FOREIGN RESERVES AND INTERNATIONAL ADJUSTMENTS UNDER THE BRETTON WOODS SYSTEM: A REAPPRAISAL.[1]

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Abstract: This paper studies the determinants of international reserves holdings under the Bretton Woods system. Using both a quarterly dataset for G10 countries and an annual dataset for 55 countries, we first show that, contrary to the common wisdom, the accumulation of reserves during the Bretton Woods system was not purely trade-based but depended on the domestic money supply. We also find that, in G10 countries, the determinants of gold accumulation are different from those of foreign exchange reserves. We interpret such a difference as an evidence of imperfect substitution between gold and foreign exchange reserves and, more generally, as an evidence that the Bretton Woods system functioned mostly as a gold standard rather than a dollar standard. Finally, we reassess the adjustment and liquidity problems, showing that the former was structural, whereas the latter was less important than what contemporaries thought. Overall, these results cast a new light on the fundamental flaws of the Bretton Woods system and challenge the view that the Bretton Woods system provided solutions to global imbalances and foreign reserves over-accumulation.

Despite the numerous studies on the demand for foreign reserves conducted during the 1960s and early 1970s, little is known about the determinants of reserve accumulation during the Bretton Woods system. Papers published at that time relied too often on short time span, small samples and spurious econometrics, preventing any rigorous or robust conclusion.[2] Despite subsequent improvements in econometric techniques and renewed interest in international reserves in the academic literature, there has been no attempt to reinvestigate the demand for foreign reserves under the Bretton Woods period. This is all the more surprising since Bretton Woods system still serves as a reference for most debates on the reform of the international monetary system and the provision of international liquidity (Dooley et al. 2004, Eichengreen 2006, Fahri, Gourinchas & Rey 2011, Volcker 2014) or on the determinants of foreign reserve accumulation (Obstfeld et al. 2010).

This paper reopens the debate by studying the determinants of the holding of international reserves from 1950 to 1971. Using a new quarterly database on reserves, trade and financial variables, we first study the determinants of reserves holdings in G10 countries using standard panel data techniques.[3] We then turn to a larger analysis (robustness check) using a panel of annual data for 55 countries and highlight important differences in our results between the core of the system (G10 countries) and the rest of the world.

Our key results are as follows. First, we show that, contrary to a common view (Triffin 1960) and to what a recent literature has suggested (Rodrik 2006, Obstfeld et al. 2010), the accumulation of reserves during the Bretton Woods system – before financial globalization – was not only trade based. Although higher trade intensity does increase reserve holdings, we find that domestic financial development (measured as money over GDP) as well as mercantilist motives influenced both (positively) the level of reserves. We also find some evidence of a positive correlation between financial openness and reserve holding, although this result depends on the definition of capital account openness used and on the sample of countries considered. Finally, we find that the positive effects of the money supply remain when estimations are run on a larger sample of 55 countries but that the role of money is higher in G10 countries than in the

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[2] In fact, studies on foreign reserves holdings under the Bretton Woods system stopped quickly after the demise of the system, and have remained inconclusive (see Grubel 1971, Williamson 1973, Cohen 1975).
[3] We focus our attention on G10 countries because of their centrality. Over the sample period, G10 countries accounted for around 70% of the international reserves and 80% of global GDP.

"periphery".[4] This first result suggests that countries accumulated reserves for other motives than current account balances and is in sharp contrast with the view that official foreign reserve policy under Bretton Woods had abandoned any link with the money stock (Williamson 1973). To the contrary, it seems that countries still accumulated official reserves in order to back their domestic stock of money (consistent with central banks' policy during the gold standard and the monetary theory of the balance of payments).

Second, we find a striking difference between the determinants of gold holding and the determinants of foreign exchange holdings for G10 countries (but not others). Whereas gold holdings are well explained by expected determinants of reserves (trade, money, exchange rate misalignment and exchange rate volatility), this is not the case of foreign exchange holding. This result suggests that, at least for core countries, the Bretton Woods system was still characterized by an imperfect substitution between gold and foreign exchange reserves and that the "confidence problem" was very severe. It also contradicts the views that the Bretton Woods system functioned as a de facto dollar standard (Despres, Kindleberger, Salant, 1966, McKinnon 1969, 1993): foreign exchange reserves were not treated as gold and were not likely to play the same precautionary role as gold. In our annual dataset – in which we are able to disentangle the roles of several money aggregates (M0, M1, M2) – we find that all components of money play a significant role but that the coefficient is higher for the ratio of currency and banknotes to GDP. Under Bretton Woods, central banks followed – at least partly - the gold standard practices of backing notes issuance with gold[5].

Third, based on our estimations of the demand for reserves, we shed a new light on the other well-known problems of the Bretton Woods system (Machlup 1964, Bordo 1993): liquidity and adjustment. Running a simple counterfactual ("what would have been the level of reserves in the 1960s if the determinants of reserve had been the same as in the 1950s?"), we show that they is no clear evidence of a shortage of liquidity (compared to the 1950s) before the mid-1960s,

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[4] The relationship between money and foreign reserves is also robust to the time period chosen as we do not observe significant difference between the 1950s and the 1960s.

[5] "In most countries, foreign reserves were not anymore officially held by central banks since the 1930s but by an Exchange Stabilization Fund, which was managed by the central bank on the behalf of the Treasury.
Reserve purchases were usually financed by the funds of the Exchange Stabilization Fund but the latter could obtain loans from the central banks. Exchange Stabilization Fund were creating in the 1930s in order to keep secret the composition and precise actual level of reserves (because the balance sheet is different from the balance sheet of the central bank) and in order to disconnect as much as possible money creation from foreign reserve purchases.

later than usually thought, and that it may even not have existed at all before 1968, when SDR were finally created. Finally, our estimations confirm the view that the adjustment problem was prevalent among G10 countries (Bordo 1993): for at least 15 years, the UK maintained an overvalued currency and (too) low a level of foreign reserves, whereas West Germany and Switzerland maintained an undervalued currency and (too) high a level of reserves.

Taken together, these findings suggest that foreign reserves policy of the major central banks under Bretton Woods remained partly anchored in the framework of the classical gold standard (gold accumulation remained linked to the issuance of domestic money; gold and foreign exchange reserves were treated as imperfect substitutes) . More importantly, they also (re)expose the fundamental flaws of the Bretton Woods system and cast doubt on the view that the Bretton Woods system provided solutions to global imbalances and foreign reserves over-accumulation.

The rest of the paper is constructed as follows. We first review the debate on foreign reserves during Bretton Woods (Section 1 & 2) as well as the current literature on the determinants of reserve holding (Section 3). Then, we present our new dataset and empirical strategy (Section 4) and our empirical investigation of the holding of foreign reserves (Section 5). Finally, we discuss the consequences of our results for the study of the adjustment and liquidity problems under Bretton Woods (section 6).

I.   Bretton Woods debate on foreign reserves, from 1944 to 1958

Together with central bank cooperation, the need for foreign reserves was one of the most important topics discussed during the meetings and conferences that led to the creation of the Bretton Woods system. Even during the rather short life of the Bretton Woods system, foreign reserve policy became a central topic of international relations. The idea that the demand for foreign reserves is linked to the volume of trade emerged - and expanded - with Bretton Woods, together with the problems of "reserve adequacy" and "reserve need". After Keynes' insights, Nurske (1944) and Triffin (1947) early writings were the first to recognize the role of trade for reserve adequacy and both anticipated economic theories that became mainstream in the early 1960s. Under bimetallism and the classical gold standard, central bank reserves were held mostly in bullions (gold and silver) in order to back note issuance. Foreign exchange reserves were not

the norm although some central banks used them increasingly over the period, in particular for temporary interventions (Lindert 1969, Bordo & Eichengreen 1998, Jobst 2009, Bazot, Bordo & Monnet 2014). The reserves required to maintain convertibility were often expressed in percentage of bank notes or central bank sight liabilities, but almost never in terms of national revenue or trade (de Beaufort Wijnholds, 1977).

Interwar convertibility problems and new economic thought changed these views and practices: central banks started to accumulate some foreign currencies and influential economists - prominently Cassel and Keynes - made the case for using foreign currencies as reserves rather than specie (de Beaufort Wijnholds 1977, Cesarano 2007, p.119 et al.). In addition, following Keynes' *Treaty on Money* (1930), the idea that reserves were held for precautionary motives in order to finance temporary balance of payments deficits became more influential. Another theory of reserves was formulated by Gustav Cassel who emphasized the link between the growth of production and the need for reserves. Both Keynes and Cassel views led to the conclusions that there was a gold shortage. This was highly influential at the times of the Bretton Woods conference, when it was decided to create a fund out of which credit could be granted to member countries (in addition to national central bank reserves) in order to finance temporary balance of payments deficits. But the Bretton Woods conference did not provide a definition of reserve adequacy. Quotas at the International Monetary Fund, which set the amount a country could borrow, were not decided on the basis of an economic formula that would have reflected a theory of reserve adequacy. Instead, political considerations finally played a prominent role in this matter (Mikesell, 1994).[6] However, during the first years of the system, it became more and more common to use the ratio of reserves to imports as a way to assess reserve adequacy (Triffin 1947), and this would later become the mainstream approach at the IMF and elsewhere. As soon as the late 1940s, Robert Triffin – then at the Federal Reserve, and later at the IMF - was one of the firsts to emphasize the new role of international liquidity, mostly because his interpretation of the interwar failures focused on the transmission of British deflation to the world through trade (Triffin 1947, Maes, 2012). In his 1960 famous book, Triffin wrote:

"*Current discussions of reserve requirements stress primarily the role of reserves in the cushioning of balance of payments deficits, and rely for an approximate, and admittedly very rough, measurement of reserve adequacy on the ratio of a country's overall reserves to annual*

[6] The Keynes Plan suggested to set quotas as a proportion of a country total trade (exports + imports) but such an idea was rejected, arguably because this would have given too much weight to the United Kindgom.

imports or exchange sales. Such a concept would have been largely alien to nineteenth century writers, and did not indeed play any prominent roles in either academic policy analyses of the problem until the Second World War. [...] The main function of reserves is no longer to preserve the overall liquidity of individual central banks, but to permit the financing of short-run deficits in the country's external transactions". (p. 31-34).

In his survey of the academic debates on international liquidity during Bretton Woods, John Williamson (1973) also endorsed the view that a radical change in the theory of international reserves during the interwar was a milestone for the creation of the Bretton Woods system:

"By 1943, there was general recognition that reserves were relevant for international purposes rather than for backing the money supply, and the Keynes Plan for an International Clearing Union applied this by proposing that bancor quotas be related to the value of trade" (p.688).

The system designed at the Bretton Woods conference may have put forward a new view of international liquidity, but it did not define foreign reserves, nor did it provide a theory of the adequate level of reserve holding. Both tasks had to be undertaken in the 1950s. In 1953, on demand of the Economic and Social Council of the United Nations (ECOSOC), the IMF prepared a report on the "adequacy of monetary reserves'' in order to assess whether there was enough accessible liquidity "to protect countries from deflationary shocks of external origin and to check the international spread of depression''. (the report is reproduced in Horsefield 1969, vol. 3, p. 311 et al.). This report stated that the definitions of both foreign reserves and "adequacy'' were not straightforward:

While the concept of adequacy presents the greatest complexity, the concept of "monetary reserves" itself bristles with difficulties.

