frac{\Delta IR^d}{GDP} \right)_{it}$ ). We present this exercise for the UK and US each for the period 1890-2009. For the US we provide complementary results for 1970-2009 making use of the richer dataset that contains additional control variables. In both cases the estimated coefficients are based on the broadest specification, namely column (10) of Table 4 for 1890-2009 and column (12) of Table 7 for the period 1970-2009. To cope with the large number of explanatory variables we group them. We group the contributions of the interest



rate and the level of government debt in “Interest rate and debt” and summarize factors whose mean individual contribution is smaller than 0.5% of GDP in the group “Other”.

[Figure 8 about here.]

As shown in Figure 8 for the UK, the level of government debt and interest payments exert a significant negative effect on its government budget balance. Rising debt levels during the two world wars increased the relative weight of this effect; since the 1950s the negative contribution of debt and interest payments has been gradually reduced. British deep financial markets have lowered its government budget balance, whereas its democratic structures have constantly contributed to higher balances. The effect of the global demand for sterling reserves is volatile and shows large swings implying economically large effects in individual years. For the years since the mid 1990s, when countries increasingly accumulated foreign exchange reserves, a large negative effect on the UK government budget is identified.

[Figure 9 about here.]

[Figure 10 about here.]

In the case of the US (see Figure 9), the following determinants distinguish themselves in both periods: The democratic structures of the US positively affect its government budget balance. Its deep financial markets, its financial center status, its level of government debt and interest rates lower its budget balance remarkably. Until the 1970s the effect of the global reserve demand fluctuated around zero. Since the 1990s it has increasingly lowered the US government budget balance. For the period 1970-2009 we also have data for some additional determinants (see Figure 10): The high US per capita income compared to other industrialized countries negatively affects its government budget balance. High inflation rates during the 1970s increased the balance and unemployment has consistently lowered it. For military expenditures data start in 1988. During the first years until 1994, military expenditures were relatively high (first gulf war) and lowered the government budget balance. The effects of real GDP growth and external shocks are negligible.

## 4.6 Use of reserve income

The provision of safe reserve assets to central banks abroad generates income for reserve country governments. The previous sections have shown that this additional income lowers the government budget balance, that is, it is partly used for increased government expenditures. But into which kinds of government spending is the reserve income channelled?

Which components of government spending face a relaxed financing constraint? This section explores these questions.

So far our regression analysis has been based on constant coefficients across all countries. This implies that we assume equal elasticities with respect to changes in our explanatory variables across countries. This specification allows us to isolate the effect of reserve currency status in the variable for global reserve demand. We now relax this assumption and allow for different coefficients in reserve currency countries. In particular, we add an interaction term between economic growth and the global demand for reserve currencies. By construction, this variable equals zero for all non-reserve countries. The interaction tests whether fiscal policies in reserve currency countries are more elastic with respect to changes in economic growth than elsewhere. We expect that reserve currency countries implement stronger expansionary policies during periods of low growth. The results are presented in Table 9.

[Table 9 about here.]

Columns 1 to 3 present regressions for the period of sterling dominance. The interaction between economic growth and the demand for dollar assets is insignificant. This is in line with the previous finding that the US did not yet behave as a reserve currency country during this early phase. For the UK, however, we find a significantly positive effect: When economic growth is negative, the government budget balance is the lower, the larger the demand for sterling reserve assets is. In periods of high economic growth, reserve demand is increasingly used to save, that is, to run larger budget balances. In sum, anticyclical fiscal policies react more aggressively to the business cycle. The same conclusions pertain to France and Germany, which are consolidated in the variable “reserve demand other”. The findings for direct effects of global reserve demand are confirmed: They lower the UK government budget balance and, during this period, increase the balance in the US.

For the period of dollar dominance beginning in 1950, which is considered in columns 4 to 6, the major difference compared to the previous period is a significantly positive effect of the interaction term for the US. That is, the US starts to behave as a reserve currency country and reacts more flexibly to swings in the business cycle. The interaction effects for France and Germany turn insignificant.

Finally, we make use of the richer dataset for the period starting in 1970. Results are presented in columns 7 to 9. While the interaction term remains positive for the US, it becomes insignificant for the UK, which may be a result of the UK losing its reserve currency status with the breakdown of the Bretton Woods system at the latest. The French and German governments decrease their budget balances less than other countries during recessions provided global reserve demand is positive. This may be read as evidence that these

secondary reserve currency countries run less flexible fiscal policies. They may be concerned to strengthen their reserve currency status by prudential fiscal policies.

## 5 Conclusions

Reserve currency status entails benefits and costs. It may affect decisions taken by individuals and the government of the reserve-providing country. While there is a vast literature examining the effects of reserve currency status on interest rates, this paper is the first to consider the impact on the government budget balance.

Reserve currency status eases the public budget constraint and enables the center country to run a lower government budget balance. Foreign central banks finance the budget deficit of the center's government by their purchase of reserves in the form of sovereign bonds. The government decision to run lower public budget balances is the optimal response to the increased demand for government bonds and their lower interest rate. As long as reserve status is retained, a higher level of debt is compatible with standard criteria of sustainability.

We provide empirical evidence that reserve currency status decreases the government budget balance of the dominant center country. Any dollar of reserve assets purchased by official institutions in the rest of the world decreases the budget balance of the center by 0.6-1.4 dollars depending on time period and specific country. This corresponds to a decrease of the budget balance measured relative to GDP by 1 to 5 percentage points. These numbers are economically significant. Expressed in absolute terms they are outstanding. For secondary reserve currencies like the French franc and the German mark we do not find robust effects on their government budget balances.

Besides reserve status, we identify wars, high interest rates and the level of government debt as robust factors that have negatively affected the government budget balance over the last 120 years. For the more recent period since 1970, unemployment, deep financial markets and low GDP growth have contributed to low government balances.

This study distinguishes itself by covering 120 years of history and including two episodes of dominant reserve currencies: the sterling period until the interwar years and the dollar dominance since World War II. While we examine both periods separately, we derive surprisingly resembling results for the US and UK government budget balances. We label this finding a “tale of two deficits” because in both countries government budget balances have been significantly lower and often in deficit when they provided the dominant reserve asset. This provides further evidence in favour of our hypothesis: The lower government budget balance is not peculiar to a specific country. On the contrary, our study allows to conclude that it is a phenomenon akin to reserve currency status. This phenomenon persists inde-

pendently of the time period, national policies or the provision of alternative reserve assets. More importantly, the facts presented may not be interpreted as evidence that the UK or US have abused their privilege as reserve currency country. The problem is a more fundamental one: It lies in the fact that a national currency is used as global reserve currency.

The flip side of this easy financing might be an increasing level of sovereign (external) debt. Persistent government deficits may question the sustainability of public debt, which, in turn, undermines the stability of the reserve currency. In conjunction with a decreasing US share in global economic activity and rising alternative reserve currencies this process might prove to be unsustainable in the long run. The US may be tempted to erode the real value of its debt by inflation (Aizenman and Marion, 2011).

A loss of confidence in reserve currencies might cause central bank runs, characterized by central banks substituting alternative safe assets for their dollar reserves. An uncoordinated shift of reserve status to other currencies, however, would entail major global disruptions. For the stability of the international monetary system it may be crucial that reserve currency countries keep their finances in order.

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## Appendix A: List of variables and data sources

In cases where for one variable two separate data sources are specified, the second one provides the historical data.

Variable	Source	Definition
Government budget balance (relative to GDP)	WEO, GFS, WDI; complemented by Bordo et al. (2001)	Data equals the variable general government net lending/borrowing provided in the WEO database, which is calculated as revenue minus total expenditure. Missing values are filled - where possible - by the variable <i>government cash surplus/deficit</i> of the GFS database (years from 1990 onwards) and <i>overall deficit/surplus of consolidated central government</i> from the historical GFS database (for years prior to 1989). Data are converted to dollars by end of period exchange rates and divided by current GDP.
Inflation	WDI  Bordo et al. (2001)	Inflation is measured as the growth rate of the GDP implicit deflator (annual %). Change in CPI
Real GDP	WDI  Comin and Hobijn (2009)	GDP is measured as gross domestic product in constant international dollars with the year 2005 as base. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.
Relative dependency ratio (old)	WDI; Mitchell (2007); for US: US Census Bureau (2003)	Ratio of old (65+ years) to working (15-65 years) population measured as deviation from world average
Wars		Dummy that takes the value one between 1914-1919 and 1940-1944; 0 otherwise.
Democracy	Marshall and Jaggers (2011)	Democracy is measured by a score, which combines the information contained in indicators of democracy and autocracy (POLITY2 variable). It ranges from +10 (strongly democratic) to -10 (strongly autocratic).
Financial deepening	WDI  Bordo et al. (2001)	Money and quasi money (M2) as a percentage of GDP. Complemented by data for the UK based on Bank of England (2012), Series LPMVWYH Money as a percentage of GDP, where money is M1, M2 or M3 depending on the country and data availability.

