Global Safe Assets*

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Abstract

Will the world run out of 'safe assets' and what would be the consequences on global financial stability? We argue that in a world with competing private stores of value, the global economic system tends to favor the riskiest ones. Privately produced stores of value cannot provide sufficient insurance against global shocks. Only public safe assets may, if appropriately supported by monetary policy. We draw some implications for the global financial system.

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1 Introduction

The notion that the global economy could be faced with a shortage of safe assets has become a significant theme in recent policy debates (see *inter alia* Caballero, 2010b, Garcia, 2011, Credit Suisse, 2011, and especially International Monetary Fund, 2012, chap. 3). Safe assets are a cornerstone of modern financial systems. They provide a reliable store of value, serve as collateral in financial transactions, fulfill prudential requirements, and serve as a pricing benchmark. Should they disappear, the argument goes, the danger is that the financial system itself might crumble. Markets for collateralized transactions (repos) would collapse; financial institutions would have difficulties meeting their prudential requirements, and the pricing and well-functioning of riskier segments of the financial system could be derailed altogether. More daunting perhaps, households, retirees and firms would live in a world without a suitably safe store of value. Without this safe anchor, the financial system would experience greater systemic instability. As recently as April 2012, the IMF in chapter 3 of its Global Financial Stability Report (2012, p.1), expressed the concern that "the shrinking set of assets perceived as safe, now limited to mostly high-quality sovereign debt, coupled with growing demand, can have negative implications for global financial stability."

Indeed, a convincing link can be established between macroeconomic shortages of safe assets and some of the most disturbing features of our recent global financial history. For instance, Caballero, Farhi and Gourinchas (2008) or Bernanke (2005) discuss how the rapid economic growth of emerging economies, coupled with a relative backwardness in financial development created a global shortage of stores of value. This shortage depressed world interest rates and fueled 'global imbalances.' This growing external demand for safe stores of value also proved a powerful stimulant for US and European financial markets. Between 2002 and 2007, they manufactured large amounts of 'private label' safe assets through the securitization of riskier assets (see Bernanke, Bertaut, DeMarco and Kamin, 2011).

The global financial crisis arose when many of these 'private label' safe assets –perceived as safe because they were bestowed with a AAA rating– lost that quality. The sudden realization that many of the safe assets undergirding the entire financial system were of questionable value led to a 'sudden financial arrest' (Caballero, 2010a). In the subsequent unraveling, most of these 'private label' safe assets disappeared. In the euro area, the strains associated with the crisis quickly morphed into concerns about the safety of sovereign debts, as governments simultaneously tried to shore up their financial sector and to sustain domestic economic activity. This led to further shrinkage in the global supply of safe assets at the same time that deleveraging financial institutions, panicked investors and anxious reserve managers all tried to fly to safety.

In short, macroeconomic shortages of safe assets can create financial instability. Crises, when they occur, further exacerbate the shortage that gave rise to it. Policy responses designed to cope with the crisis such as liquidity injections and monetary easing prolong the conditions for financial instability and delay the necessary balance sheet adjustment of households and financial institutions (see BIS, 2011).

Could this destabilizing positive feedback loop lead to the ultimate disappearance of safe assets –a recognition that nothing is really safe– with potentially disastrous consequences for financial stability?