The report explained the difficulties of the IMF to build statistics of reserves for each country as there was no international definition of reserves and central banks across the world used different definitions. The report thus presented a broad definition that remained at the core of the IMF's view in subsequent years:

Viewed in this manner, the monetary reserves of a country may be defined as the assets which its authorities have available to meet payments to other countries. The nature and ownership of these funds may be quite varied. The two tests of the reserve, or near-reserve, character of any item which may be in doubt are, first, its availability to the monetary authorities of the country in case of need and, second, its acceptability by potential creditors.

So, according to IMF's definition, the reserves of official authority included *"gold and currencies readily convertible into gold held by monetary authorities[7]"* as well as other assets held by the monetary authorities *"which can perform the deficit-financing function"* (including inconvertible currencies, credit balances in bilateral or multilateral payments agreements, and debt-type securities payable in foreign currencies).

Two important elements were excluded from the definition of reserves: first, silver and precious stones (because *"they are not readily salable at an approximately predetermined price"*) and, second, conditional drawing-rights. Excluding drawing-rights from the actual definition of international reserves, the 1953 IMF report anticipated what would later be known as the distinction between conditional and unconditional reserves (Machlup 1964, 1966, Williamson 1973). Nevertheless, the IMF report acknowledged that what was not included in the definition of official reserves could affect the standard of adequacy of reserves:

> *While access to foreign exchange under predetermined conditions cannot be regarded as reserves, such rights do perform some of the functions of reserves and affect the standard of adequacy of reserves. Stand-by agreements and the provisions for drawing needed currencies from the International Monetary Fund, the right to incur debit balances with the EPU or under bilateral payments agreements, and established lines of credit against which a foreign currency may be drawn all provide means of meeting balance of payments deficits.*

As a conclusion, the 1953 IMF report stated that:

> *the adequacy of reserves is a matter of judgment— depending on the country, on the time, and on the purpose for which the reserves are intended.*

Despite such a relativist tone, the IMF attempted to quantify the adequacy of reserves using a ratio of reserves to imports since the buffer should be proportional to the volume of transactions (the denominator was "imports'' rather than "exports + imports'' because the series of exports were unreliable in some countries). In other words, the IMF restated the view expressed at the 1944 Bretton Woods conference on the role of international reserves, which also justified the use of the ratio of reserves to imports to assess the adequacy of reserves:

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[7] However: *"As stated previously, no comprehensive data are available separating foreign exchange reserves into those held in convertible and in inconvertible currencies."*

A function of reserves upon which considerable emphasis was placed in the planning for the postwar period is that of preventing the spread of depression from one country to another[…]One of the principal purposes of the International Monetary Fund is to combat this mechanism for the international spread of depressions. The amount of reserves necessary to prevent the spread of a depression depends upon the duration and intensity of the depression in the country of primary origin and the importance of that country in world trade.[8]

To sum up, the 1953 IMF report became a milestone for postwar international reserves policy, for at least three reasons. First, it explained clearly the definition of official reserves used by the IMF for the statistics published in *International Financial Statistics*. Statistics were retropolated such that the IMF volumes offered comparable statistics from at least 1950. These are the statistics we will use in this paper. Second, the conclusion that the adequacy of reserves was a matter of judgment remained the official position of the IMF during the era Bretton Woods (even when the IMF would recognize in 1967-1969 that they may have been inadequacy of reserves starting 1964-1965). Third, the ratio of reserves to imports remained the main and mostly used criteria of reserves adequacy under Bretton Woods.

All these principles were restated in a more comprehensive study by the IMF on the same topic published in 1958 (Horsefield 1969):

It is therefore natural that in the first place reserves should be compared with a country's trade figures. […] To relate the reserve position to the volume of foreign trade is no doubt a useful method of approach, but it can give at best only a preliminary indication of adequacy.

Although the ratio of reserves to imports remained the main indicator used by the IMF[9], the debate on the definition of reserves experienced a new birth in academic and policy circles in the early 1960s.

II. The debate on reserves during the 1960s and the first econometric estimations

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[8] However, the IMF recognized that reserves would be insufficient to face a great international depression of total world trade, as in the 1930s, without implementing exchange controls. Anticipating the formulation of the so-called Triffin dilemma, the report also discussed the huge cost that would represent a US deflation on the world economy.
[9] Williamson (1973) writes that ''by 1960, it [reserves/imports ratio] was regarded as the standard approach to the subject.''

The rebirth of the debate on foreign reserves was motivated by the problems experienced by the Bretton Woods system at the turn of the 1960s, as well as by new economic theory and econometric methods.[10] It is impossible to sum up all the literature on foreign reserves that burgeoned in the 1960s. In fact academic research has already been surveyed in comprehensive studies such as Grubel (1971), Williamson (1973) Cohen (1975) and de Beaufort Wijnholds (1977). At the general level, we can distinguish the following novelties of the 1960s on the foreign reserves issue:

1. The volume of trade was not the only variable used to assess the adequacy of reserves anymore. The ratio of reserves to the money supply started to be used as an alternative.

2. Developments in economic theory and in econometrics pushed economists to build and estimate functions of demand of foreign reserves. Rather than looking at ratios and assessing their deviations from historical average, economists started to investigate the determinants of the accumulation of foreign reserves.

3. The idea that the world was suffering from a liquidity shortage (or reserve inadequacy) became increasingly popular. This was mainly due to the decrease of the ratio of reserves to trade in most industrialized countries during the 1960s.

II.1. Money and other factors of reserves accumulation

Although the ratio of reserves to imports remained the most widely used indicator during the 1960s, some authors, such as Fritz Machlup, proposed to use the ratio of reserves to the money supply (Machlup 1966). Machlup remained however skeptical towards the use of any ratio and believed that the accumulation of reserves was not driven by rational motives. Machlup's rationale for using the ratio of reserves to money supply was admittedly in reference to the old view on reserves, during the gold standard, when central banks must back their note issuance by metallic reserves. But Machlup did not believe that what was true for the money printed by the central bank would be true for the total money supply including bank deposits. However, some people were less reluctant than Machlup to endorse an extension of the "old" (gold standard) theory of reserves. The Nederlandsche Bank, under the leadership of M.W Holtrop in the 1950s,

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[10] France devalued in 1959, Germany revalued in 1961, UK experienced a permanent balance of payments deficit, the US started to run a balance of payments deficit and central banks had to cooperate through swaps and the London gold pool in order to maintain the dollar-gold parity; cf Bordo 1993 and James 1996 for a survey.

had developed such an approach (Holtrop 1957, 1963), which later became more influential. The Dutch argument exceeded the old gold standard view on the need for monetary reserves and stated that money needed to be mobilized in order to buy foreign reserves and import goods. In the words of de Beaufort Wijnholds (1977, p.46): "this implies that an increase in domestic liquidity assets necessitates an enlargement of the monetary reserves and, conversely, that a decrease in domestic liquid assets permits a reduction of reserves''.

A more elaborate argument about the importance of the money supply for foreign reserves was developed in the late 1950s by Tibor Scitoswky (1958) and Harry Johnson (1958), as a part of what would later be known as the "monetary theory of the balance of payments". According to Scitowksy and Johnson, a reduction in reserves is equivalent to an excess of aggregate demand over aggregate supply. Such an excess spending leads to a reduction of cash balances; reserve losses and balance of payments deficits are the two faces of a same coin. As a consequence, the international reserves of a country should be such that domestic agents can have enough available liquidity to move cash into commodities or assets without provoking a reserve crisis. The monetary theory of the balance of payments thus draws an analogy between the holding of international reserves by monetary authorities and the holding of domestic reserves by commercial banks.

II.2.Econometrics estimations of the holding of foreign reserves

In the early 1960s, the literature on the adequacy of reserves based on the observation of ratios was unsuccessful and had not reached a consensus, despite Triffin (1960)'s strong statement on the shortage of international liquidity. The value of the ratios of reserves to trade, or reserves to money, had changed too much overtime and, as a consequence, could not provide a useful normative benchmark. One option was to follow the IMF position, stating that the level of reserves was a "matter of judgment" while still paying attention to ratios in order to observe countries' potential short-term difficulties (IMF, 1970). One more radical option was to conclude with Fritz Machlup that no theory could explain the need to hold foreign reserves, and that reserves were not held for a purpose.[11]

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[11] Machlup (1964, 1966) compared the need for reserves of a country to the need of his wife for dresses: a country always wants more reserves, especially to keep up with the Joneses. This analogy (known as the "Ms Machlup's

But a new strand of literature came to challenge the skeptical view. It was mostly motivated by the development of econometrics tools. New theories (such as in Kenen and Yudin 1965) also favored such developments. As stated by Grubel (1971) in his survey of these studies, they were "based on the principle that observed holdings of reserves reveal demand, and that the fundamental task of the econometrician is to find and measure determinants of this demand.''

It is remarkable that this principle and the underlying method are still the same in today's studies of the holding of foreign reserves (see below) as in these studies that began around 1965. However, the limited econometric methods and computer power of the times make these studies look like inconclusive and spurious. Most of them focused on a very narrow sample of countries or a short time span. None of them covered more than 10 years of the functioning of the Bretton Woods system. The very few that explored the time series dimension of data rather than cross-section did not use fixed-effect panel data estimations but estimate the value of the coefficients for each country (that is with less than 20 observations when quarterly data was used, as in Courchene and Youssef 1967). Finally, estimations were spurious because all these studies used the level of reserves (in nominal values) as independent variables.

This field of research produced numerous papers but the investigated period evolved over time and, after the end of Bretton Woods, papers stopped to include Bretton Woods years in their estimation sample. To our best knowledge, the last paper that covered some years of Bretton Woods (1963-1972) in his cross-country sample was Frenkel (1978). Twenty years later, Bordo and Eichengreen (1998) also included Bretton Woods in their study of the holding of gold reserves spanning more than a century. These two studies found that the volume of trade was positively correlated with international reserves but they suffered from the same misspecifications as previous studies since the dependent variable was the nominal level of reserves. Moreover, they did not test for the effect of financial depth (see section 3, below)[12].

The main result of the numerous studies on the demand of reserves under the Bretton Woods system was that trade and reserves were indeed positively correlated. The effect of the propensity to import (measured as imports to GDP) was less clear according to Kelly (1970).

wardrobe theory"; see for Cheung and Qian, 2009, for a recent assessment) became widely used in academia and among policy circles (from which women were absent).

[12] Bordo and Eichengreen (1998) studied a sample of 11 countries with annual data. They explain both the nominal level of total reserves and of gold reserves. They include the volatility of M0 as an explanatory variable but did not look at the effects of the size of the banking or financial sector, measured as M2 over GDP (see the discussion in section 3).

Only few studies brought insights on other factors. The influential work by Kenen & Yudin (1965) highlighted the role of past instability of the balance of payments (measured as the mean of the residual of an autoregressive estimation of the level of reserves). Heller (1966) introduced a theory of the demand for reserves as a tradeoff between the benefits of reserves and the opportunity cost of holding them. But, since then, empirical studies have been unable to provide a good measure of this opportunity cost as explained in Obstfeld et al. (2010). Surprisingly, the only paper to investigate the influence of the money supply on the level of reserves was Courchene and Youssef (1967). Despite the positive results reported in this paper, the role of money for the demand of international reserves was not recognized in subsequent literature. In his 1973 celebrated survey, Williamson did not build on Courchene and Youssef (1967) but relied on Machlup (1966) to conclude that:

> *Johnson argued that, on welfare grounds, reserves should be large relative to the money supply so as to permit the public to execute a desired shift out of money into goods without obliging the authorities to intervene to prevent a payments crisis, which would frustrate the public's profit- and utility-maximising decisions. The difficulty with the argument is that the object of demand-management policy is precisely that of frustrating the desires of the public to shift between money and goods, with their inevitable consequence of destabilising income. **It is of course possible that countries may actually determine their reserve holdings with reference to their money supplies even if this is an irrational act based on traditional superstitions, but there is no persuasive evidence that they do.*** (Williamson, 1973, p.689 ; we underline)

II.3. The liquidity problem

The number of studies on the demand of foreign reserves had grown rapidly in the 1960s as the debates on the "liquidity problem" of the Bretton Woods system became more active. Triffin (1960) was the leading economist claiming that the amount of reserves was inadequate. Based on his analysis of reserves-to-imports ratios, Triffin argued that there was a shortage of gold reserves that could not be made up by the IMF but by the United States via its balance of payments deficit. An increase in the US deficit would nevertheless create a confidence problem in the dollar that would undermine the foundation of the Bretton Woods system. This reasoning came to be known as the *Triffin dilemma*.