## Appendix A (ctd.): List of variables and data sources

Variable	Source	Definition
Interest rate	Armingeon et al. (2011); Bordo et al. (2001)	Long term (in most cases 10 years) interest rate on government bonds. Missings filled with data on government bonds as provided in the IFS if at least 10 data points could be added for a given country. Historical data (based on Bordo) use long-term interest rates, mostly for government securities or high-grade bonds.
Policy rate	Center for Financial Stability, ECB	Interest rate set by the central bank
Government debt	Reinhart and Rogoff (2011)	Central government debt as a percentage of GDP
Unemployment rate	WDI	Percentage of unemployed out of total labour force
External shock	WDI, own calculation	Growth rate of terms of trade multiplied by trade openness
Relative income	WDI	Relative income is measured as real GDP per capita as a ratio to its average value across all countries. GDP is measured as gross domestic product in constant international dollars with the year 2005 as base.
Civil liberties	Freedom House	Index of civil liberties, which is based on ratings with respect to the freedom of expression, right of assembly, rule of law and individual rights. The ratings lie between 1 and 7 with 1 representing the highest degree of freedom.
Military spending	WDI	Deviation of military expenditure (expressed as % of GDP) from its country-specific mean over the period under consideration.
Financial center, dummy	Own calculations based on Lane and Milesi-Ferretti (2007) and GFCI	The dummy takes on the value one in a country year where the country is identified as a financial center. A financial center is defined as having both a ratio of foreign assets to GDP and of foreign liabilities to GDP that exceed the mean plus one standard deviation of the respective variables in a given year over the whole sample. Based on information provided by the Global Financial Centres Index the following countries are labelled financial centers over the whole period: Hong Kong, Japan, Switzerland, the United Kingdom and the United States.
Market capitalization	Standard & Poor's and WDI	Market capitalization is the market value (share price times the number of shares outstanding) of domestic companies listed on the country's stock exchanges. Investment companies, mutual funds or other collective investment vehicles are not included.
Net change in Treasury bonds held by foreign official institutions	Federal Reserve	Difference of Treasury securities held by non-US official institutions (Flow of Funds, Table L.107, line 11) between two consecutive years.

## Appendix A (ctd.): List of variables and data sources

Variable	Source	Definition
Net change in UK Gilts held by foreign central banks	Office of National Statistics and Bank of England	Difference in UK central government liabilities held by foreign central banks (Sheet “Distribution of gilt holdings” at <a href="http://www.dmo.gov.uk/index.aspx?page=Gilts/Data">http://www.dmo.gov.uk/index.aspx?page=Gilts/Data</a> ). Series starts in 1987.
World foreign exchange reserves	IFS, Lindert (1969)	Central banks’ reserves of foreign exchange, converted in US\$
World official gold reserves	IFS, Lindert (1969)	Total amount of gold at historical prices (35 US\$ per ounce) held at central banks
Imports	WDI, Bordo et al. (2001)	
Commodity prices	Grilli and Yang (1998), update of Pfaffenzeller et al. (2007)	Index of 24 primary commodity prices deflated by an index of the value of manufactured goods. It includes nonfood agricultural commodities, food agricultural commodities and metals. Energy commodities are not part of the index. The index is constructed as a trade-weighted (average export share during base period 1977-79) average of the 24 commodity prices.
Oilprice	BP (2015)	Crude oil price in constant US\$
<b>Auxiliary regression: demand for foreign exchange</b>		
Trade openness	WDI	Sum of exports and imports divided by GDP
Volatility	WDI	Standard deviation of the previous five years of the growth rate of exports as a capacity to import.
Total external debt (divided by GDP)	WDI	Total external debt is the sum of public, publicly guaranteed, and private nonguaranteed long-term debt, use of IMF credit, and short-term debt.
Short-term external debt (divided by GDP)	WDI	Short-term external debt includes all debt that has an original maturity of one year or less.
Fixed exchange rates, dummy	AREAER	Equals one if one of the following finer de jure categories applies: dollarized, currency board, monetary union, single currency peg, published basket peg and secret basket peg.
Economic globalisation	Dreher (2006) and update	Index based on actual flows of goods and capital and restrictions concerning these flows.

Sources: AREAER: Annual Report on Exchange Arrangements and Exchange Restrictions, IMF; GFCI: Global Financial Centres Index provided by Z/Yen; GFS: Government Finance Statistics (online and historical database); IFS: International Financial Statistics; WEO: World Economic Outlook Database; WDI: World Development Indicators.

## Appendix B: Sample of countries

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Australia	Denmark	Greece	Japan	Norway	Sweden
Austria	Finland	Iceland	Luxembourg	Portugal	Switzerland
Belgium	France	Ireland	Netherlands	Russia	United Kingdom
Canada	Germany	Italy	New Zealand	Spain	United States

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## Appendix C: Data sources for shares of reserve currencies in total foreign exchange reserves

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1899 & 1913	Lindert (1969) [used in Figure 4]
1890-1913	Lindert (1967) via Troutman (2010) [used in regression analysis]
1920-1936	Eichengreen and Flandreau (2009) via Troutman (2010)
1953-1994	IMF Annual Report, various years
1995-2010	IMF, COFER Database

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## Appendix D: Summary statistics: 1890-2009

Variable	Mean	Std. Dev.	Min.	Max.	N
Government budget balance	-0.024	0.059	-0.812	0.192	1888
Inflation	5.341	14.739	-24.59	344.394	1888
Real GDP growth	0.029	0.045	-0.329	0.688	1888
Relative dependency ratio (old)	0.063	2.482	-7.463	9.997	1888
Wars	0.059	0.237	0	1	1783
Democracy	7.774	4.908	-9	10	1794
Financial deepening	54.025	32.619	10.798	242.239	1613
Interest rate	6.405	3.558	0.51	29.742	1598
World policy rate	4.549	2.466	0.25	13	1888
Government debt (in % of GDP)	47.875	37.693	3.28	261.76	1806
$\Delta$ global dollar reserves * US dummy	0	0.003	-0.009	0.061	1855
$\Delta$ global sterling reserves * UK dummy	0	0.002	-0.017	0.028	1854
$\Delta$ global mark reserves * GER dummy	0	0.003	-0.011	0.053	1852
$\Delta$ global franc reserves * FRA dummy	0	0.001	-0.018	0.012	1860

Summary statistics are computed for the period 1890-2009 for the sample used in Table 4, column (1).

## Appendix E: Summary statistics: 1970-2009

Variable	Mean	Std. Dev.	Min.	Max.	N
Government budget balance	-0.022	0.044	-0.162	0.192	859
Inflation	6.848	13.638	-4.028	307.298	859
Real GDP growth	0.087	0.123	-0.331	0.481	859
Relative dependency ratio (old)	10.704	3.422	1.485	22.41	859
Unemployment rate	7.166	3.786	1.481	23.883	636
External shock	0.002	0.031	-0.178	0.303	564
Relative income	2.82	0.773	0.776	6.124	691
Military expenditure (deviation from mean)	-0.056	0.486	-2.619	1.697	491
Democracy	9.628	1.714	-7	10	785
Left government	35.545	37.946	0	100	837
Financial deepening (M2 in % of GDP)	71.34	44.966	13.976	242.239	420
Financial center (dummy)	0.163	0.37	0	1	859
Market capitalization	73.472	57.204	0.038	479.742	500
Interest rate	8.131	4.098	1.003	29.742	780
World policy rate	5.745	3.1	0.25	17	859
Government debt (in % of GDP)	46.107	29.86	3.28	183.78	821
Quantity $\Delta$ global dollar reserves * US dummy	0	0.003	-0.007	0.035	859
Quantity $\Delta$ global sterling reserves * UK dummy	0	0.001	-0.007	0.016	859
Quantity $\Delta$ global mark reserves * GER dummy	0	0.003	-0.009	0.039	858
Quantity $\Delta$ global franc reserves * FRA dummy	0	0.001	-0.002	0.006	858

Summary statistics are reported for the period 1970-2009 for the sample used in Table 7, column (1).

## Appendix F: Time-series analysis

In this section, we examine the determinants of the government budget balance for the US and the UK separately in a time series analysis. This analysis focuses on the question whether the demand for reserves is an important determinant of the budget balance in reserve currency countries. Importance is evaluated by the estimated magnitude of the effect and the marginal contribution of the reserve demand to R squared. To make use of the richest dataset, we concentrate on the more recent period (1970-2009).

Estimation is based on equation (1) used for the US and UK individually (without country and time fixed effects). Results are presented in Table F.1. While the parsimonious model (columns 1-2 and 5-6) is estimated by OLS, the remaining columns are based on the instrumental variable approach using 2SLS. To control for potential endogeneity of interest rates, these are instrumented by the German interest rate. The validity of the instrument is confirmed by a F-test: An instrument is relevant when it is highly correlated with the instrumented variable. The F-statistic of a regression of the US interest rate on the German policy rate equals 14.7; for the UK interest rate it amounts to 17.7.<sup>29</sup> The correlation coefficient between the German policy rate and the US interest rate equals 0.53; with respect to the UK interest rate it amounts to 0.56. With respect to the exogeneity of the instrument there is no reason to believe that the government budget balance of the US or UK affect the German policy rate. Because of the small number of observations, findings should be interpreted with caution.