We argue in this paper that this analysis is incomplete. In particular, it ignores that the global economy also exhibits poweful *stabilizing* mechanisms. One such mechanism, at work both before and during the crisis, is the decline in the natural real interest rate, resulting from the excess demand for stores of value. Figure 1 plots three different measures of global real interest rates: a world short term real rate, defined as the GDP weighted average of G7 3-months nominal interest rates minus ex-post inflation, a U.S. 10 year real rate defined as the annualized yield on 10-year government bonds minus annualized 10-year expected inflation from the Survey of Professional Forecasters, and the 10-year annualized yield on Inflation-indexed Treasuries. All three measures illustrate the strong decline in global real interest rates. In the case of the short term real rate, it reached -2.7 percent (p.a.) towards the end of 2011. The decline in the natural rate operates both on the intensive and the extensive margins. At the intensive margin, it increases the market value of existing assets, hence their supply. Simultaneously, it improves the solvency of borrowers, especially sovereign ones. In addition, the mechanism operates also at the extensive margin, stimulating the supply of *additional* stores of value, i.e. stimulating borrowing. The important economic insight is that while this additional borrowing can further fragilize the economy, as emphasized in Diamond and Rajan (2011) and BIS (2011), it also contributes to an increase in stores of value, i.e. a self-correcting mechanism. It is the tension between the fragility induced by the additional leverage, and the stabilization induced by the additional supply of stores of value that is of interest to us. In particular, we are interested in understanding the way in which monetary policy can potentially contribute to the strengthening of the financial system. As we will see, monetary policy will be important along two margins. First, it will need to accompany the decline in the natural rate that occurs when the scarcity of stores of value becomes more acute. Second, monetary policy can also play an important role as a backstop for public securities. We show that a natural way to eliminate the financial instability arising from the asset scarcity consists in supplying *public* safe assets. In turn, the safety of public asset may require a monetary backstop. We show that this backstop can increase significantly the safety of public securities, with minimal or no consequences in terms of price stability.

This mechanism is illustrated in its purest form in the Samuelsonian's emergence of pure rational bubbles (e.g. fiat money) in economies that suffer from a shortage of stores of values (Samuelson, 1958). As we show with a model,[1] if these bubbles were 'safe', in the sense of

[1]This model makes a number of simplifying assumptions. For instance, the financial bubbles that we will consider here are of the 'rational' kind. A good argument can be made that departures from fundamental valuation may not simply reflect rational behavior, but also cognitive biases, institutional constraints, and limits to arbitrage. That we do not consider these here does not mean these things are not important, simply that we can convey our point in a simple manner without making reference to them. Similarly, our model does not feature financial frictions –beyond the fundamental market incompleteness that gives rise to a demand for stores of value. Financial frictions and/or agency problems are critical to many policy questions and this simplification is also meant to keep our analysis as simple as possible, not to claim these

being perfectly substitutable with other existing assets in short supply, then the problem of asset shortages would be easily solved and quite trivial to analyze. But financial bubbles, even of the rational variety, can amplify financial instability. They suffer from an important design flaw: their current valuation rests on the common belief that their future value will be preserved. Uncertainty about their future value can lead to a collapse and a relapse of the asset shortage.

The preceding discussion suggests that the relevant question is not whether the world economy can suffer from a shortage of stores of value. Through endogenous and self-correcting macroeconomic responses, the economy as a system will strive to compensate for any shortage. The more interesting question lies in the composition of this asset supply and how to make it less 'fragile.' Here, we would argue in favor of coming back to the basics. It is of the essence of a safe asset that it cannot become unsafe. The definition of safe assets has a key impact on the financial sector and so should not be left entirely to the private sector. The authorities should commit themselves to a clear definition of safe assets and back it with a policy regime that makes those assets credibly safe. Claims on the private sector are inherently risky and should stay so to limit moral hazard: for this reason they may not provide a good basis to produce safe assets. Besides money, government debt remains the best candidate for the status of safe asset. Central banks, furthermore, have a role to play in making government debts safe.

The paper is structured as follows. Section 2 reviews basic conceptual issues and stylized facts related to safe assets and discusses whether there is (or will be, going forward) a gap between the supply and the demand of safe assets. We discuss, in section 3, the role that fiscal and monetary policies play in the supply of safe assets. Section 4 discusses the role of safe assets in the global economy.

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are not important policy considerations.

2 Conceptual Issues & Stylized Facts

At a primitive level, a safe asset is simply a secure store of value, i.e. a secure promise of future repayment. In a world with complete financial markets and no financial frictions, safe assets would play no specific role. Households and firms could smooth consumption, finance projects and more generally diversify risks away using state-contingent Arrow-Debreu securities and there would be no need for safe assets per se. When instead markets are incomplete and/or in presence of financial frictions, the inability to convert future cash flows into current resources when needed (i.e. the inability to create secure claims on future resources in sufficient quantities) creates a precautionary motive: the real sector (households and firms) needs to hoard assets in a form easily convertible into real resources. This is where the demand for safe assets arises in the real economy.