As previously argued, there was no consensus on a liquidity shortage (Machlup, 1966) but the decrease of the ratio of reserves to imports during the 1960s raised doubts on the ability of the system to provide countries with enough reserves. A group of ten countries formed the G10

in 1961 in order to address these issues. The G10 became the political center of the Bretton Woods system where reform proposals were discussed. Three types of solutions to the liquidity problem were proposed and implemented by the G10 (Bordo, 1993, James 1996, Monnet 2012): expanding the Fund's resources (50% increase in members' quotas in 1960, 25% increase in 1966 ; creation of the General Agreement to Borrow in 1961) ; creating new resources outside the Fund (network of swaps, cf. Bordo, Humpage & Schwartz 2015); and creating a new type of reserve asset, the special drawing right (SDR) in 1967 (implemented in 1969).

III.   The new view on foreign reserve holding

It is fair to say that the interest in the demand for foreign reserves under the Bretton Woods system quickly decreased after 1973. More recently, because of the surge of foreign reserves held by central banks in emerging markets, the Bretton Woods system has experienced a modest renewed interest in the literature on foreign reserves. This literature does not rely on new studies on the Bretton Woods system. Instead it uses the Bretton Woods period (viewed as times of purely trade-based accumulation of reserves when capital controls were prevalent) as a reference in order to assess what has changed with the globalization of financial markets. This recent literature highlights the role of both financial openness and the size of the banking sector, in addition to trade and mercantilist motives, for explaining the demand for foreign reserves in the post Bretton Woods period (Burke-Lane 2001, Ainzenman 2005, Rodrik 2006, Obstfled, Shambaugh & Taylor 2010). A key argument of this new strand of literature is that the motives and objectives of reserves accumulation have changed fundamentally because of financial globalization, and thus differ from those of the Bretton Woods period. In contrast to current concerns about sudden stops and preference for precautionary accumulation, Obstfled, Shambaugh & Taylor (2010) view reserve accumulation under Bretton Woods as "trade-based" and state that "the collapse of the Bretton Woods regime after 1973 shifted the ground under the arguments about reserve holdings." In the same line of reasoning, Dany Rodrik (2006) writes that "prior to the era of financial globalization, countries held reserves mainly to manage foreign exchange demand and supply arising from current account transactions" whereas financial globalization forces central banks to hold more reserves, which is costly for their economies. The political consequences of the comparisons between the current period and Bretton Woods are

important. Either it follows that because of financial liberalization countries need to hold more reserves than before (Obstfeld et al., 2010), or it follows that capital controls should be imposed (Rodrik 2006) in order to reduce the amount of foreign reserves which are costly to hold.

In Obstfeld et al. (2009, 2010), the authors find a correlation between the ratio of money to GDP (a proxy of financial depth) and the ratio of reserves to GDP and build a model to show how foreign reserves are to be used to avoid a "double drain effect". Whereas most of the literature on reserves had focused on "sudden stops" (exports of home assets to foreigners suddenly stops), they recall that the reverse can happen: import of foreign assets by domestic residents suddenly starts. In the latter case, capital flight from the home country is financed through withdrawal of domestic bank deposits (i.e from a decrease in M2). Hence, if monetary authorities are willing to maintain financial stability, they must internalize the potential cost of capital flight. As a result, Obstfeld et al. view "M2, the quasi-liquid deposits of the banking system, as the best proxy for the potential pressure on reserves resulting from a flight out of the domestic banking system" (p.65). Conversely, according to the authors, such a mechanism would not have mattered during the Bretton Woods system, when capital controls were imposed (or could be imposed at any time).[13]

IV. New estimations of the demand for foreign reserves under Bretton Woods

Our survey of the literature on the holding of international reserves from Bretton Woods to present has suggested straightforward questions and econometric tests.

First, whether there was relation between the ratio of money to GDP and the ratio of foreign reserve to GDP before 1971 remained an open question. If we follow Obstfeld et al. (2009, 2010), we should not expect a positive correlation between these two variables under Bretton Woods because of capital controls that prevented the risk of "double drain". Other reasons to believe in such a positive relationship during Bretton Woods were ruled out by Williamson (1973) as, according to him, it would have implied that central banks' policy after WWII was "an irrational act based on traditional superstitions" following the practices of the gold standard. On the contrary, central bankers' narratives, such as Holtrop (1957)'s, as well as the monetary

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[13] Note that Obstfeld, Taylor and Shambaugh (2009, 2010)'s argument is actually close to the Holtrop-Scitowsky-Johnson's thesis, except that the latter considered that the flight out of the domestic banking system could also arise for the purpose of buying commodities.

theory of the balance of payments – developed during Bretton Woods – suggest that money mattered for international reserve holding.

Second, an issue missing in the econometric literature on reserve holding under Bretton Woods (and that disappeared thereafter) was the distinction between gold and foreign exchange reserve. This was however an issue at the core of the discussions on the viability of the Bretton Woods system. Triffin (1960) and many others argued that the gold-dollar parity undermined the system because it imposed too much constraint on US domestic policy. On the contrary, Despres, Kindleberger and Salant (1966) and McKinnon (1969, 1993) argued that the system was functioning as a dollar standard and that the link to gold was not a constraint for the system. Bordo (1993) and Williamson (1993) state that the Bretton Woods system became a *de facto* dollar standard in 1968 when a two-tier gold market was implemented. But they also emphasize the confidence problem in the dollar that occurred before. The connection between gold and dollar especially became an important issue in the 1960s when several central banks threatened to convert dollar in gold and when much international efforts were devoted to maintain the gold-dollar parity. Mundell (1968, chp.20) built a theory of signaling where conversion of dollar into gold by European countries aimed at pushing the United States to restrict monetary expansion so as to restore its reserve ratio. For Fritz Machlup, the composition of reserves, as well as their level (as explained previously), was only a matter of political considerations.[14] In reaction to this line of reasoning, many studies, starting with Kenen (1960) and surveyed in Williamson (1973), were devoted to discussions and empirical tests of a portfolio theory of the composition of reserves. Some of them acknowledged that central banks faced a fundamental dilemma between avoiding the collapse of the system (cooperation) and maintaining the rational choices of the portfolio theory (Officer and Willett 1969, Makin 1971). But none of these studies attempted to estimate separately functions of gold reserve holding and functions of foreign exchange holdings. A very empirical question is whether countries treated gold and dollar as substitutes. We do not attempt to assess the rationality of the composition of reserves but to look at whether the holding of gold and the holding of foreign exchange reserves had similar determinants.

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[14] "Official dollar holdings, on the other hand, are determined largely by political considerations. The central bank of a large industrial country does not look in the first place at the alternative costs and earnings of his asset mix, but rather on the advantages or necessities of international financial cooperation or noncooperation." (F. Machlup quoted in Makin, 1971)

Third, an econometric model of the holding of international reserves can also provide insights on the issues of liquidity and adjustment. Knowing the determinants of reserve holding in the 1950s, we can predict what should have been the level of reserves in the 1960s, and check whether the actual level was below the predicted level. Regarding the adjustment problem, we can check whether some countries persistently under-accumulated or over-accumulated reserves compared to what the estimated model would predict.

IV.1. Specifications and variables

As in all the econometric literature on reserve holding, we cannot distinguish exactly between passive and active demand of reserves. Central banks (or Exchange Stabilization Fund) accumulate reserves both because of automatic balance of payments mechanisms and because of policy choices. The underlying assumption of the literature (Grubel 1971, Cohen 1975, Rdrik 2006, Obstfeld et al. 2010), however, is that - at least in the medium or long run - the level of reserve holding is a policy choice: central banks or governments can always affect the level of reserves that they have accumulated because of short-term movements in the balance of payments. There is always a tradeoff in holding foreign reserves because they are costly but precautionary (Rodrik 2006).

Hence, we follow the standard method of Lane and Burke (2001) and Obstfeld et al. (2010), among others, to estimate the determinants of the demand for foreign reserves:

$$log(RES_i/GDP_i) = \alpha + \beta Z_i + u_i$$

where *RES_i* is the level of reserves and *Z_i* is a set of variables influencing the level of reserves to GDP. Using logarithms and ratios avoid the problems of non-stationarity and spurious correlations that characterized estimations of the demand for reserves in the 1960s and 1970s. It also accounts for the well-documented link between the level of reserves and national income. Cross-country and time fixed effects can be included in the model, as in Obstfeld et al. (2010).

Zi include the logarithm of trade (imports + exports) to GDP[15], as well as the logarithm of money to GDP in order to test whether, despite capital controls, the accumulation of reserves under the

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[15] Our conclusions are the same if we use the ratio of imports to GDP.

Bretton Woods system was correlated to the money supply. We will use different definitions of the money supply (M0, M1, M2), depending on data availability, in order to examine whether such a correlation is driven by a specific money aggregate. The other explanatory variables included in *Zi* depend on whether we are working with the quarterly panel of 10 countries of with the annual panel of 55 countries (see below).

IV.2.   Panel of G10 countries (quarterly data)

We introduce several other variables in the estimations in order to control for other potential determinants of the demand for reserves used in the literature.

First, we use the difference between the official exchange rate and the black market exchange rate in New York.[16] This parallel market premium controls for persistent real exchange rate misalignment. If the premium is positive, the exchange rate is overvalued and devaluation is expected. On the contrary, a negative premium emphasizes undervaluation of the exchange rate. Such an undervaluation can be motivated by mercantilist purposes: the exchange rate is kept undervalued to promote exports. Aizenman and Lee (2008) among others have interpreted a high level of international reserves as an evidence of monetary mercantilism.

Second, we provide a measure of financial openness based on US claims on each other country. We obtain the liabilities to the US for each of our sample countries from IFS publications and we divide this number by the GDP of the country in order to measure financial openness. In IFS, "US Claims on foreigners include deposits, loans, collections outstanding, and other items held by banks for their own account or for customers' accounts". Although this measures financial openness to the US only, we view this variable as the best available proxy for the potential threat of foreign capital flight. The literature on the demand for reserves usually uses dummy variables (such as the index by Edwards 2007, Quinn and Toyoda 2008 or Chinn & Ito 2008; cf Obstfeld et al. 2010). But for our purpose, such indices would be inappropriate because they feature too little time variation and they are only annual. The Quinn and Toyoda index will be used however in the next section in a panel of annual data. The problem with our measure of financial openness (US claims) is that data are not available before 1959 for most countries (because capital accounts were strictly controlled before).

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[16] Data is from Reinhart and Rogoff (2004). The monthly black market exchange rate in New York was available in Pick's Currency Yearbook.

Third, we control for the free floating period of Canada (September 1950 to May 1962) using a dummy variable that equals 0 when the Canadian $ was pegged to the US $ and 1 otherwise. No other G10 country let its exchange rate float during the period under study.