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<sup>29</sup>As a rule of thumb a F-statistic below 10 indicates weak instruments (see Stock and Watson, 2010).

Table F.1: Determinants of government budget balance (1970-2009): Time series analysis

	United States				United Kingdom			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inflation	0.0020 (0.53)	0.0007 (0.23)	0.0091 (0.97)	0.0048 (0.76)	0.0070** (2.44)	0.0078*** (3.32)	0.0017 (0.07)	-0.0090 (-0.59)
GDP growth	0.3311 (1.46)	0.2309 (1.05)	0.7451 (0.97)	0.4625 (0.92)	0.0637 (1.06)	0.0539 (0.87)	0.0516 (0.85)	0.0180 (0.34)
Relative dependency ratio (old)	0.0075 (1.41)	-0.0028 (-0.40)	0.0206 (1.03)	0.0015 (0.16)	0.0029 (0.21)	-0.0097 (-0.76)	-0.0057 (-0.15)	-0.0340 (-1.41)
Unemployment	-0.0145*** (-4.50)	-0.0165*** (-6.13)	-0.0078 (-0.89)	-0.0130** (-2.37)	-0.0069** (-2.48)	-0.0081*** (-2.92)	-0.0098 (-0.73)	-0.0168** (-2.07)
External shock	0.4165 (0.69)	0.1440 (0.23)	0.5485 (0.78)	0.1125 (0.18)	-0.8046 (-1.61)	-0.8066 (-1.46)	-0.5036 (-0.37)	0.1407 (0.15)
Interest rate			-0.0092 (-0.68)	-0.0061 (-0.63)			0.0066 (0.23)	0.0209 (1.14)
$\Delta$ global dollar reserves		-0.7517** (-2.43)		-1.0807* (-1.95)				
$\Delta$ global sterling reserves						-1.2571* (-1.97)		-0.9764* (-1.65)
Observations	29	29	29	29	26	26	26	26
R-squared	0.66	0.73	0.38	0.65	0.39	0.47	0.43	0.44
Estimation	OLS	OLS	2SLS	2SLS	OLS	OLS	2SLS	2SLS

Notes: The dependent variable is the government budget balance to GDP ratio. Robust t-statistics are reported in parentheses. Standard errors are estimated robust to autocorrelation and heteroskedasticity. The symbols \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% levels, respectively. Interest rates are instrumented by the German rate in columns 3-4 and 7-8. The global change in reserves is measured relative to GDP.

The results for the US (columns 1 to 4) show that besides unemployment the demand for dollar reserves by the rest of the world significantly lowers the government budget balance: If the rest of the world accumulates dollar reserves equal to 1% of US GDP, the US government budget balance relative to GDP decreases by 0.75 to 1.1 percentage points. The inclusion of the demand for reserves raises the R squared considerably (from 0.38 to 0.65 in the full specification).

Columns 5 to 8 show the results for the UK. Like in the US, unemployment significantly lowers the government budget balance. When the rest of the world accumulates sterling reserves equal to 1% of UK GDP the UK government balance decreases between 1.0 and 1.3 percentage points. Consideration of reserve currency status positively affects the R squared; this effect is especially strong in the parsimonious specification (increase by more than 10%).

## Appendix G: Implication of reserve currency status for the public budget

This section takes a supply-side view and demonstrates that it is in the own interest of the reserve-providing country to run lower budget balances in the presence of lower nominal interest rates  $i$ . Our



starting point is the public budget identity, which is given by

$$D_t = (1 + i_t)D_{t-1} - S_t \quad (2)$$

where  $D_t$  denotes the level of public debt at the end of year  $t$  and  $S$  the primary government surplus. Scaled by nominal GDP, the dynamics of public debt can alternatively be expressed as

$$d_t = \left( \frac{1 + i_t}{1 + g_t} \right) d_{t-1} - s_t \quad (3)$$

where variables denoted by lower cases are scaled by GDP (e.g.  $d = \frac{D}{Y}$ ) and  $g$  is the growth rate of nominal GDP. After adding standard assumptions and some algebraic manipulation (see Bohn, 1995, 2005), the intertemporal budget constraint of fiscal policy can be obtained as

$$d_t = \sum_{j=0}^{\infty} \frac{1}{\prod_{k=0}^j (1 + r_k)} E_t[s_{t+j}] \quad (4)$$

where the “return on debt” is defined as  $r_k = (1 + i_k)/(1 + g_k)$ .  $E_t$  denotes conditional expectations. The constraint requires that the present value of future primary surpluses be equal to the initial level of debt. This expression can be solved for the present public budget balance:

$$s_t = (1 + r_t)d_t - \sum_{j=1}^{\infty} \frac{1}{\prod_{k=0}^j (1 + r_{t+k})} E_t[s_{t+j}] \quad (5)$$

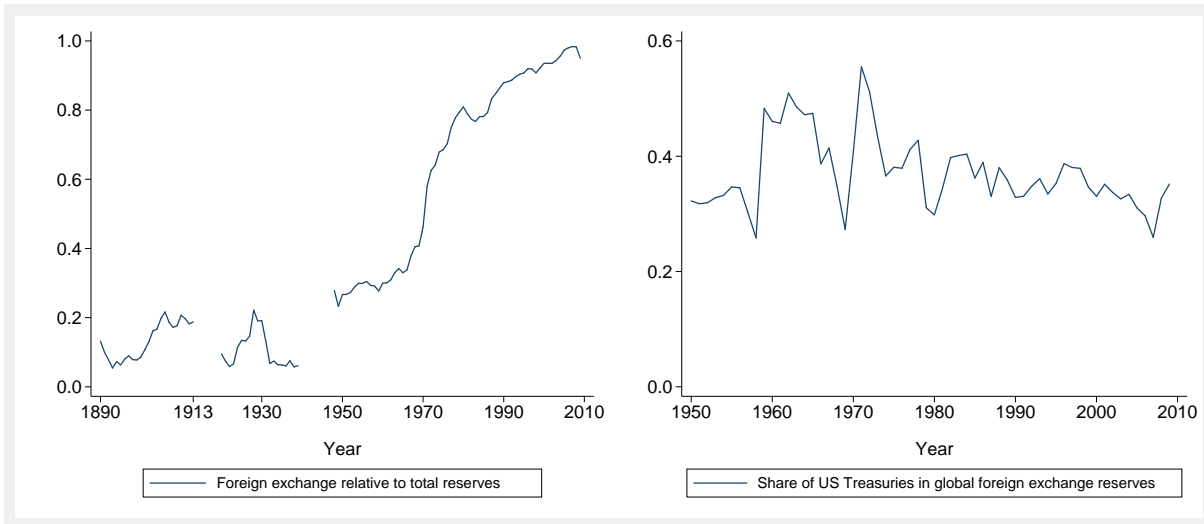
If a country attains reserve currency status, its interest rate decreases. We denote this lower interest rate by  $i^{RC}$ . Equation (5) shows that for a given level of debt  $d_t$  and a given stream of future surpluses the intertemporal budget constraint requires a lower current public budget balance in the presence of lower interest rates.<sup>30</sup> This also holds if reserve currency status is considered to be temporary: If the country enjoys reserve status from now until period  $N$ ,  $i$  is replaced by  $i^{RC}$  for  $0 \leq j \leq N$  in the expression for  $r$  in equation (5). By implication, in the limit the budget constraint is satisfied for a lower current public budget balance.

According to simple economics of intertemporal choice with utility-maximizing agents, an unexpected fall in interest rates induces substitution and income effects. According to the substitution effect, optimizing agents exchange future consumption for present consumption. The income effect depends on the sign of agents’ net wealth: The effect is positive for borrowers and negative for creditors. This textbook analysis of intertemporal choice assumes that there is one homogeneous asset with a given interest rate. In our case it is more plausible to assume that various assets with limited substitutability exist. A decrease in interest rates of government bonds need not affect the return of other assets in which the sovereign itself may invest. This implies that the income effect of the sovereign is positive if it has outstanding liabilities and zero if it is a creditor without liabilities. The net effect of combined substitution and income effect is unambiguously positive. The optimal government response to a lower interest rate is an increase in present consumption.

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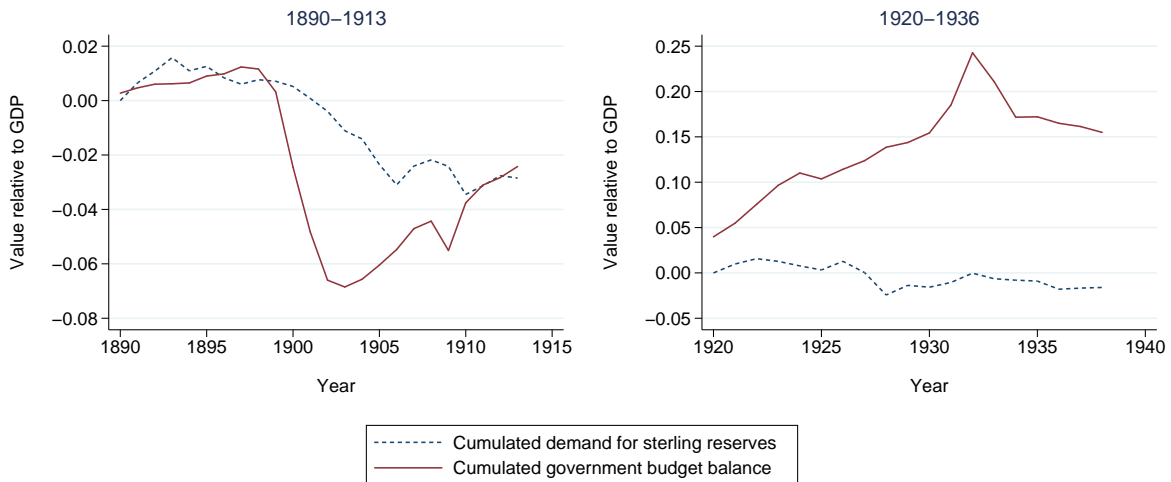
<sup>30</sup>If lower interest rates enhance economic growth, this rise in  $g$  additionally lowers  $r$ .