In choosing which assets to invest into, households and firms will look for the following characteristics (see International Monetary Fund, 2012, ch. 3): low credit or market risk; high market liquidity; limited inflation risk; low exchange rate risk and limited idiosyncratic risk. A quality of safe assets that has been emphasized by Dang, Gorton and Hölmstrom (2010) and Holmström (2008) is that they are "information insensitive." A bond with a zero default risk is information insensitive in the sense that its value depends only on the yield curve up to the maturity of the bond, and not on the characteristics of the issuer. Once this bond has been certified as safe (for example by a credit rating agency), investors can agree about the value of the bond without collecting further information about its issuer. Information insensitiveness implies that there is no informational asymmetry about the asset, so that its market will not be affected by illiquidity coming from adverse selection problems.

In the short run at least, money is the safe asset par excellence. By extension, a safe asset can be defined as any debt asset that promises a fixed amount of money in the future with no default risk.[2] Safety is also in the eye of the holders and depends on their liquidity needs. An agent who is likely to need liquidity in the nearer future will find short-term bonds safer than long-term bonds. An agent looking for a long-term safe asset will have to worry about the inflation risk. An agent trading with the rest of the world will have to worry about exchange rate risk. These individual variations in the demand for safe assets notwithstanding, one can define safe assets as cash (including insured deposits) plus any debt that is tradable, liquid and enjoying a top credit rating.

The safety of a given asset does not depend only on the characteristics of the issuer, it is also determined by the features of the market in which the asset is traded. For example, the liquidity of an asset is determined by the depth of the market in which it is exchanged (Pagano, 1989). The safety of bank deposits depends on the extent to which they are insured by the government or backed by the central bank's lending-in-last-resort. Any asset can be made safe by an implicit or explicit promise by the central bank to buy it if its price falls below a certain price. Thus, for a safe asset to be truly information insensitive (in the sense of Gorton), it is not enough to look at the individual characteristics of the asset: the behavior of key participants in the system, such as the central bank, must also be taken into account.

One crucial role of the financial sector is to produce safe assets out of assets that are less safe. The relationship between the financial sector, the government sector and the private real sector is represented in Figure 2. The financial sector is composed of banks and financial institutions, including those that belong to the shadow banking system.[3] The private real sector is composed of households and nonfinancial firms. The government sector is composed of the different levels of the general government and of the central bank. The

[2] This is assuming an environment with low and stable inflation. When inflation is high and volatile even short-term money-like instruments become risky in real terms. The trade-offs between default risk and inflation risk will be discussed in section 4.

[3] For the purpose of our analysis, the monetary authority is considered a part of the government rather than the financial sector, since we view central bank liabilities as safe assets that are provided by the government. On the other hand, agencies and government sponsored entities (GSEs) are considered part of the private sector.

arrows correspond to the outstanding stock of debt claims between different agents of the economy. The first arrow (labeled "1") represents the private real sector's claims on the government, such as the currency in circulation or the Treasury securities held by households. Arrow 2 represents the claims of the private real sector on the financial sector sector (such as bank deposits) and conversely arrow 3 corresponds to the claims of the financial sector on the real private sector (e.g. mortage loans). The last two arrows (4 and 5) represent the cross-holdings between the financial sector and the government (where the latter includes the central bank). Arrow 4 covers the bank reserves at the central bank and arrow 5 the central bank's claims on financial institutions.

What is the share of *safe* assets in the cross-sector claims and liabilities represented in Figure 2? Figure 3 shows the US real sector total holdings of safe assets as a fraction of US GDP.[4] This variable is remarkably stable. As a fraction of domestic output, holdings of safe assets by the real sector remain stable, around 80 percent of GDP. Two notable deviations from that long term ratio occurred. The first deviation took place between 1981 and 1988, during the Savings & Loans episode; the other between 2002 and 2007 during the most recent housing bubble. But even during these episodes, the increase in holdings of safe assets represented at most 20 percent of output. This demand for safe assets has been satisfied by holdings of government debt securities and safe claims on the financial sector, mostly in the form of bank deposits and money market mutual funds. Figure 3 shows that safe assets issued by the financial sector represent the largest component (88 percent).