Fourth, we control for a measure of (past) volatility of the exchange rate. Since, parity were fixed during most of the periods, we use the moving volatility over the previous 8 quarters as an indicator of the pressures faced by a country on the exchange market. Other variables used in the literature are the volatility of reserves or of exports in order to account for similar effects of payments volatility (Kenen & Yudin 1965, Grubel 1971, Lane & Burke 2001). The results reported below are robust to the use of these alternative measures in the estimations.

IV.2.1. Data

Definition of foreign reserves

We use the level of international reserves published in IFS (*International Financial Statistics*) monthly and quarterly bulletins. Described previously, the IMF definition includes gross gold and foreign exchange reserves of monetary authorities (either the central bank or an exchange stabilization fund belonging to the Treasury, or both, depending on the country and to the extent that they perform similar monetary functions), excludes silver or precious stones that would not be salable at a predetermined price, and includes only unconditional reserves (that is it includes only used stand-by facilities at the IMF or EPU, rather than conditional drawing rights that are not exercised). Reserve Positions in the Fund are unconditional assets that arise from countries' Gold Subscriptions to the Fund and from the Fund's use of their currencies to finance the drawings of others or to purchase gold. Starting 1969, reserves include SDRs which are unconditional international reserve assets created by the IMF to meet the need for an appropriate level of world liquidity. In general, foreign exchange is defined in IFS as holdings by monetary authorities of bank deposits, Treasury bills, short and long-term government securities, and other usable claims when denominated in convertible currency, including nonmarketable claims arising from inter-central bank (typically swaps, cf. Bordo, Humpage, Schwartz 2015) and inter-governmental arrangements between convertible currency countries, without regard to whether the claim is denominated in the currency of the debtor or the creditor.

Foreign exchange reserves are not net, nor of IMF position neither of EPU position. The European Payments Union (EPU) first became effective on July 1, 1950 and terminated in December 1958. The EPU provided automatic facilities for extending credit to debtor countries and created for creditor countries an international asset reserve that could be used to cover deficits arising from current transactions within the EPU system. With the liquidation of the EPU, the excess of member's claims on EPU over their liabilities was settled by gold and dollar payments to creditors. Remaining claims and liabilities were converted into bilateral claims and included in the reserve positions of creditor countries in IFS, but were not deducted from reserves of debtors because IFS reserves are measured gross, and not net of liabilities.

Definition of the money supply

Money comprises the monetary liabilities of the central bank to the private sector (Notes and coins in circulation), Treasury coin in circulation outside banks, and private sector holdings of sight deposits with deposits money banks and post office. This IMF definition is similar to the definition of M1. Time deposits were not included. Except the notes and coins in circulation, it does not include the other components of the money base, that is notes, coins and gold in central bank vaults and required reserves at the central bank. This series does not distinguish between resident and non-resident money.

Except for Japan and the United Kingdom, where the series start in 1954 and 1959 respectively (in the UK, monetary statistics were not available before the Radcliffe report), we have complete series of this variable over the period.

Quarterly GDP

In order to exploit the time series dimension of the data (within a country), we use quarterly data. All data on reserves, money, trade and finance are available quarterly in the IFS bulletins, but GDP figures are available at the annual frequency only. Only US and France have official quarterly statistics over the period. So we construct quarterly GDP series interpolating the annual GDP with the Denton-Cholette method, using the industrial production index as the indicator. With such a method, quarterly data follow the pattern of the industrial production index and the sum of the value of GDP in the 4 quarters equals the annual figure. Annual series are from the Penn World Table (nominal GDP); quarterly production indices are from the IFS bulletins

(checked with official monthly statistics published by each country if available). To scale foreign reserves (always expressed in US $), we convert the nominal GDP figures in US $ using the official exchange rate.

Data are not seasonally adjusted; instead, quarterly dummy variables (or time fixed effects) are used in the regressions.

When comparing our (seasonally adjusted) interpolated quarterly GDP series to the official (seasonally adjusted) quarterly GDP for France (one of the 2 only countries, together with the US, for which quarterly GDP is published as soon as 1950), we find that the series are very close: the correlation between the variation of the series is 0.98. If we use a quadratically interpolated GDP, the correlation with official statistics would be 0.86 only. For further details on the links between industrial production and GDP over the period, see Monnet and Puy (2015).

The sample starts in 1950 because data are not reliable and comprehensive enough before. Thus, the period under study excludes the 1948-1949 troubles in most countries (hyperinflation, exchange rate crises) that ended with more than 30 devaluations in September 1949.

IV.2.2. Country coverage

For historical reasons as well as because of data availability, we focus – with a quarterly analysis – on the following 10 advanced economies known as the Group of Ten (G10) under Bretton Woods: the United States, the United Kingdom, France, Germany, Japan, Belgium, Canada, the Netherlands, Italy and Switzerland. Sweden also belonged to the G10 (which actually included 11 countries…) but is excluded of this analysis because we were not able to gather a sufficient amount of data for this country.

The G10 started in 1962 when a group of countries agreed to participate in the General Arrangements to Borrow (GAB) and was strengthened in 1964 by the association of Switzerland, then a nonmember of the IMF. Then the G10 became the leading forum for discussing international monetary policy matters. It published reports on the problems of reserves and on the need for reserve assets that led to the creation of the Special Drawing Right (SDR) in 1969 and became the forum for discussions that led to the December 1971 Smithsonian Agreement following the collapse of the Bretton Woods system.

These countries were the most important in terms of reserves and international liquidity management. Our 10 countries share of (noncommunist) world trade was 55% at the beginning of the period and kept growing over the period up to 70% (the US share of world trade declined slightly) as seen on Figure 1. The G10 share of (noncommunist) world reserves remained almost constant over the period, at 70% (Figure 1), but declined quickly after 1968 as several countries (France, UK) experienced severe currency crises, and as non-G10 countries started to accumulate more because of the Gold crisis of the spring 1968. As seen on Figure 2, the G10 decomposition of reserve holding is roughly similar to the one of the 55 countries that we will study later on (and which held around 90% of total world reserves over the period), although the G10 held more gold (and 85% of the official world gold stock on average).

Figure 1 G10 share of world trade and share of world reserves
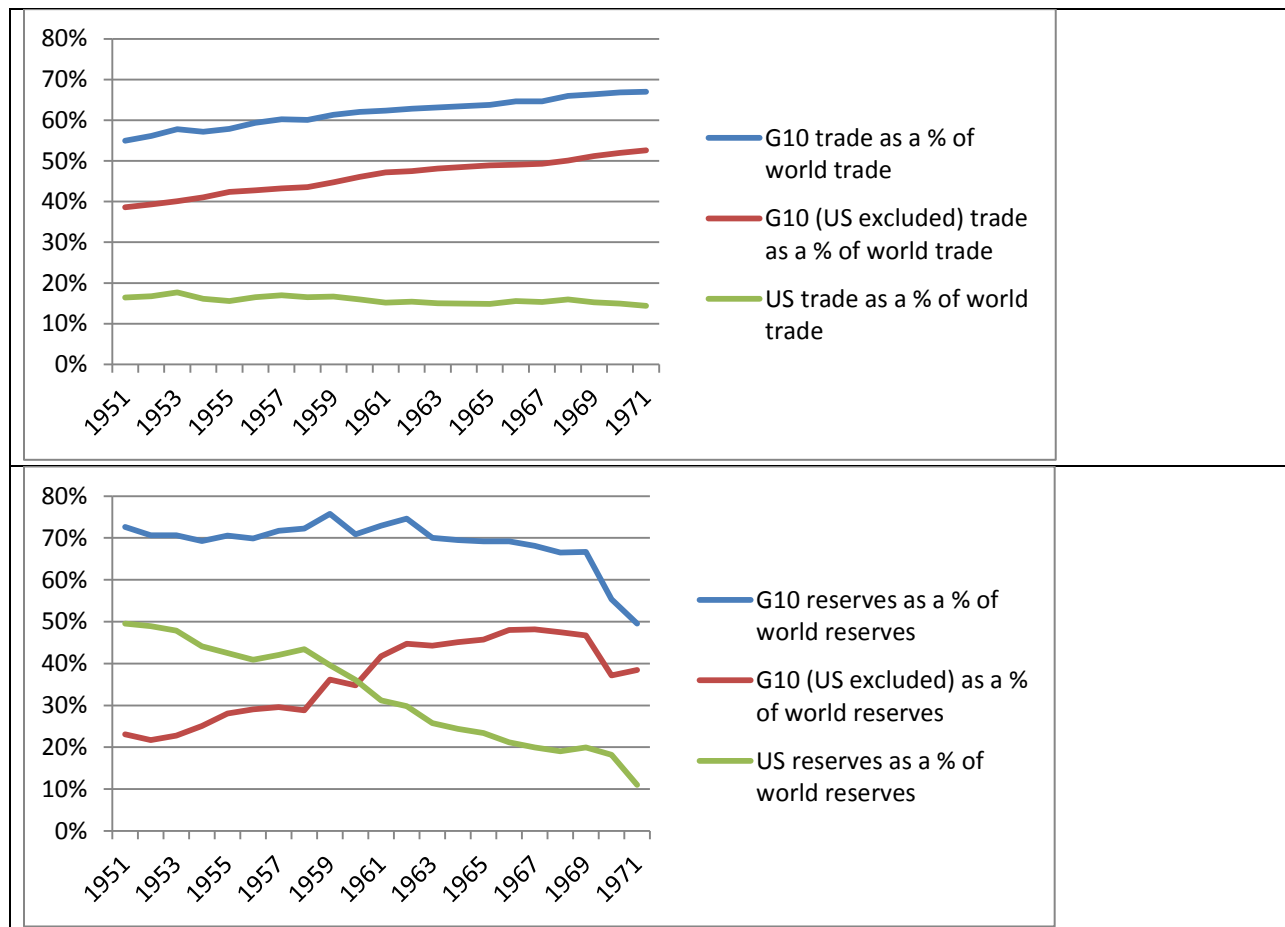
Figure 2 Decomposition of G10 reserves vs. decomposition of world reserves (55 countries)

International reserves of G10 countries (in billion of $), 1950 Q1 - 1971 Q3

Creation of the
Gold Pool

Two-tier
gold market

Total Gold reserves
US Gold reserve
Total Foreign exchange reserves
Other reserves (position at the Fund, SDR)