Figure 1: Relative importance of foreign exchange reserves and US Treasuries



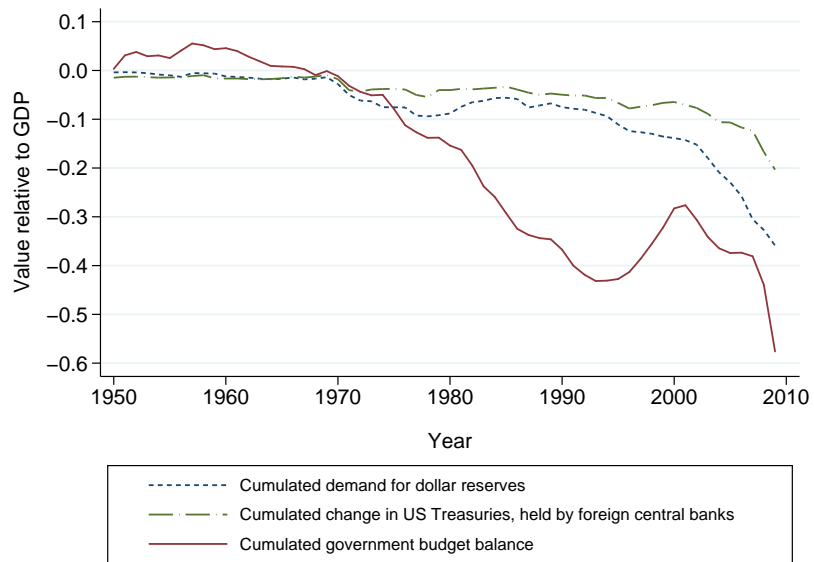
Data sources: see Appendix A.

Figure 2: Cumulated government budget balances and reserve supply: United Kingdom



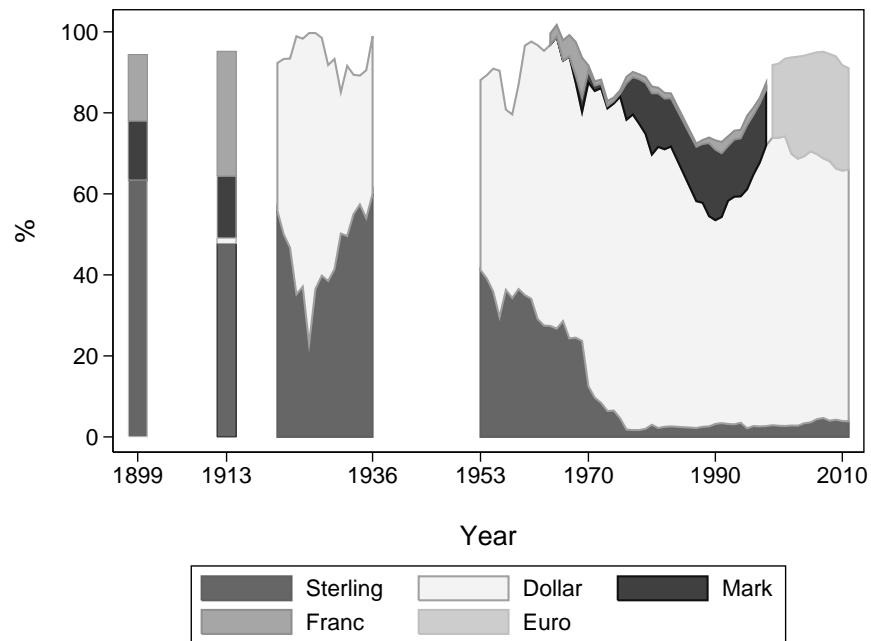
This graph shows the UK government budget balance and the demand for sterling reserves, both cumulated over the depicted period and expressed relative to GDP. The demand for sterling reserves in a given year is measured as the change in worldwide foreign exchange holdings denominated in sterling. A negative value of the demand for sterling reserves corresponds to an increase in foreign central banks' sterling holdings. The left-hand side graph shows the behaviour pre World War I and the right-hand graph is devoted to the inter-war period. The years of World War I are omitted because they would inflate the graph due to large government budget deficits. Data sources: see Appendix A.

Figure 3: Cumulated government budget balances and reserve supply: US



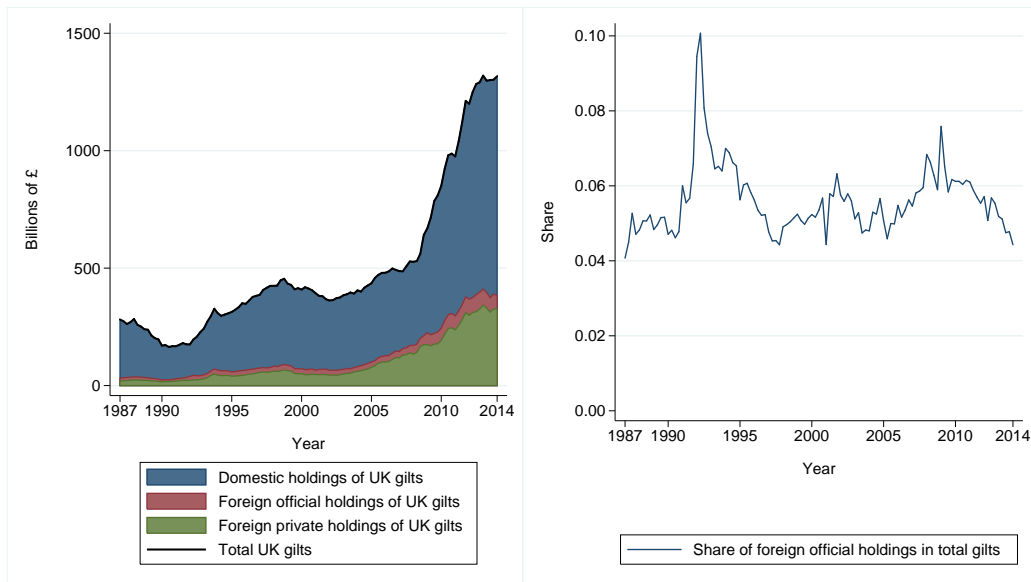
This graph shows the US government budget balance and the demand for dollar reserves, both cumulated over the depicted period and expressed relative to GDP. The demand for reserves is shown by two different measures: The series “cumulated demand for dollar reserves” is calculated as the sum of the year-over-year changes in worldwide foreign exchange holdings denominated in US dollar. The series “cumulated change in US Treasuries” depicts the changes in the value of US Treasuries held by central banks abroad. A negative value of the change in reserves corresponds to an increase in foreign central banks’ dollar holdings. Data sources: see Appendix A.

Figure 4: Shares of reserve currencies in total foreign exchange reserves



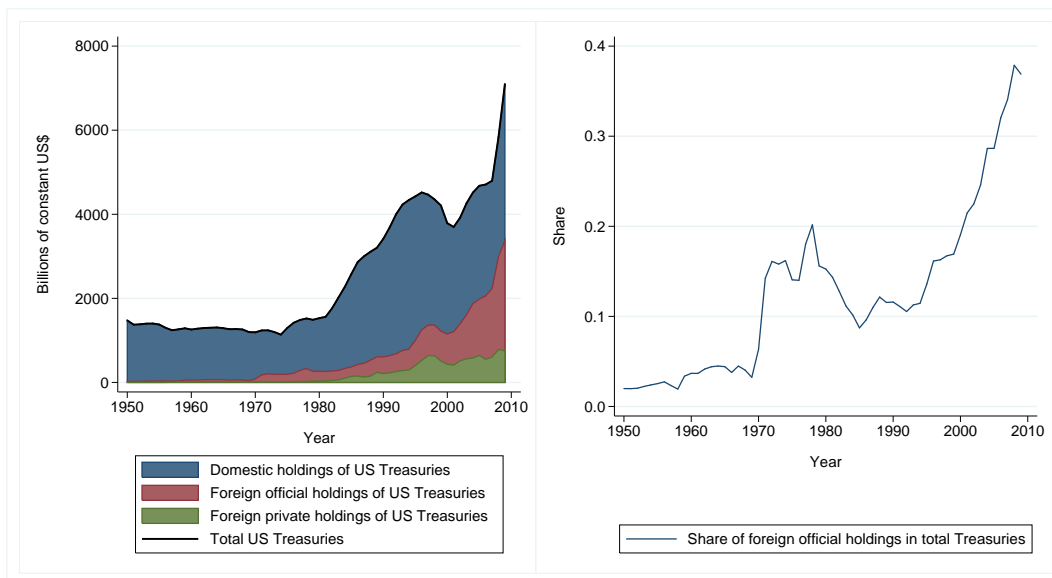
Note: This graph shows the temporal development of the share of the major reserve currencies in total foreign exchange reserves. Prior to World War I, data in Lindert (1969) is only available for 1899 and 1913. In the regression analysis we use annual data based on Lindert (1967).