The stability of the private real sector's demand for safe assets is a feature observed in countries other than the US. Figure 4 shows the private real sector's holding of safe assets in Japan, the UK, Germany, France and the euro area (as a share of each country's GDP). The ratio is quite stable, and comparable to the US for Germany, France, or the Euro area

[4]Safe assets are defined as non-credit instruments (checkable deposits and currency, foreign deposits, time and saving deposits, shares of money market mutual funds, repos) and credit instruments (commercial paper, Treasuries and agencies and munis). Data are from the Flows of Funds Accounts of the U.S. Federal Reserve. See appendix B for details.

as a whole. For the UK, the real private demand for safe assets was also quite similar until 2002. After that date, the demand for safe assets increased rapidly, from 100 percent of GDP to 133 percent in 2008. A substantial part of that increase, however, is accounted for by a sharp increase in the deposits of the nonfinancial sector with monetary and financial institutions in the rest of the world. In other words, it represents an increased demand of safe assets generated by foreign financial institutions. The only true exception to the main pattern is Japan. Japan stands out both for the high level of demand for safe assets (starting at 126 percent in 1979) and its increase (reaching 236 percent in 2010). Most of this reflects the unusually high demand for transferrable and time deposits by Japanese households, representing 162 percent of GDP in 2010. It has long been known that Japanese households have a strong preference for safe assets (see Nakagawa and Yasui, 2009). This may reflect demographic characteristics (as an aging society will prefer to shift its wealth towards safer assets) as well as the consequence of the financial crisis of the 1990s, pushing households towards safer forms of investment. Lastly it is possible that in a liquidity-trap environment, returns on assets become compressed and the portfolio share on safe assets becomes indeterminate.

It follows from the previous discussion that most of the increase in demand for (and supply of) safe assets occurred -with the notable exception of Japan– *within* the financial system itself. The Flow of Funds Accounts do not provide the ideal data to illustrate this development since to a large extent they net holdings of the financial sector onto itself. Nevertheless, we can trace out the contours of this increased demand by looking at holdings of US safe assets by the rest of the world. By and large these positions reflect demand arising from foreign financial institutions (or foreign subsidiaries of domestic financial institutions) as well as foreign official agencies. Figure 5 reports the holdings of US safe assets by the rest of the world, expressed as a fraction of US GDP. It also reports holdings of US official assets (SDR, currency, Treasuries, munis) only. The figure shows a dramatic increase, from less than 3 percent in 1946 to more than 54 percent at the end of 2011. This dramatic rise reflects an increased foreign demand for US official assets (from 1 percent to 34 percent of US GDP) and for financial sector safe assets (from 2 percent to 20 percent).

The private real sector wants to hold safe assets but it itself supplies risky assets to the financial sector. Figure 6 illustrates this in the case of the US since 1946. The details of how claims are classified are given in appendix B. Unlike the demand for safe assets, the supply of risky assets by the real sector has increased dramatically, from 31 percent of output in 1946 to 144 percent at the peak of the housing bubble. Most of this increase reflects the growing importance of household mortgages over that period (from 10 percent of output in 1946 to 75 percent in 2007).[5]

The banking sector is able to transform less liquid assets into more liquid assets in several ways. First, it pools risks, both on the asset and on the liability side (Diamond and Dybvig, 1983). More recently, it has distilled safe assets out of assets that were less safe through securitization and tranching, for example by creating senior tranches of mortgage-backed securities. The liquidity transformation chain has become increasingly complex, with more and more institutions involved in smaller steps of the liquidity transformation process (Shin 2012). There was an explosion of claims that are internal to the banking sector due to securitization, increased leverage and the development of shadow banking.

Accordingly, the financial institutions' demand for liquidity and safe assets has increased. In principle, this demand can be satisfied in two ways: by holding safe claims on the real sector, such as Treasury bonds or senior tranches of asset-backed securities, or by holding safe claims on other financial institutions. These two sources of safe assets correspond to Holmström and Tirole (1998)'s distinction between "outside" and "inside" liquidity. Inside liquidity is created by lending between agents that are inside the sector, whereas outside

[5]The opening gap between the supply of safe assets to the real private sector (on the liability side of the financial sector) and the demand for risky claims on the real private sector (on the asset side of the financial sector) reflects a decline in holdings of US government securities, as well as an increasing reliance on foreign wholesale funding.

liquidity consists of claims on agents that are outside the sector. Holmström and Tirole (1998) considered only two sectors in their original model, the government and firms. Inside liquidity is then obtained through lending between firms, whereas outside liquidity consists of government debt. Here, we define outside liquidity from the point of view of the financial sector, so that it may also include safe claims on firms and households (what Bernanke et al. (2011) calls "private label safe assets"). As noted by Bernanke et al. (2011), one problem with "private label safe assets" is that their quality tends to deteriorate when there is a negative aggregate shock, i.e., precisely when they are needed the most. The government's ability to tax makes its debt intrinsically safer than that of the private sector.