International reserves (sample of 55 countries), in billion of $

Total Gold reserves
US Gold reserve
Total reserves minus gold

22
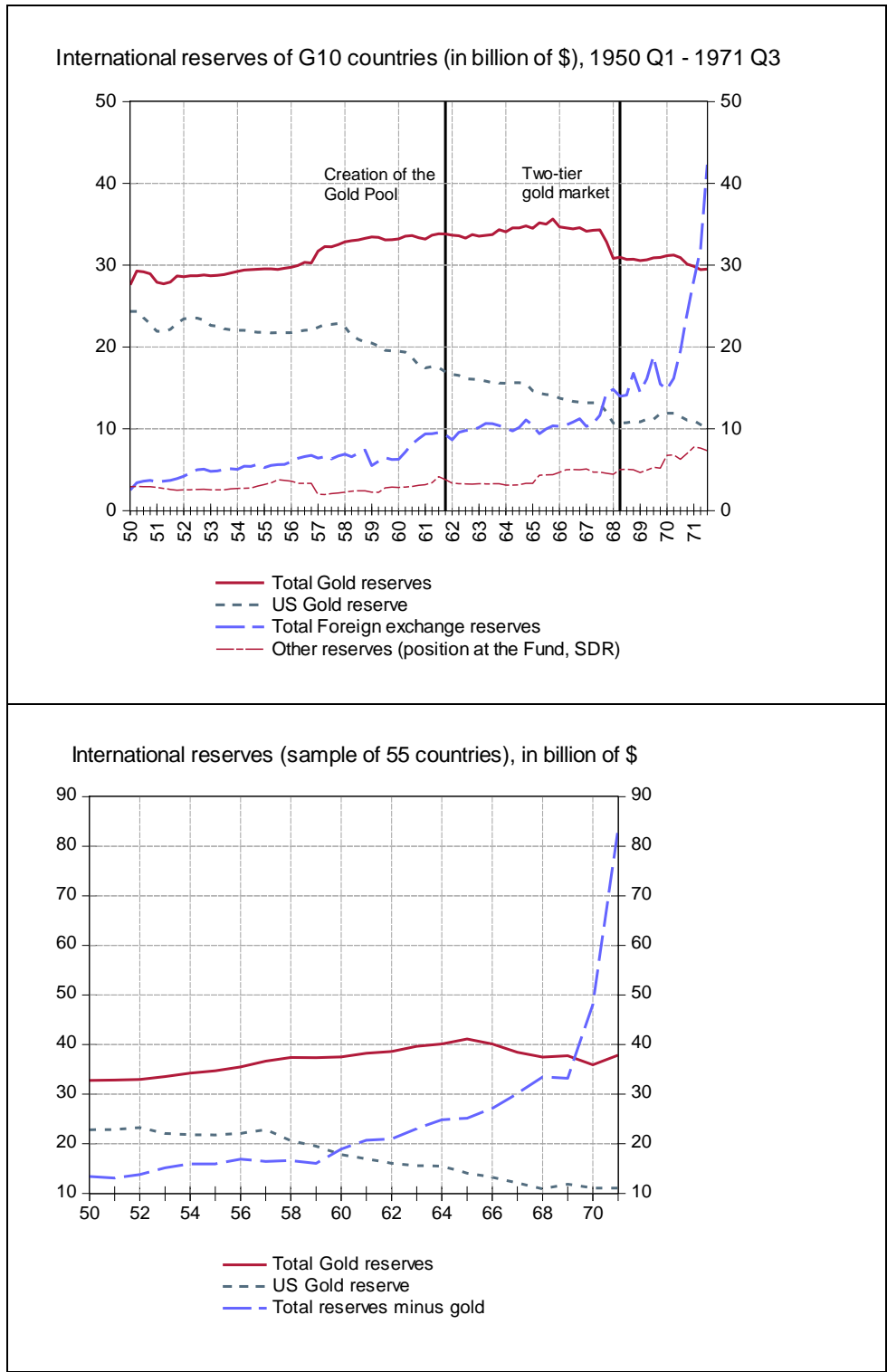
IV.2.3. Descriptive statistics (reserves/trade, reserves/GDP, reserves/money)

The opposition between the increase in the G10 world share of trade and the stability or decrease in the G10 world share of reserves suggest that, at least in the 1960s (as noted by Triffin (1960), among others), the ratio of reserves to imports decreased in the G10 countries. As shown on Figure 3, this was true overall but not for every country, and the decrease in the ratio did not take place in each country according to the same timing. The magnitude of the fall in the reserves to money ratio was much less pronounced (Figure 4) because the increase of money was less important than the increase in trade. Figures 3& 4 show that the variations in the ratio of reserves to trade and the ratio of reserves to money were substantial, both within a country overtime and between countries. Within a country, the ratio of reserves to imports usually varied between 20 and 80% overtime (between 60% and 170% for Switzerland which was an exception, besides the US). It implies that both the time and cross-country dimension of the demand for reserves are important to investigate.

Figure 3 Ratio of reserves to imports (in %)

23
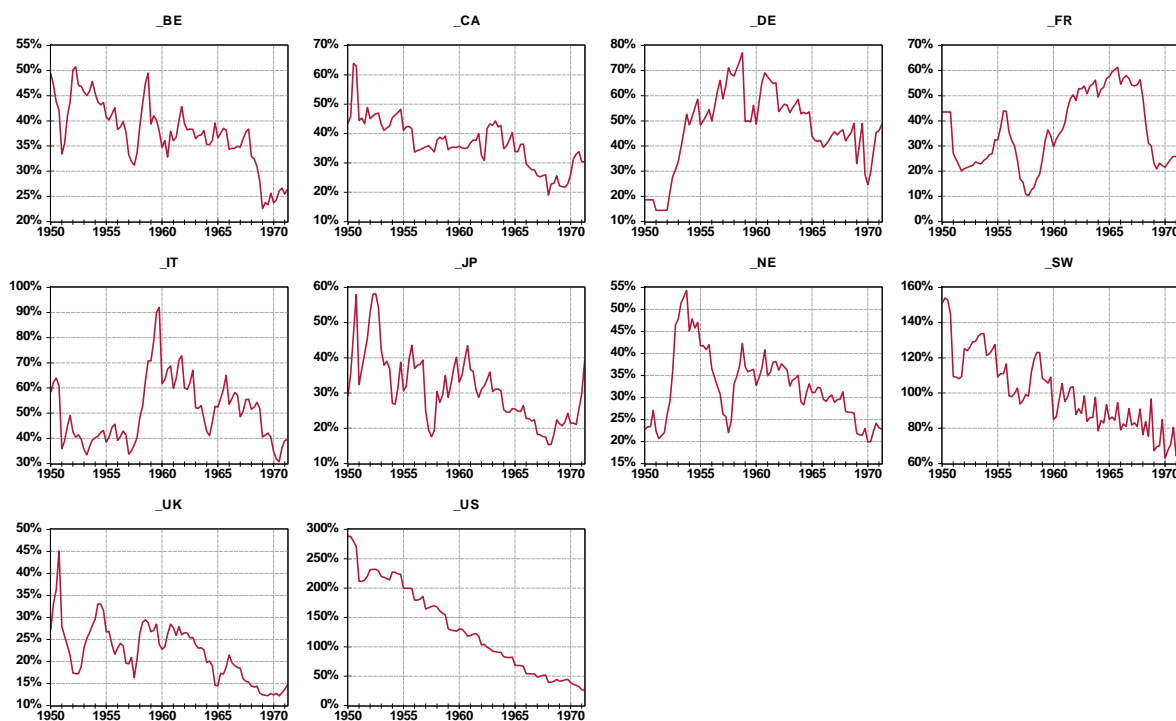
Figure 4 Ratio of foreign reserves to money (in %)
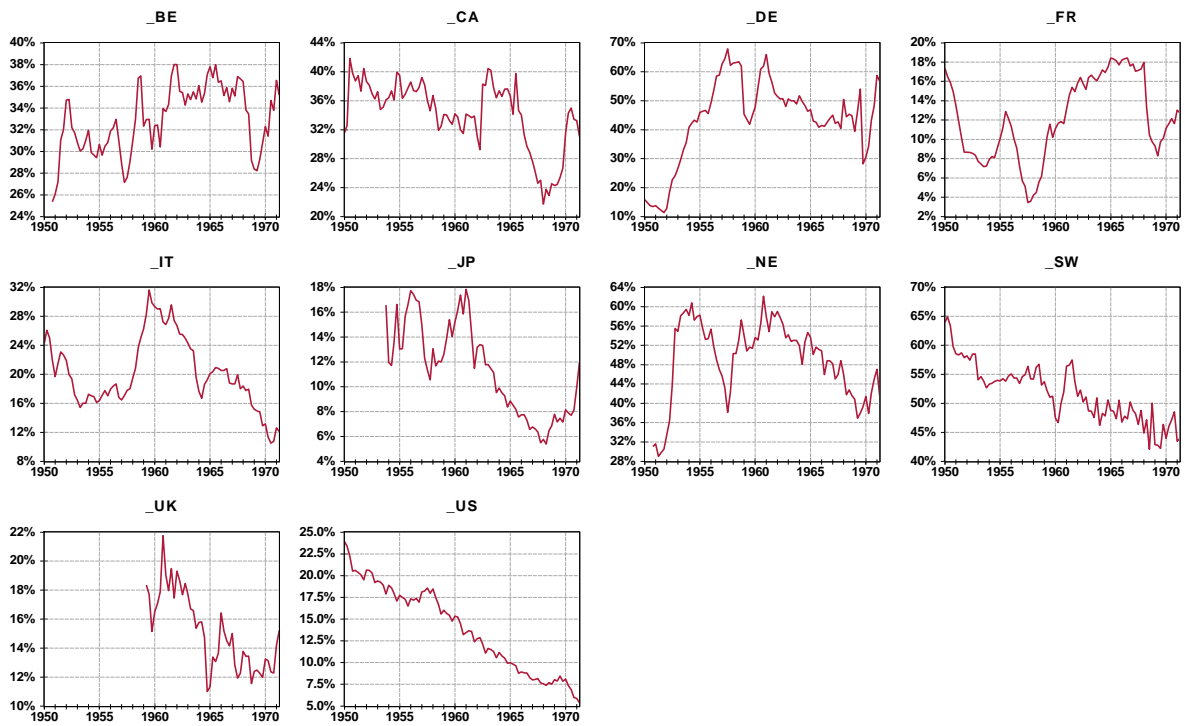
Figure 5 Ratio of reserves to GDP (%)