Figure 5: UK Treasury debt



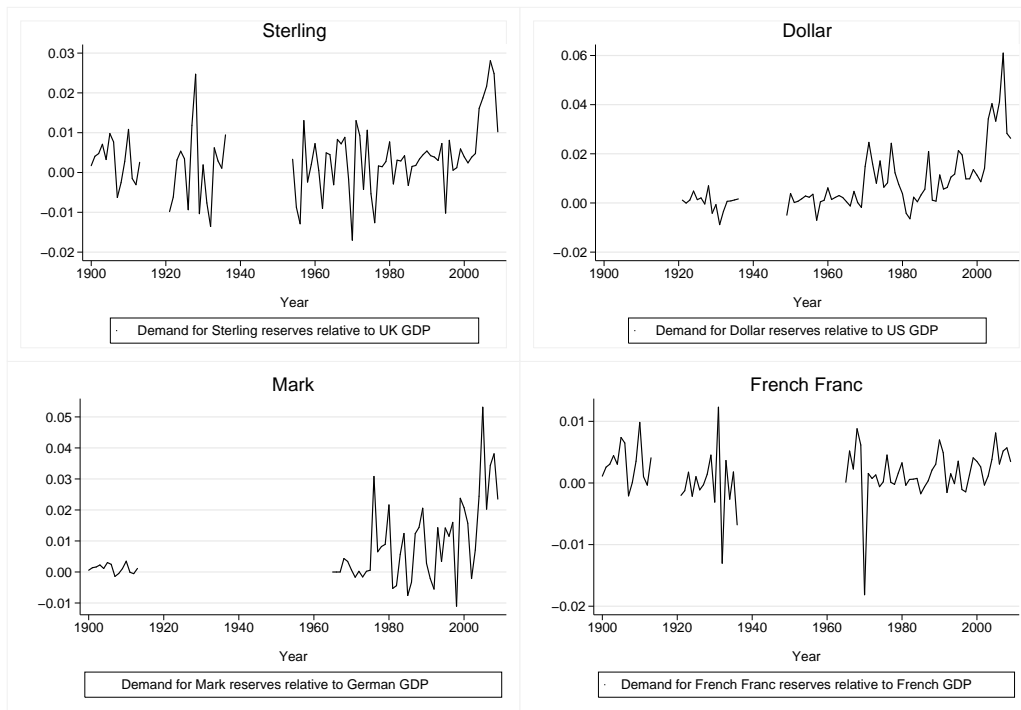
Notes: The left hand panel shows the distribution of outstanding gilts (bonds issued by the British government) by holder. Data are deflated by the UK GDP deflator (base year 2010 = 1), which is provided by IMF (2014). The right hand panel depicts the share of UK gilts held by foreign official entities over total gilts outstanding. Data source: UK Debt Management Office, distribution of gilt holdings (online).

Figure 6: US Treasury debt



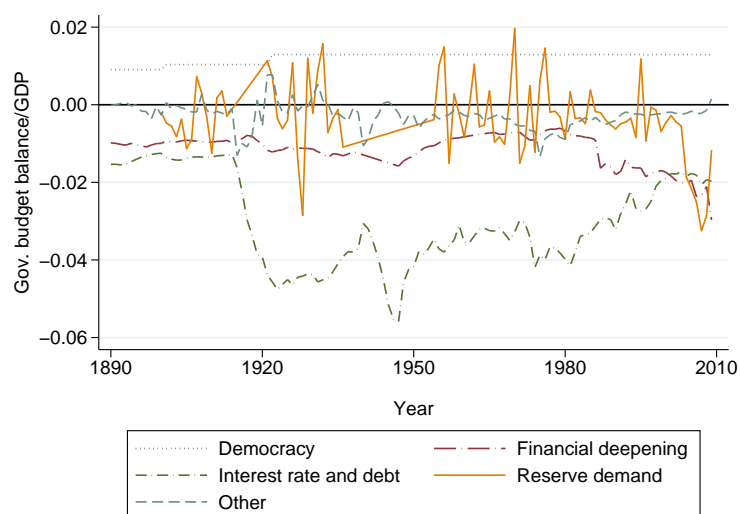
Notes: The left hand panel shows the distribution of outstanding Treasury securities by holder. Data are deflated by the US GDP deflator (base year 2005 = 1), which is provided by IMF (2011a). The right hand panel depicts the proportion of US Treasury securities that are held by foreign official entities. Data source: Flow of Funds, Federal Reserve, Tables L.106 (line 11 and 12) and Table L.209 (line 1).

Figure 7: Change in global official holdings of major reserve currencies



Note: These graphs show the annual change in the level of globally held foreign exchange reserves denominated in four key currencies. The level of reserves denominated in the respective key currencies in a given year is computed as the global level of foreign exchange reserves multiplied by the share of the key currency in total foreign exchange reserves. To strip out the effect of exchange rate changes, reserves are converted in the respective currency before taking the difference.

Figure 8: Estimated contributions to the UK government budget balance (1890-2009)



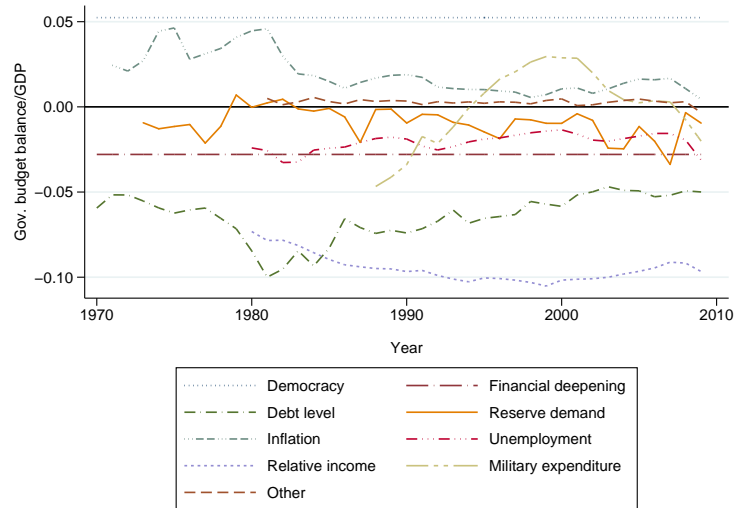
Notes: The graph shows the estimated contributions of the individual determinants to the government budget balance. The group “Other” summarizes the contributions of factors whose individual contribution is small (mean contribution smaller than 0.3% of GDP) and relatively stable over time (standard deviation smaller than 0.0035). These factors are the inflation rate, real GDP growth and the relative dependency ratio with respect to old people. The category “Interest rate and debt” visualizes the aggregate contribution of the interest rate and the level of government debt. We do not show the effect of wars because their strong effect would inflate the graph. Due to the dummy variable specification, wars decrease the government budget balance in crisis years by 0.1% of GDP. Data sources: see Appendix A.

Figure 9: Estimated contributions to the US government budget balance (1890-2009)



Notes: The graph shows the estimated contributions of the individual determinants to the government budget balance. The group “Other” summarizes the contributions of factors whose individual contribution is small (mean contribution smaller than 0.5% of GDP) and relatively stable over time (standard deviation smaller than 0.0025). These factors are the inflation rate, real GDP growth and the relative dependency ratio with respect to old people. The category “Interest rate and debt” visualizes the aggregate contribution of the interest rate and the level of government debt. We do not show the effect of wars because their strong effect would inflate the graph. Due to the dummy variable specification, wars decrease the government budget balance in crisis years by 0.1% of GDP. Data sources: see Appendix A.

Figure 10: Estimated contributions to the US government budget balance (1970-2009)



The graph shows the estimated contributions of the individual determinants to the government budget balance for the period 1970-2009, where data on additional determinants is available. The group “Other” summarizes the contributions of factors whose individual contribution is small (mean contribution smaller than 0.5% of GDP) and relatively stable over time (standard deviation smaller than 0.0025). These factors are real GDP growth and external shocks. The category “Interest rate and debt” visualizes the aggregate contribution of the interest rate and the level of government debt. Data sources: see Appendix A.



Table 1: Share of government securities in total foreign assets held by central banks (in %)

	1913	1920	1924
Australia	n.a.	72.5	73.7
Denmark	34.5	7.6	0.4
Finland	19.8	4.3	0.5
Japan	n.a.	9.9	n.a.
Italy	60.4	15.5	33.8
Norway	18.0	6.9	8.1
Portugal	n.a.	7.4	34.2
Sweden	21.1	8.7	27.5

Notes: n.a. = not available  
 Data source: League of Nations (1925), p.150-159.