25
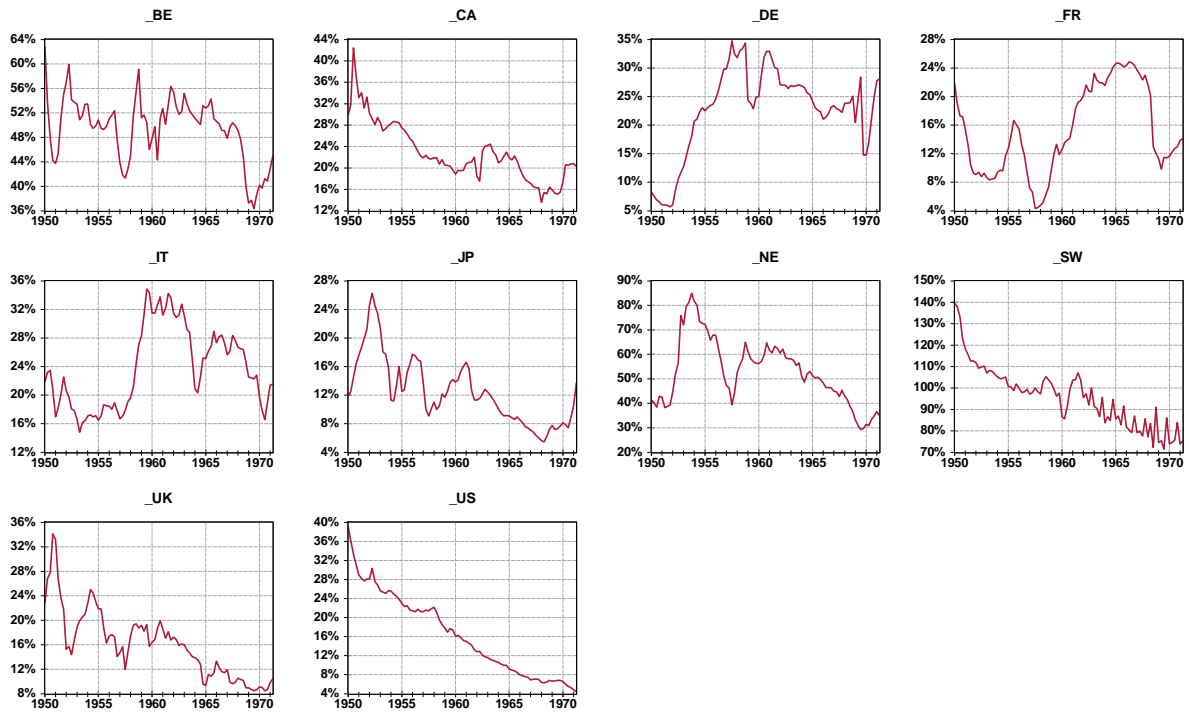
Figure 6 Trade to GDP (%)
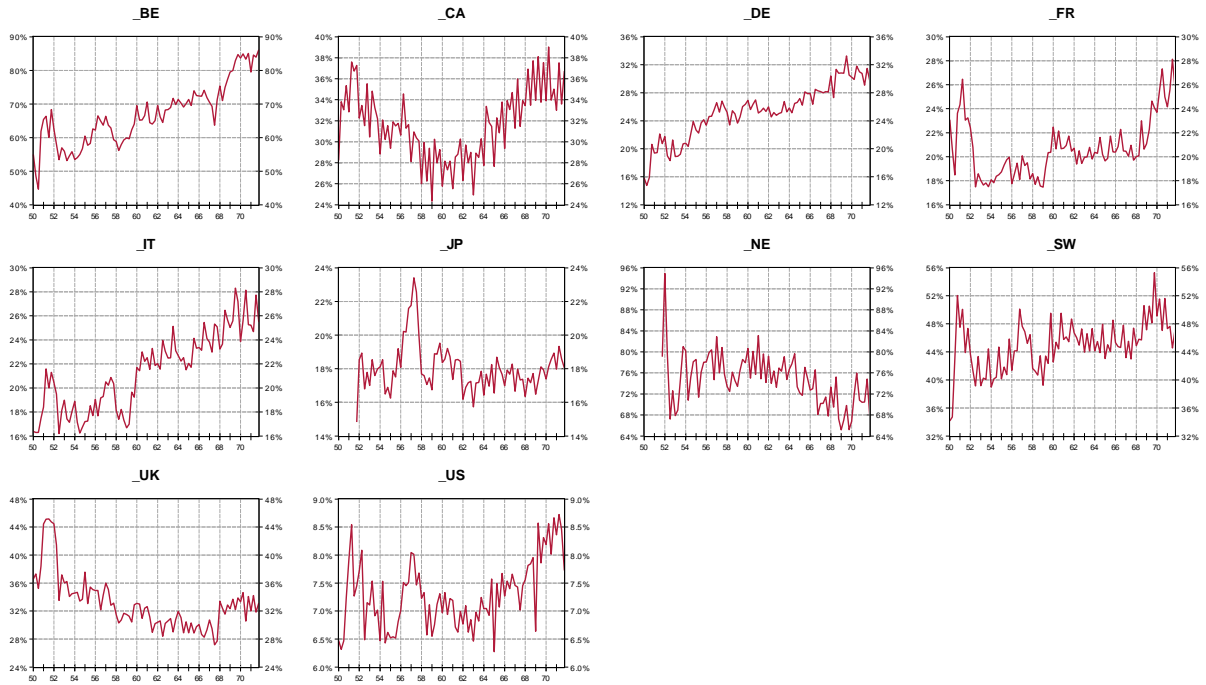
Figure 7 Money to GDP (%)
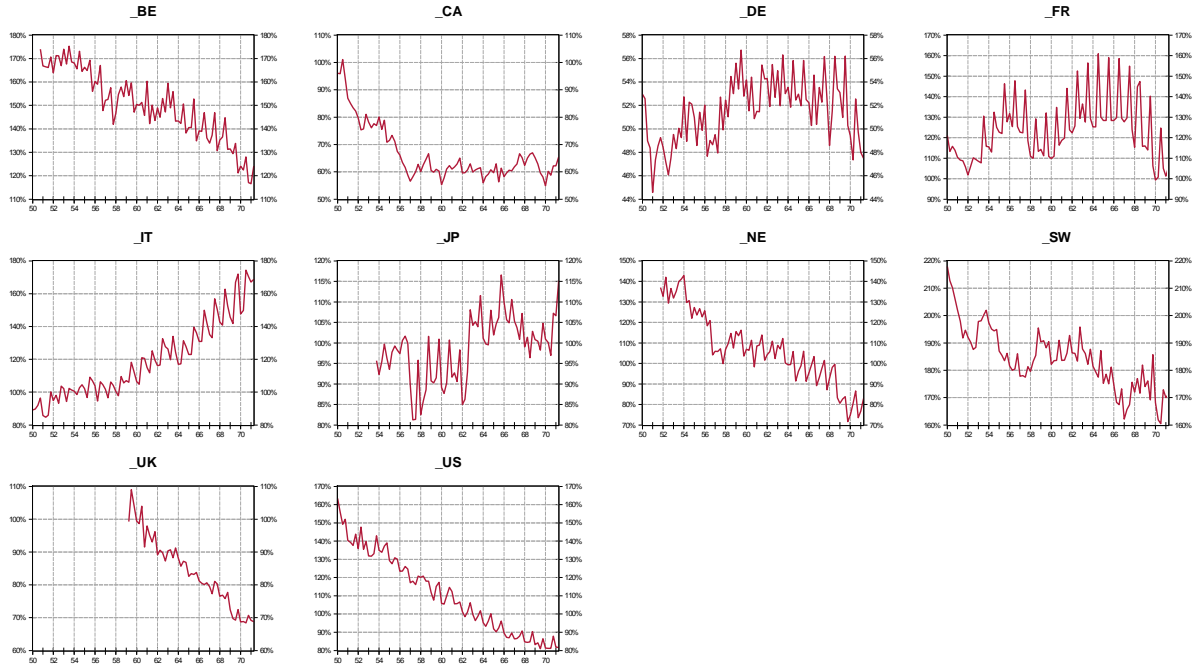
V.   Results of the estimations (G10 countries with quarterly data)

First we present estimations over the full period (1950 Q1 – 1971 Q2) for G10 countries, without taking into account our financial openness variable which is only available after 1957. The panel is however unbalanced as data for the money supply start in 1959 for the UK and in 1954 for Japan. The US is first excluded from the estimations reported below as we do not want the US behavior to drive the results but, interestingly, (as shown in Table 3), the effect of trade and money are robust to the inclusion of the US.

Table 1 shows the results of these estimations and distinguishes between the estimators: pooled panel without any fixed effect, mixed model with only a fixed effect for each time period, mixed model with country fixed effects, model with time and country fixed effects. The two first

estimators explain the variation of reserves between countries whereas the two others explain the variation of reserves within country overtime.

Standard errors are reported next to the value of the coefficients and a black font denotes that the coefficients are significant at the 0.01 level whereas a grey font denotes non-significance of the coefficient. A constant is included in all estimations.

The first striking result is that, whatever the estimator and the period, the correlation between money (divided by GDP) and total foreign reserves (divided by GDP) is highly significant (Table 1). This rules out the argument of Obstfeld et al. (2010) who interpreted such a positive correlation as specific to the post Bretton Woods period of financial liberalization. The coefficient is not only significant but has a high value. According to the specification without fixed-effects (Figure 5), a 1% increase in the ratio of money to GDP is associated with a 0.64% increase in the ratio of reserves to GDP. Using an unbalanced panel of 134 countries with annual data from 1980 to 2004 and a similar specification (where the log of trade and reserves to GDP are significantly correlated with the log of reserves to GDP), Obstfeld et al. (2010) found a coefficient for money equal to 0.263 and a coefficient for trade equal to 0.706.

Both trade and money were important determinants of the demand for foreign reserves under the Bretton Woods system.

We also find that the parallel market premium was negatively correlated with the holding of reserves. It means that a country with an undervalued (overvalued) currency held more (less) reserves. This is consistent with a mercantilist motive for the holding of reserves: a country would maintain its currency undervalued, increase exports and accumulate reserves.

If we divide the Bretton Woods system in two periods, before and after the return to full convertibility at the end of 1958 (see Bordo 1993), coefficients change little. Such as result was quite unexpected as commentators have often describe the functioning of the Bretton Woods system in the 1950s and in the 1960s as very different (Bordo 1993). The only major difference is that the coefficient on trade is negative after 1959 when country fixed-effects are used. This result simply reflects the fact that, as anticipated by Triffin (1960) and observed by Courchene and Youssef (1967), in most countries the ratio of reserves to GDP decreased in the 1960s whereas the ratio of trade to GDP increased (however, the ratio of trade to GDP decreased

slightly in the UK and in the Netherlands). Although the positive correlation between trade and reserves is usually taken as a robust result of the studies of demand for reserves, it is worth noting that it was not the case, within country (the coefficient is still positive with the between estimator) during the second half of the Bretton Woods system. When the US is included in the sample, the coefficient is not negative but is non-significant (Table 3).

Table 1 G10 countries (US excluded), full sample.

(Unbalanced panel. Non-significant coefficients are in grey font)

	Pooled		Pooled, time FE		Cross section FE		Cross section and time FE	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	4,06	0,16	3,39	0,15	5,10	0,38	2,65	0,45
log(trade/gdp)	0,77	0,01	0,79	0,02	0,25	0,10	1,23	0,09
log(money/gdp)	0,64	0,03	0,53	0,02	0,88	0,06	0,36	0,07
FX Premium	-0,04	0,00	-0,06	0,00	-0,03	0,00	-0,04	0,00
Free float dummy	0,12	0,03	-0,14	0,02	0,15	0,04	0,03	0,04
Adj.R2	0,70		0,78		0,90		0,94	
countries	9		9		9		9	
obs.	712		712		712		712	

Table 2 Split sample, before and after 1958

(Unbalanced panel. Non-significant coefficients are in grey font)

	Time FE		Cross section FE		Time FE		Cross section FE	
	1950-1958		1950-1958		1959-1971		1959-1971	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	2,89	0,32	6,58	0,80	3,48	0,53	3,48	0,53
log(trade/gdp)	0,78	0,04	0,80	0,16	-0,66	0,12	-0,66	0,12
log(money/gdp)	0,43	0,05	0,98	0,12	0,80	0,08	0,80	0,08
FX Premium	-0,05	0,00	-0,03	0,00	-0,01	0,01	-0,01	0,01
Free float dummy	-0,18	0,04	0,03	0,07	-0,05	0,04	-0,05	0,04
Adj.R2	0,83		0,95		0,75		0,91	
countries	9		9		9		9	
obs.	263		263		467		467	

Table 3 US included

(Unbalanced panel. Non-significant coefficients are in grey font)

| | Time FE | | Cross section FE | | Time FE | | Cross section FE | |
	1950-1958		1950-1958		1959-1971		1959-1971	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	5,57	0,56	8,54	0,66	3,77	0,13	5,04	0,53
log(trade/gdp)	0,58	0,02	1,10	0,12	0,79	0,02	-0,87	0,10
log(money/gdp)	0,89	0,09	1,22	0,09	0,61	0,02	1,10	0,07
Adj.R2	0,57		0,87		0,75		0,91	
countries	9		9		10		10	
obs.	299		299		499		499	

Then we decompose foreign reserves and we study whether the determinants of gold accumulation and foreign currencies accumulation were similar. Estimations show that they were not. While results for the demand of gold are pretty similar to the results for the demand of total reserves (both in terms of magnitude of the coefficient and in terms of R2), results for the demand of foreign exchange reserves show no significant coefficients with country fixed effects. When only time fixed-effects are included, the R2 is much smaller than in previous estimations, the coefficient of money is negative and the coefficient of trade is much smaller than for the demand of gold. We do not know the currency composition of foreign exchange reserves for each country, but the IMF published an estimation of the currency composition of world reserves (reproduced in Eichengreen, Chitu, Mehl 2014). In 1950, 40% of world foreign exchange reserves were US dollars; in 1955, the share was 50%; in the 1960s, it was 70% on average. But since the alternative currency (the Pound sterling) was probably mainly held by Commonwealth countries, we expect the share of US $ to be much higher in G10 countries.

The imperfect substitution between gold and foreign currency suggest that the Bretton Woods system was still a gold exchange standard and that, for monetary authorities, the US dollar – or any other currency – never replaced gold as a precautionary asset that should depend on the financial depth and trade openness. It became clear in the mid-1960s when France asked the USA to convert its dollar in gold (Bordo, Simard, White 1996, Monnet 2012). These results go against the view of Mc Kinnon (1993), among others, who argued that the Bretton Woods

system functioned as a dollar standard. The French 1965 claim, although extreme, revealed a profound problem of the system which, as our estimations show, was prevalent during the entire period, and which was known as the "confidence problem" (Machlup 1964, Bordo 1993). Interestingly, if we run the same estimation for the period 1968-1971 only, that is once the system has become a de facto dollar standard (Bordo 1993), because the US had implemented a two-tier system for gold sales and other central banks had committed not to convert their dollar in gold, then we find that the demand for foreign exchange reserves was positively and significantly correlated to the ratio of trade to GDP (but still not to money).

The fact that foreign exchange reserves included other currencies than dollars is not likely to undermine our conclusion about the confidence problem and the special role played by gold. If countries wanted to use dollars only for precautionary motives, we should still observe a correlation between foreign exchange holding and money (or trade) because the demand for other reserves was then determined randomly. For our results to miss that the dollar was indeed treated as gold, it would require that the holding of other currencies varied systematically negatively with the holding of dollars (such that an increase in dollar holding driven by an increase in financial depths would be compensated by the sales of other currencies). In this case, it would reveal a very low level of confidence in other currencies.

Table 4 Decomposition of foreign reserves: gold vs currency

(Unbalanced panel. Non-significant coefficients are in grey font)

	Time FE		Cross section FE		Time FE		Cross section FE	
	Gold		Gold		Foreign Exchange		Foreign Exchange	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	10,96	0,25	12,85	0,62	0,76	0,37	3,89	1,25
log(trade/gdp)	1,15	0,03	0,32	0,17	0,27	0,04	-0,06	0,16
log(money/gdp)	0,99	0,04	1,42	0,10	-0,24	0,05	0,27	0,19
FX Premium	-0,16	0,01	-0,10	0,01	-0,02	0,01	-0,01	0,01
Free float dummy	-0,09	0,07	0,57	0,05	-0,03	0,07	-0,07	0,06
Adj.R2	0,83		0,92		0,22		0,5	
countries	9		9		9		9	
obs.	684		684		684		684	

Finally, we add our financial openness variable, defined as the US liabilities to each country over GDP. The estimations start in 1957 since this measure is not available before. The results for the other variables are consistent with previous estimations. The coefficient of the financial openness variable is negative. This result differs from standard results on the demand for reserves in the post-Bretton Woods period (Obstfeld et al. 2010). An explanation is that international capital mobility was still low and that, as a consequence, country did not fear sudden stops. However, our measure of financial openness only focuses on capital flows from the US which may not have represented the majority of capital inflows in the 1960s. Further research may challenge this finding. The estimation with annual data in the next section will show that the result is different if we use an alternative measure of financial openness.

The regressions in Table 5 also include a measure of the past volatility of the exchange rate (on the black market).It is computed as a moving average of the black market exchange rate over the previous 2 years (hence the series starts in 1952). A suggested by Grubel (1971) among others, central banks are more likely to accumulate reserves as a buffer when they have experienced a high level of exchange rate volatility in the past. We find a positive and significant effect of this variable but it is very small and the adjusted R2 increase by 0.01 points only.

Table 5 Estimation with measures of financial openness and exchange rate volatility

(Panel starts in 1957. Non-significant coefficients are in grey font)

	Pooled		Pooled, time FE		Cross section FE		Cross section and time FE	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	4,07	0,14	4,07	0,14	3,88	0,52	0,84	0,50
log(trade/gdp)	0,84	0,03	0,84	0,03	-0,55	0,12	0,41	0,10
log(money/gdp)	0,65	0,02	0,65	0,02	0,84	0,08	0,27	0,08
FX Premium	-0,08	0,01	-0,08	0,01	-0,01	0,01	-0,02	0,01
Free float dummy	0,18	0,04	0,18	0,04	0,00	0,04	-0,10	0,03
BM exchange rate volatility	0,01	0,00	0,01	0,00	0,01	0,00	0,01	0,00
log ($ liabilities/GDP)	-0,01	0,01	-0,01	0,01	0,00	0,02	-0,05	0,02
Adj.R2	0,70		0,79		0,92		0,96	
countries	9		9		9		9	
obs.	507		507		507		507	

VI.   Estimation on a sample of 55 countries

VI.1.   Benchmark estimations

Do previous results hold for other countries? We estimate a simple equation with only two explanatory variables (money/gdp and trade/gdp) for 55 countries, using cross-country and time fixed effects. Data are annual. Results of estimations with time and country fixed effects are reported in Table 6, including a distinction between G10 countries and others and between gold and non-gold reserves.[17] The definition of money is the same as in the previous section (M1). We include Sweden in the G10 countries but we exclude the US (the main conclusions remain if the US is included). Contrary to quarterly data with which we were able to distinguish between gold and foreign exchange, the annual panel only distinguishes between gold reserves and non gold reserves.

We find again a positive effect of the ratio of money to GDP which is stronger for G10 countries but remains for other countries. More important, as with quarterly data, we find that non-gold reserves of G10 countries are not explained by trade and money. On the contrary we do not find such a pattern for non G10 countries. In non G10 countries, the motives of gold accumulation

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[17] Following Obstfeld et al. (2010), population and real GDP have been tested for in the regression – when available – but did not add any explanatory power.

and non-gold reserves accumulation are very similar. In other words, the estimations with annual data and with a larger sample confirm that gold and foreign exchange reserves were not treated the same but demanded for different reasons.

Table 6 Estimations for 55 countries (annual data)

(Unbalanced panel. Non-significant coefficients are in grey font)

	Country and Time Fixed Effects. All countries.					
	Total		Gold		Non gold reserves	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	11,12	0,34	8,94	0,52	10,68	0,29
log(trade/gdp)	1,09	0,14	1,20	0,20	1,27	0,15
log(money/gdp)	0,28	0,11	0,57	0,19	0,28	0,10
Adj.R2	0,78		0,84		0,69	
countries	55		55		55	
obs.	1066		1066		1066	
	Country and Time Fixed Effects. G10 countries (US excluded)					
	Total		Gold		Non gold reserves	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	11,01	0,24	10,25	0,52	9,79	0,49
log(trade/gdp)	0,70	0,24	1,24	0,20	0,12	0,34
log(money/gdp)	0,91	0,21	1,55	0,19	0,68	0,45
Adj.R2	0,83		0,88		0,63	
countries	10		10		10	
obs.	199		199		199	
	Country and Time Fixed Effects. Non G10 countries					
	Total		Gold		Non gold reserves	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	11,25	0,47	8,86	0,56	10,91	0,41
log(trade/gdp)	1,14	0,14	1,23	0,21	1,39	0,17
log(money/gdp)	0,22	0,13	0,48	0,19	0,22	0,12
Adj.R2	0,78		0,84		0,69	
countries	45		45		45	
obs.	867		867		867	

The conclusions are robust to the use of M2 (which is available at yearly frequency in retrospective IFS issues but was not available quarterly) instead of M1. The coefficient is only slightly lower.

VI.2.   More variables, and different definitions of money

In order to assess the robustness of our results, we introduce a measure of financial openness (the index computed by Quinn and Toyoda 2008, based on regulation of capital inflows and outflows) as well as the volatility of foreign reserves during the 2 previous years. Because of data availability, the estimation sample is then reduced to 47 countries and starts in 1952. We also distinguish between the three components of M2: M0 (currency and banknotes in circulation), M1-M0 and M2-M1[18].

Table 7 shows that previous results are robust, especially the striking difference between the determinants of gold holding and determinants of non-gold reserves in G10 countries (US excluded). Note that this difference also rules out the hypothesis that international reserves are not sterilized and that they affect directly the money supply (as suggested by Heller 1976 and Genberg & Swoboda 1993) since they would be no reason that this effect would concern gold only. The link between gold reserve holding and money is observed for all components of M2 in G10 countries, and the capital account openness Quinn-Toyoda index is significant and has the expected sign positive (the introduction of capital account openness in the regression turned the coefficient of trade/gdp non-significant for the holding of gold in G10 countries). It means that this result is compatible with all the theories listed in the previous section: heritage of the gold standard (back the money stock), monetary theory of the balance of payments, fear of double drain. It is noteworthy that the coefficient is stronger for currency/GDP than for the two other components of M2.

As in Table 6, we do not observe clearly such patterns in non G10 countries. Money matters, but less than trade. Gold seems to back M0, whereas foreign exchange reserves are mostly linked to the level of deposits. Capital account openness does not play a role; probably because in most countries it varied little.

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[18] Annual data on money are taken from Brian Mitchell, *International Historical Statistics*, Palgrave, 1988. Mitchell'sources for M1 and M2 are actually International Financial Statistics. For banknotes and currency, he uses various national sources.

Table 7 Estimations for 47 countries (annual data)

(Unbalanced panel. Non-significant coefficients are in grey font)

	Country and Time Fixed Effects. All countries.					
	Total		Gold		Non gold reserves	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	9,91	0,28	6,75	0,45	10,98	0,43
log(trade/gdp)	0,77	0,13	0,92	0,18	1,16	0,19
log((M2-M1)/gdp)	0,13	0,03	0,08	0,03	-0,01	0,04
log((M1-M0)/gdp	0,45	0,08	0,24	0,09	0,36	0,15
log(M0/gdp)	0,11	0,16	1,22	0,26	-0,20	0,24
capital acc. openness	0,01	0,00	0,01	0,00	0,01	0,00
reserve volatility	0,01	0,00	0,01	0,00	0,01	0,00
Adj.R2	0,81		0,9		0,69	
countries	47		47		47	
obs.	849		849		849	
	Country and Time Fixed Effects. G10 countries (US excluded)					
	Total		Gold		Non gold reserves	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	11,82	0,32	9,79	0,40	9,87	0,45
log(trade/gdp)	0,76	0,18	-0,33	0,47	0,65	0,51
log((M2-M1)/gdp)	0,39	0,06	0,54	0,06	0,12	0,21
log((M1-M0)/gdp	0,16	0,09	0,64	0,26	0,30	0,20
log(M0/gdp)	0,36	0,28	0,81	0,35	-0,82	0,57
capital acc. openness	0,02	0,00	0,02	0,00	0,00	0,00
reserve volatility	0,01	0,00	0,00	0,00	0,01	0,00
Adj.R2	0,94		0,94		0,63	
countries	10		10		36	
obs.	186		186		186	
	Country Fixed Effects. Non G10 countries					
	Total		Gold		Non gold reserves	
	Coeff.	SdE	Coeff.	SdE	Coeff.	SdE
c	9,19	0,46	5,44	0,71	10,35	0,70
log(trade/gdp)	0,74	0,14	1,01	0,19	1,08	0,22
log((M2-M1)/gdp)	0,11	0,03	0,04	0,03	-0,01	0,04
log((M1-M0)/gdp	0,39	0,09	0,02	0,14	0,39	0,16
log(M0/gdp)	0,17	0,18	1,42	0,27	-0,09	0,27
capital acc. openness	0,00	0,00	0,00	0,00	0,00	0,00
reserve volatility	0,01	0,00	0,01	0,00	0,01	0,00
Adj.R2	0,81		0,9		0,69	
countries	36		36		36	
obs.	643		643		643	

VII.   The liquidity shortage and the adjustment problem

What would have been the level of foreign reserves in the 1960s if the determinants of the demand for foreign reserves had been the same as in the 1950s? This simple counterfactual can help us to assess whether Triffin (1960) was right to identify a liquidity shortage as soon as 1960. To answer this question, we go back to our econometric model with quarterly data (G10 countries) as the estimation is more precise. We use the model with money/gdp, trade/gdp and the parallel market premium since it is the only one for which we can use data starting in 1950. On Figure 8, the red line is the forecast value of the demand of foreign reserves with coefficients estimated over the period 1950-1959 (model with both time and country fixed effects). The dot grey line is the actual level of reserves over GDP. We conduct this analysis using quarterly data for the G10 countries. Except for Switzerland, the two lines do not differ significantly before 1965. This suggests that the shortage of international liquidity (if there was any), identified by Triffin as soon as 1960, actually did not arise clearly before the mid-1960s. However, this counterfactual, in itself, is not a proof of a liquidity shortage but just assesses that countries accumulated less reserves after 1965 compared to what they would have accumulated if they had followed the same behavior than in the 1950s. However, if we drop the parallel market premium from the estimations, the liquidity shortage is much less pronounced (Figure 9). Since this premium was higher in the 1950s than in the 1960s and the coefficient is negative, this second counterfactual predicts a higher value of the level of reserves in the 1950s. Thus, if we take into account trade and money only, there is no clear evidence of a liquidity shortage for G10 countries before 1968.