Table 2: Demand for reserves relative to GDP of issuing country (in %, mean over periods)

	Sterling	Dollar	Mark	French Franc
1899-1913	0.29	n.a.	0.11	0.32
1920-1936	0.08	0.03	n.a.	-0.04
1948-1969	0.14	0.11	0.16	0.45
1970-1994	0.19	0.85	0.53	0.04
1995-2009	0.94	2.48	1.93	0.28

Notes: For major reserve currencies, the table shows the global demand for additional reserves per year averaged across time periods in % of GDP of the issuing country. By way of example, during 1890-1913 the rest of the world accumulated on average Sterling reserves equivalent to 0.29% of UK GDP per year. n.a. = not available.

Table 3: Unit root test results

Panel variables	Fisher-type test				Im-Pesaran-Shin			
	1890-2009		1970-2009		1890-2009		1970-2009	
	statistic	p-value	statistic	p-value	statistic	p-value	statistic	p-value
Government budget balance	188.65	0.00	87.19	0.00	-9.23	0.00	-5.22	0.00
Inflation	295.08	0.00	61.20	0.10	-16.16	0.00	-2.32	0.01
Real GDP growth	454.32	0.00	138.41	0.00	-23.79	0.00	-12.22	0.00
Relative dependency ratio (old)	107.70	0.00	34.32	0.93	2.87	1.00	3.44	1.00
Wars	280.29	0.00	97.67	0.00				
Democracy	93.26	0.00	166.30	0.00				
Financial deepening	35.95	0.86	2.45	0.99				
Interest rate	30.63	0.96	17.93	1.00	-0.57	0.28	2.25	0.99
World policy rate	79.36	0.00	12.72	1.00	-9.06	0.00	-3.63	0.00
Government debt	80.72	0.00	36.46	0.84	-0.21	0.42	1.86	0.97
Unemployment			53.34	0.28			-3.43	0.00
External shock			88.79	0.00			-13.666	0.00
Relative income			96.20	0.00			-4.20	0.00
Left government			140.33	0.00				
Financial center			7.74	1.00				

Notes: Null hypothesis of both test procedures: All panels contain a unit root. The Fisher-type test conducts augmented Dickey-Fuller (ADF) tests on each panel (see Choi, 2001). To remove higher-order autoregressive components of the series three lags are included. This test combines the p-values from panel-specific unit-root tests; Choi (2001) proposes four methods how to combine them. We present the statistic based on the inverse  $\chi^2$  transformation of p-values. The results of the other three methods do not differ substantially. The Im-Pesaran-Shin test (see Im et al., 2003) is based on a set of Dickey-Fuller regressions. The lag length is chosen by minimization of the Akaike information criterion (AIC) where the maximum lag length is restricted to 5 lags. The presented two panel unit root tests are chosen over other test (e.g. Breitung, Hadri and Levin-Lin-Chu test) because they allow for unbalanced panels. Moreover, in contrast to the other tests, their autoregressive parameters are panel specific. The tests are conducted on the series of both datasets, the historical one (1890-2009) and the one restricted to 1970-2009. Missing entries are due to insufficient observations or to the fact that the variable does not figure in the historical dataset.

Time-series variables	Dickey-Fuller				Phillips-Perron			
	1890-2009		1970-2009		1890-2009		1970-2009	
	statistic	p-value	statistic	p-value	$\tau$ statistic	p-value	$\tau$ statistic	p-value
$\Delta$ global dollar reserves	-2.99	0.04	-3.85	0.00	-2.81	0.06	-3.87	0.00
$\Delta$ global sterling reserves	-6.95	0.00	-2.54	0.11	-7.01	0.00	-2.50	0.11
$\Delta$ global mark reserves	-4.48	0.00	-3.86	0.00	-4.40	0.00	-3.95	0.00
$\Delta$ global franc reserves	-9.37	0.00	-3.31	0.01	-9.35	0.00	-3.36	0.01

Notes: The changes in the global demand for reserve currencies are time-series variables. To test whether they exhibit a unit root we perform two time-series unit root tests: The augmented Dickey-Fuller test and the Phillips-Perron test. In case of the Dickey-Fuller test we report the Dickey-Fuller test statistic and the MacKinnon approximate p-value. The columns for the Phillips-Perron test show the  $\tau$  test statistics. Both tests are based on the null hypothesis that the variable contains a unit root.

Table 4: Government budget balance (1890-2009)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Inflation	-0.0001 (-0.78)	-0.0001 (-0.68)	-0.0001 (-0.63)	-0.0002 (-0.82)	-0.0004** (-2.22)	-0.0003* (-2.05)	-0.0003* (-2.03)	-0.0005*** (-2.87)	-0.0005*** (-2.88)	-0.0005*** (-3.61)
Real GDP growth	0.0570 (0.81)	0.1147*** (2.11)	0.1065* (1.77)	0.1109* (1.97)	0.0101 (0.21)	-0.0176 (-0.45)	-0.0257 (-0.62)	-0.0476 (-0.58)	-0.0473 (-0.58)	-0.0392 (-0.60)
Relative dependency ratio (old)	-0.0010 (-0.71)	-0.0019 (-1.62)	-0.0020* (-1.71)	-0.0016 (-1.25)	-0.0014 (-1.00)	-0.0008 (-0.81)	-0.0009 (-0.97)	-0.0012** (-2.08)	-0.0012** (-2.10)	-0.0000 (-0.01)
Wars				-0.1698* (-2.02)	-0.1110** (-2.44)	-0.11429*** (-3.81)	-0.1496*** (-3.76)	-0.1187*** (-5.01)	-0.1183*** (-4.99)	-0.1077*** (-4.59)
Democracy					-0.0001 (-0.11)	0.0003 (0.59)	0.0004 (0.68)	0.0013** (2.51)	0.0013** (2.50)	0.0013*** (2.60)
Financial deepening						-0.0003* (-1.88)	-0.0003* (-1.83)	-0.0003*** (-3.48)	-0.0003*** (-3.48)	-0.0002*** (-3.44)
Interest rate								-0.0020*** (-3.70)	-0.0021*** (-3.76)	-0.0022*** (-4.50)
Government debt										-0.0002*** (-4.69)
$\Delta$ global dollar reserves		-1.3412*** (-4.50)	-1.3387*** (-4.46)	-1.2828*** (-3.87)	-1.2281*** (-3.44)	-1.0226*** (-4.68)	-1.0200*** (-4.67)	-0.9892*** (-5.39)	-0.9887*** (-5.39)	-0.6988*** (-3.88)
* US dummy										
$\Delta$ global sterling reserves		-1.2537*** (-6.22)	-1.2638*** (-6.06)	-1.2433*** (-5.52)	-1.1828*** (-5.06)	-0.8314*** (-5.01)	-0.8287*** (-5.15)	-0.8379*** (-2.72)	-0.8407*** (-2.73)	-1.1545*** (-2.99)
* UK dummy										
$\Delta$ global mark reserves			-0.1435 (-0.83)				0.1367 (0.81)	0.0274 (0.11)	0.0296 (0.12)	0.0807 (0.33)
* GER dummy										
$\Delta$ global franc reserves			-0.2421 (-0.72)				0.3742 (0.90)	0.1193 (0.26)	0.1130 (0.25)	0.3102 (0.67)
* FRA dummy										
Observations	1888	1821	1757	1716	1650	1436	1373	1164	1168	1146
R-squared	0.39	0.38	0.38	0.38	0.37	0.43	0.44	0.43	0.43	0.47
Number of countries	24	24	24	24	22	21	21	19	19	19

Notes: The dependent variable is the government budget balance to GDP ratio. Regressions include fixed country effects and time dummies. Estimation by OLS except columns (8) to (10) where 2SLS is used because interest rates are instrumented. Robust t-statistics are reported in parentheses. Standard errors are estimated robust to intragroup correlations. The symbols \*, \*\*, and \*\*\* denote statistical significance at the 10%, 5% and 1% levels, respectively. The global change in reserves is measured relative to GDP.

Table 5: Government budget balance (1890-1935)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation	-0.0002 (-1.28)	-0.0002 (-1.32)	-0.0002 (-1.28)	-0.0002 (-1.30)	-0.0002 (-1.30)	-0.0002 (-1.29)	-0.0017* (-1.68)	-0.0017* (-1.68)	-0.0015 (-1.56)
Real GDP growth	0.0318 (0.65)	0.0040 (0.08)	0.0318 (0.65)	0.0399 (0.84)	0.0147 (0.30)	0.0168 (0.30)	0.0455 (0.63)	0.0455 (0.63)	0.0674 (0.88)
Relative dependency ratio (old)	-0.1640* (-1.90)	-0.1326 (-1.14)	-0.1640* (-1.90)	-0.1376 (-1.68)	-0.1212 (-1.41)	-0.0460 (-0.46)	0.0310 (0.19)	0.0310 (0.19)	0.1909 (0.80)
Wars			-0.0793* (-1.82)	-0.0468** (-2.33)	-0.0776 (-1.62)	-0.0928 (-1.73)	-0.0348*** (-4.66)	-0.0348*** (-4.66)	-0.0416** (-2.23)
Democracy				0.0003 (0.37)	0.0004 (0.48)	0.0010 (1.22)	0.0023 (1.63)	0.0023 (1.63)	0.0033* (1.69)
Financial deepening					-0.0001 (-0.75)	0.0001 (0.31)	0.0000 (0.08)	0.0000 (0.08)	0.0005 (1.60)
Interest rate							0.0094 (0.79)	0.0094 (0.79)	0.0135 (1.14)
Government debt									-0.0001 (-0.64)
$\Delta$ global dollar reserves	1.5726*** (3.40)	1.5186** (2.94)	1.5726*** (3.40)	1.5269*** (3.39)	1.7245*** (4.63)	1.6483*** (4.13)	1.8115*** (3.76)	1.8115*** (3.76)	1.7660*** (2.97)
* US dummy									
$\Delta$ global sterling reserves	-0.5812** (-2.53)	-0.5656** (-2.23)	-0.5812** (-2.53)	-0.6224** (-2.53)	-0.5471* (-2.16)	-0.6039* (-2.12)	-0.8007** (-2.27)	-0.8007** (-2.27)	-1.1747** (-2.31)
* UK dummy									
$\Delta$ global mark reserves		-0.2667 (-0.62)				-0.5878 (-0.92)	-0.5444 (-0.74)	-0.5444 (-0.74)	-1.6246 (-1.52)
* GER dummy									
$\Delta$ global franc reserves		0.4676 (1.30)				0.5746 (1.40)	0.6743 (1.54)	0.6743 (1.54)	0.7327 (0.98)
* FRA dummy									
Observations	475	444	475	448	419	389	298	298	280
R-squared	0.27	0.27	0.27	0.27	0.27	0.27	0.35	0.35	0.38
Number of countries	14	14	14	14	13	13	10	10	10

Table 6: Government budget balance (1950-2009)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation	0.0000 (0.16)	0.0000 (0.33)	-0.0002 (-0.48)	-0.0001 (-0.13)	-0.0006 (-1.07)	-0.0005 (-0.89)	0.0006 (1.37)	0.0006 (1.36)	0.0007 (1.52)
Real GDP growth	0.1426** (2.48)	0.1465** (2.41)	0.1299** (2.42)	0.1201** (2.19)	0.0750* (1.73)	0.0826* (1.74)	0.0787 (1.63)	0.0749 (1.57)	0.0170 (0.37)
Relative dependency ratio (old)	-0.0014 (-1.06)	-0.0016 (-1.16)	-0.0010 (-0.64)	-0.0010 (-0.61)	-0.0001 (-0.05)	-0.0004 (-0.26)	-0.0005 (-0.77)	-0.0005 (-0.75)	0.0025*** (3.56)
Democracy				-0.0007 (-1.34)	-0.0006 (-1.03)	-0.0005 (-0.71)	-0.0003 (-0.88)	-0.0003 (-0.86)	-0.0007** (-2.06)
Financial deepening					-0.0002 (-1.15)	-0.0001 (-0.87)	-0.0001** (-2.27)	-0.0002** (-2.32)	-0.0002*** (-3.65)
Interest rate							-0.0014** (-2.15)	-0.0014** (-2.18)	-0.0022*** (-3.77)
Government debt									-0.0005*** (-6.74)
$\Delta$ global dollar reserves	-1.1765*** (-4.16)	-1.1634*** (-4.03)	-1.0854*** (-3.23)	-1.1255*** (-3.16)	-0.8883*** (-4.39)	-0.8732*** (-4.36)	-0.8657*** (-5.04)	-0.8662*** (-5.04)	-0.5713*** (-3.49)
* US dummy									
$\Delta$ global sterling reserves	-1.3769*** (-5.40)	-1.3990*** (-5.39)	-1.3489*** (-4.62)	-1.3631*** (-4.48)	-1.0437*** (-5.30)	-1.0731*** (-5.57)	-0.9717*** (-2.62)	-0.9691*** (-2.62)	-1.2968*** (-2.71)
* UK dummy									
$\Delta$ global mark reserves		-0.5142*** (-3.89)				-0.1583 (-1.71)	-0.1132 (-0.45)	-0.1153 (-0.46)	-0.1568 (-0.66)
* GER dummy									
$\Delta$ global franc reserves		-1.4356*** (-5.38)				-0.2387** (-2.60)	-0.2707 (-0.47)	-0.2668 (-0.46)	-0.3516 (-0.47)
* FRA dummy									
Observations	1225	1195	1120	1092	918	888	795	798	796
R-squared	0.36	0.37	0.36	0.36	0.35	0.37	0.36	0.36	0.42
Number of countries	24	24	24	22	21	21	19	19	19

Notes for Tables 5 and 6: The dependent variable is the government budget balance to GDP ratio. The global change in reserves is measured relative to GDP. Regressions include fixed country and time effects. Estimation by OLS. Instrumental variable 2SLS is used in specifications including the interest rate. While interest rates are instrumented by its lagged level in column (7), in columns (8) and (9) the world policy rate is used as instrument. Robust t-statistics are reported in parentheses. Standard errors are estimated robust to intragroup correlations. The symbols \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7: Government budget balance (1970-2009)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Reserve demand:	predicted by auxiliary regression											
Inflation	0.0000 (0.28)	-0.0008 (-1.02)	-0.0009 (-1.04)	-0.0012 (-0.63)	-0.0007 (-0.33)	0.0054*** (4.78)	0.0000 (0.30)	-0.0008 (-0.99)	-0.0008 (-0.94)	-0.0014 (-0.74)	-0.0009 (-0.43)	0.0052*** (4.66)
Real GDP growth	0.0751*** (5.06)	0.0550** (2.40)	0.0548** (2.38)	0.0604** (2.56)	0.0628** (2.34)	0.0530*** (2.67)	0.0771*** (5.40)	0.0584** (2.59)	0.0586** (2.60)	0.0627** (2.69)	0.0655** (2.47)	0.0561*** (2.78)
Relative dependency ratio (old)	-0.0019 (-1.01)	-0.0019 (-0.74)	-0.0019 (-0.76)	-0.0030 (-1.15)	-0.0022 (-0.81)	-0.0015 (-0.96)	-0.0019 (-1.02)	-0.0019 (-0.76)	-0.0020 (-0.77)	-0.0027 (-1.02)	-0.0018 (-0.70)	-0.0012 (-0.74)
Unemployment		-0.0048*** (-4.04)	-0.0049*** (-4.07)	-0.0046*** (-2.88)	-0.0048** (-2.59)	-0.0033*** (-4.11)		-0.0050*** (-4.16)	-0.0051*** (-4.16)	-0.0047*** (-2.89)	-0.0049** (-2.64)	-0.0035*** (-4.26)
External shock		0.0587 (1.05)	0.0597 (1.07)	0.0883 (1.00)	0.0990 (1.05)	-0.1529** (-2.22)		0.0559 (1.03)	0.0540 (0.99)	0.0928 (1.06)	0.1029 (1.10)	-0.1480** (-2.19)
Relative income		-0.0066 (-0.42)	-0.0072 (-0.45)	-0.0090 (-0.49)	-0.0035 (-0.16)	-0.0291*** (-2.98)		-0.0073 (-0.44)	-0.0090 (-0.54)	-0.0083 (-0.44)	-0.0038 (-0.17)	-0.0297*** (-3.01)
Military expenditure (deviation from mean)				-0.0140 (-1.25)	-0.0098 (-0.89)	-0.0209*** (-4.32)				-0.0190* (-1.75)	-0.0148 (-1.41)	-0.0262*** (-5.04)
Democracy				0.0072 (1.54)	0.0055 (1.16)	0.0058** (1.98)				0.0065 (1.42)	0.0049 (1.05)	0.0055* (1.68)
Left: government				-0.0000 (-0.43)	-0.0000 (-0.34)	-0.0000 (-0.45)				-0.0000 (-0.32)	-0.0000 (-0.26)	-0.0000 (-0.50)
Financial center (dummy)				-0.0555*** (-2.94)		-0.0258** (-2.07)				-0.0559*** (-3.01)		-0.0258** (-2.16)
Market capitalization					0.0002* (1.85)						0.0002* (1.79)	
Interest rate						-0.0067*** (-6.58)						-0.0065*** (-6.45)
Government debt						-0.0003*** (-2.67)						-0.0003** (-2.41)
$\Delta$ global dollar reserves						-1.2628*** (-3.69)						-1.3787*** (-3.16)
* US dummy	-1.7110*** (-7.29)	-1.5249*** (-4.25)	-1.5298*** (-4.26)	-1.4228*** (-3.74)	-1.3452*** (-3.14)	-1.2628*** (-3.69)	-1.4796*** (-3.84)	-1.6597*** (-3.33)	-1.7192*** (-3.41)	-1.5275** (-2.77)	-1.4139** (-2.47)	-1.3787*** (-3.16)
$\Delta$ global sterling reserves						-3.3659*** (-3.01)						-3.0181*** (-3.52)
* UK dummy	-1.1619** (-2.70)	-2.5549*** (-6.61)	-2.5619*** (-6.61)	-3.2110*** (-5.38)	-3.0209*** (-4.77)	-3.3659*** (-3.01)	-2.9802*** (-4.64)	-3.7553*** (-6.61)	-3.8551*** (-6.72)	-3.5435*** (-4.75)	-3.1414*** (-4.17)	-3.0181*** (-3.52)
$\Delta$ global mark reserves						0.3104 (1.43)				0.0045 (0.02)		-0.0043 (-0.02)
* GER dummy						0.3104 (1.43)				0.0045 (0.02)		-0.0043 (-0.02)
$\Delta$ global franc reserves						-1.8414 (-2.87)				-5.3187*** (-4.86)		-5.9624*** (-6.11)
* FRA dummy						-1.8414 (-2.87)				-5.3187*** (-4.86)		-5.9624*** (-6.11)
Observations	860	531	531	418	411	409	861	531	531	418	411	409
R-squared	0.38	0.53	0.53	0.57	0.58	0.65	0.38	0.53	0.54	0.58	0.58	0.66
Number of countries	24	21	21	20	20	20	24	21	21	20	20	20