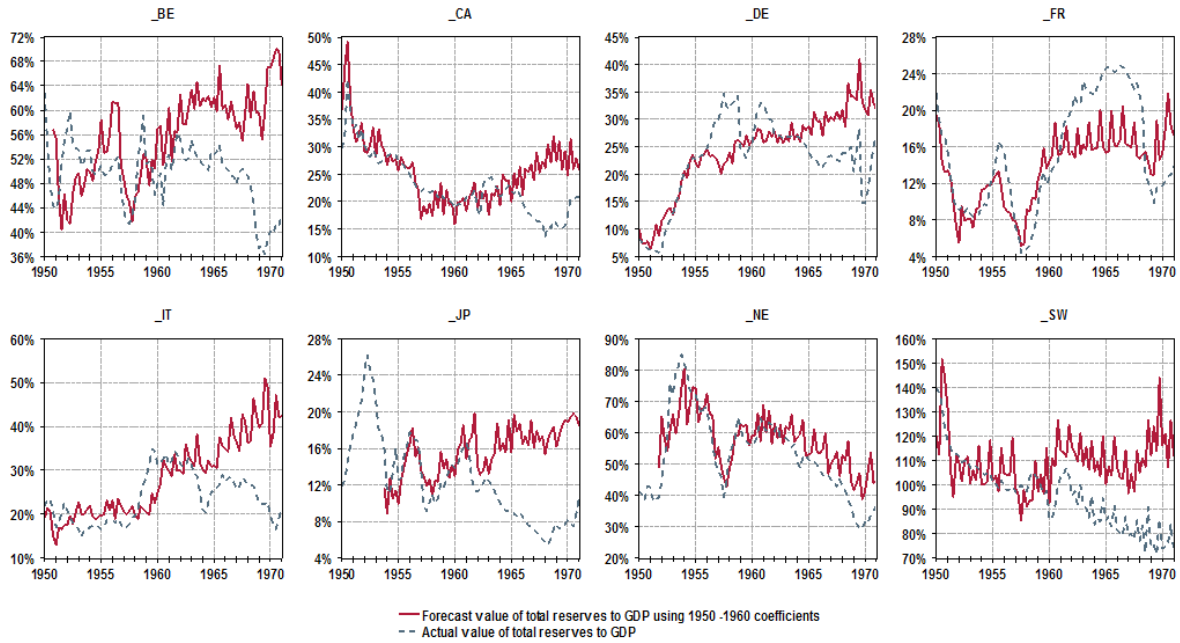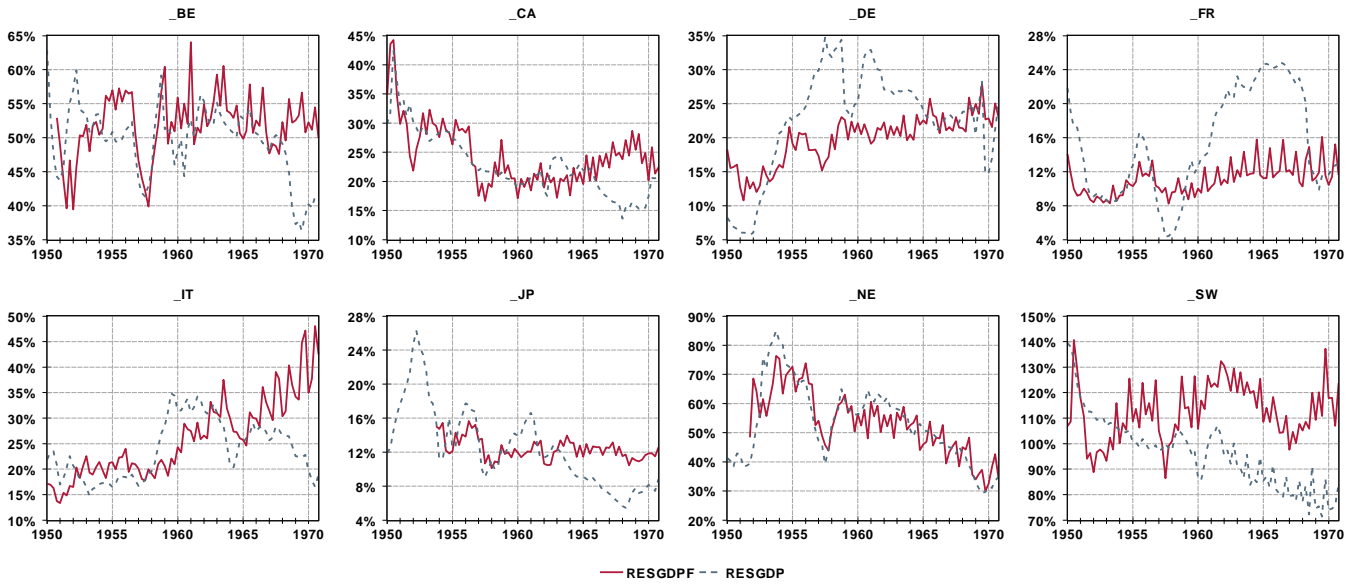## Figure 8 Counterfactual n°1 (parallel market premium included)

Forecast value of total reserves to GDP using 1950 -1960 coefficients
Actual value of total reserves to GDP

Figure 9 Counterfactual n°2 (parallel market premium included)

RESGDPF   RESGDP

The adjustment problem was more important. As seen on Figure 10, if we simulate the level of reserves for each country based on our between estimation (without country fixed-effects), we find that Germany and Switzerland permanently (after 1955 for West Germany) had a higher level of reserves than the one predicted by the model whereas the United Kingdom had a permanent deficit of reserves. Germany revalued twice in 1961 and 1969 and the UK devalued in 1967 only. The German and English stories are well known examples of the adjustment problem during the Bretton Woods system (Obstfeld 1993, Bordo 1993): countries had actually very few incentives to adjust. They maintain balance of payments deficit or surplus and foreign reserves under or over accumulation for years. Our estimations show strong evidence of this adjustment problem that was reflected in over accumulation for West Germany and under accumulation for the UK (compared to other countries).

Figure 10 Difference between predicted reserves across countries
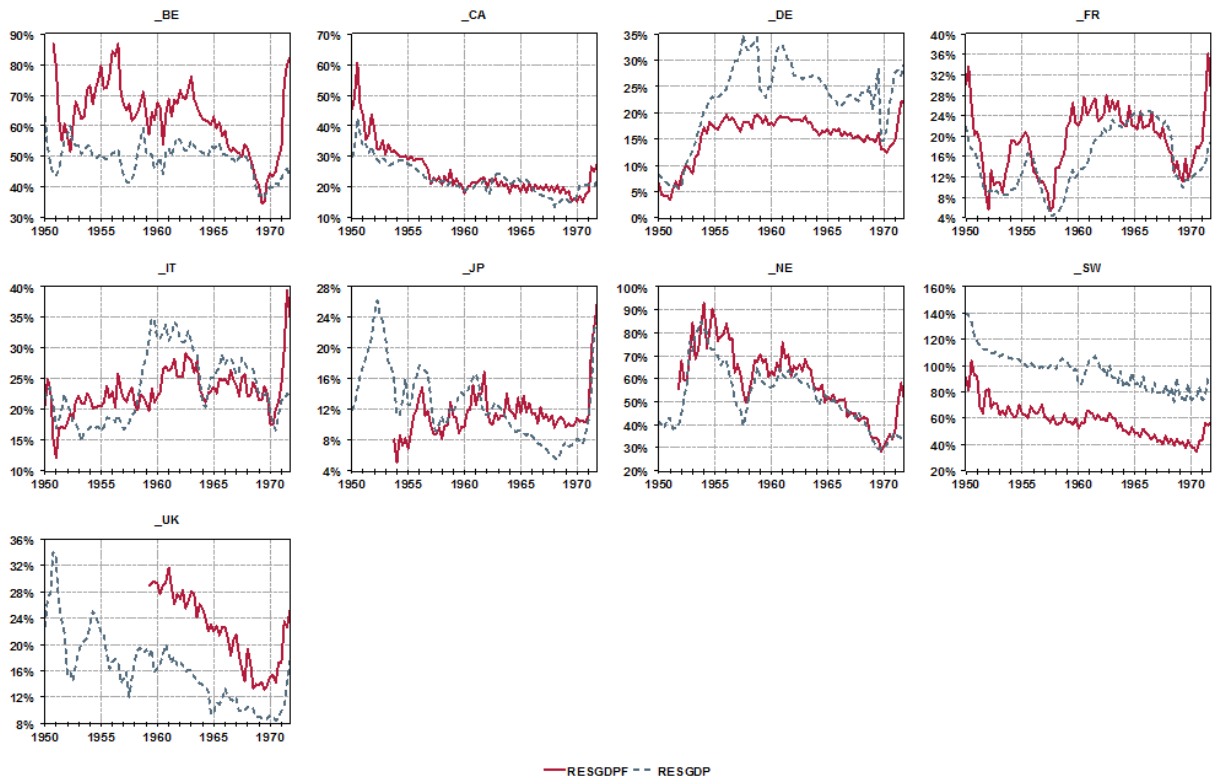
CONCLUSION

This paper has investigated the determinants of foreign reserve holding under Bretton Woods, with an emphasis on the core of the system (G10 countries). One of the most striking results of this analysis is the observed correlation between gold reserves (as a % of GDP) and money (as a % of GDP). This single finding raises three conclusions that pave the way for further research. First, since the correlation is observed for all components of money - including currency – we should study further how the previous gold standard practices may have continued to shape the behavior of monetary authorities in G10 countries after WWII (and why not in other countries). Second, more research is needed on the potential explanations of imperfect substitution between gold reserves and non-gold reserves (in what extent did it reveal a confidence problem in the dollar?). Third, since the correlation between money and foreign reserves is still observed in the post-Bretton Woods world but is then explained by financial globalization factors that were not likely to matter as much under Bretton Woods, we should wonder whether this correlation can also be explained by similar factors or mechanisms before and after 1973, such as those highlighted in the monetary theory of the balance of payments.

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