The dependent variable is the public budget balance to GDP ratio. The global change in reserves is measured relative to GDP. Regressions include fixed country and time effects. Estimation by OLS except regressions including the interest rate where an instrumental variable approach is used (2SLS). In columns 1-6 the global reserve demand is proxied by the change in US Treasuries and UK gilts at foreign central banks. In columns 7-12 the global reserve demand is estimated by an auxiliary regression. Robust t-statistics are reported in parentheses. Standard errors are estimated robust to intragroup correlations. The symbols \*, \*\*, and \*\*\* denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8: Government budget balance (1890-2009): Instrumentation

	Instrumentation by imports			Instrumentation by commodity prices		
	(1)	(2)	(3)	(4)	(5)	(6)
Inflation	-0.0001 (-1.14)	-0.0004*** (-3.06)	-0.0005*** (-3.83)	-0.0001 (-1.10)	-0.0004*** (-3.06)	-0.0005*** (-3.82)
Real GDP growth	0.0858 (1.26)	-0.0173 (-0.34)	-0.0290 (-0.60)	0.0876 (1.29)	-0.0163 (-0.32)	-0.0267 (-0.55)
Relative dependency ratio (old)	-0.0021*** (-4.06)	-0.0008 (-1.56)	-0.0001 (-0.13)	-0.0026*** (-4.99)	-0.0014** (-2.53)	-0.0010 (-1.64)
Wars		-0.1425*** (-5.28)	-0.1006*** (-5.70)		-0.1419*** (-5.30)	-0.0999*** (-5.60)
Democracy		0.0003 (1.15)	0.0012*** (2.78)		0.0003 (1.08)	0.0012*** (2.70)
Financial deepening		-0.0003*** (-3.97)	-0.0003*** (-4.39)		-0.0003*** (-3.95)	-0.0002*** (-4.07)
Interest rate			-0.0023*** (-4.73)			-0.0021*** (-4.20)
Government debt			-0.0002*** (-4.01)			-0.0002*** (-3.69)
$\Delta$ global reserves (US and UK)	-1.8983*** (-4.99)	-1.3683*** (-4.01)	-0.9498*** (-2.88)	-3.4491*** (-5.77)	-2.6065*** (-5.04)	-2.4963*** (-4.66)
Observations	1874	1477	1245	1874	1477	1245
R-squared	0.38	0.43	0.45	0.36	0.42	0.44
Number of countries	24	21	19	24	21	19

The dependent variable is the public budget balance to GDP ratio. The global change in reserves is measured relative to GDP. Regressions include fixed country and time effects. Estimation by instrumental variable approach (2SLS): Global demand for reserves is instrumented by global imports (columns 1-3) and by commodity and oil prices (columns 4-6). Interest rate is instrumented by the world policy rate. Robust t-statistics are reported in parentheses. Standard errors are estimated robust to intragroup correlations. The symbols \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% levels, respectively.

Table 9: Expansionary fiscal policies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1890 - 1935	1890 - 1935	1890 - 2009	1890 - 2009	1890 - 2009	1890 - 2009	1890 - 2009	1890 - 2009	1890 - 2009
Inflation	-0.0002 (-1.30)	-0.0002 (-1.27)	-0.0014 (-1.57)	0.0000 (0.35)	-0.0005 (-0.88)	0.0007 (1.53)	-0.0009 (-1.04)	-0.0014 (-1.04)	0.0051*** (4.51)
Real GDP growth	0.0036 (0.07)	0.0146 (0.24)	0.0642 (0.78)	0.1404** (2.24)	0.0737 (1.49)	-0.0005 (-0.01)	0.0533** (2.32)	0.0528** (2.26)	0.0491** (2.38)
Growth * reserve demand US	-0.0678 (-0.64)	-0.0666 (-0.61)	-0.0364 (-0.26)	0.2776*** (5.71)	0.1746*** (3.60)	0.1979** (2.15)	0.5094*** (3.46)	0.4378** (2.76)	0.4312** (2.35)
Growth * reserve demand UK	0.2478*** (3.38)	0.2574** (2.74)	0.4227* (1.92)	0.4579*** (5.66)	0.4220*** (6.05)	0.5084*** (2.70)	-0.0154 (-0.58)	0.0524 (1.55)	0.0404 (0.48)
Growth * reserve demand other	0.4093*** (7.02)	0.4105*** (4.72)	0.3717* (1.96)	0.0273 (0.27)	-0.0218 (-0.20)	0.0431 (0.40)	-0.0297** (-2.42)	-0.0301** (-2.42)	-0.0352* (-1.89)
Relative dependency ratio (old)	-0.1312 (-1.14)	-0.0463 (-0.46)	0.2234 (0.94)	-0.0016 (-1.20)	-0.0005 (-0.27)	0.0025*** (3.56)	-0.0019 (-0.74)	-0.0026 (-0.74)	-0.0009 (-0.37)
Wars		-0.0921 (-1.71)	-0.1446 (-1.40)					-0.0206* (-1.81)	-0.0263*** (-5.41)
Unemployment								-0.0047*** (-4.25)	-0.0032*** (-4.00)
External shock								0.1011 (1.20)	-0.1363** (-1.99)
Relative income								-0.0080 (-0.43)	-0.0261*** (-2.66)
Democracy		0.0010 (1.19)	0.0034* (1.71)		-0.0005 (-0.73)	-0.0007** (-2.20)		0.0074 (1.58)	0.0058* (1.95)
Left government								-0.0000 (-0.25)	(-0.18)
Financial deepening		0.0000 (0.20)	0.0004 (1.47)		-0.0001 (-0.88)	-0.0002*** (-3.70)			
Financial center (dummy)									
Interest rate			0.0137 (1.15)			-0.0022*** (-3.75)		-0.0573*** (-3.03)	-0.0279** (-2.21)
Government debt			-0.0002 (-0.71)			-0.0005*** (-7.00)			-0.0003*** (-2.65)
$\Delta$ global dollar reserves	1.3962** (2.87)	1.5268*** (3.96)	1.7231*** (2.82)	-1.5461*** (-4.73)	-1.1574*** (-4.86)	-0.8938*** (-3.76)	-3.7620*** (-3.37)	-3.6699*** (-2.99)	-3.4915*** (-3.08)
* US dummy									
$\Delta$ global sterling reserves	-0.8122** (-2.54)	-0.8520** (-2.27)	-1.6131** (-2.19)	-2.1523*** (-6.25)	-1.7958*** (-7.94)	-2.1713*** (-4.32)	-4.3625*** (-5.70)	-5.0844*** (-3.74)	-3.4622** (-2.54)
* UK dummy									
$\Delta$ global mark reserves	-1.3402** (-2.58)	-1.5577*** (-2.32)	-2.5211*** (-2.99)	-0.5659** (-2.46)	-0.1012 (-0.30)	0.1183 (0.63)	0.1183 (0.44)	0.1008 (0.37)	0.2625 (1.24)
* GFR dummy									
$\Delta$ global franc reserves	1.9399*** (4.19)	2.0663*** (3.30)	1.6705 (1.46)	-1.5553** (-2.62)	-0.1035 (-0.20)	-0.5593 (-0.59)	-2.6225*** (-2.85)	-3.5165*** (-3.34)	-2.5837* (-1.69)
* FRA dummy									
Observations	444	389	280	1195	888	796	531	418	409
R-squared	0.27	0.28	0.39	0.38	0.37	0.42	0.54	0.58	0.65
Number of countries	14	13	10	24	21	19	21	20	20

The dependent variable is the public budget balance to GDP ratio. The global change in reserves is measured relative to GDP. Regressions include fixed country and time effects. Estimation by OLS except regressions including the interest rate. In these cases an instrumental variable approach is used (2SLS) where the interest rate is instrumented by the world policy rate. Robust t-statistics are reported in parentheses. Standard errors are estimated robust to intragroup correlations. The symbols \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% levels, respectively.