Outside liquidity and inside liquidity are substitutable in normal times: the financial sector can work with less outside liquidity if it can create more inside liquidity. However, inside liquidity in the Holmström and Tirole (1998) model is not designed to withstand aggregate shocks. Only outside liquidity can, and must be provided in greater quantity in a crisis. From this perspective, one can define the "outside safe assets" of the financial sector as the liquid and safe claims on the real sector that are held by financial institutions. These outside safe assets can be viewed as an input into the production of liquidity by the financial sector. It is these "outside safe assets" that people have in mind when they worry about the implications of a shortage of safe assets for financial stability.

To illustrate, Figure 7 shows the holdings of government safe assets (government securities and central bank liabilities) by the US financial sector, as a share of GDP. There was a large fall from almost 65 percent of GDP down to 17 percent of GDP between the aftermath of World War II and the 1970s. This fall coincided with a large rise, of about the same size, in the supply of risky assets by the private real sector (see Figure 6). As the US government was reducing its debt-to-GDP ratio (which amounted to almost 150 percent in the aftermath of World War II), the financial sector was allocating an increasing share of the US loanable funds to the private real sector.

Indeed, the recent episodes of financial instability were triggered by the downgrading of outside safe assets that turned out to be not safe (MBS in the US, and government debt in the euro area). This directly affected the banking/financial sector which held those assets. The shock was amplified, inside the sector, by fire sales and network externalities (Brunnermeier, 2009). In addition, certain debt markets stopped functioning because they relied on using assets that were no longer safe as collateral.

The recent concerns about safe assets stem from the notion that there is a gap between the increasing demand for safe assets, coming especially from the financial sector, and the shrinking supply from governments and the private sector. International Monetary Fund, 2012, chap. 3 show that if the government debts of advanced economies with 5-year CDS spread above 200 bps at end-2011 are excluded from the safe-asset universe, the supply of safe public debt will be reduced by more than \$9 trillion by 2016. As for private-label safe assets, private sector securitization issuance declined from more than \$3 trillion in the United States and Europe in 2007 to less than \$750 billion in 2010. It is argued that something should be done by the official sector to maintain an appropriate supply of safe assets.

With regard to this debate we would like to emphasize two points. First, the increase in demand should not be taken as given. Since the demand for safe assets stems from financial frictions (with complete markets, as noted above, there would be no need for safe assets), an increase in the demand for safe assets must come from an increase in these frictions. Should an increase in the demand for safe assets be met by an increase in their supply, or by a policy effort to mitigate the underlying friction? This question becomes more concrete once its is asked in specific contexts (as we do below) and the answer is not obvious. Second, on the side of supply, we would argue that the problem is not so much an insufficient quantity per se as the fact that the definition of safe assets has been shifting over time.

Let us start with the demand side. First, it is not clear that there is a legitimate durable increase in the demand for safe assets from the financial sector. The financial sector's supply of safe assets to the real sector has remained quite stable relative to GDP, as shown by Figure 3 in the case of the US. It is unclear why the financial sector would need more safe assets from the real sector as an "input" to supply the same quantity of safe assets to the real sector. One could argue that there is more demand for outside safe assets because of the expansion of balance sheets inside the financial sector. But in normal times, this larger demand is satisfied by the creation of inside liquidity. Inside liquidity may collapse in a crisis and then have to be replaced by outside liquidity for a while (as we observe in figure 7 in the case of the US), but this increase in the supply of outside liquidity is a crisis measure that should be temporary. In the long run, one of two things should occur: either inside liquidity is restored, or the internal structure of the financial system should change in such a way that it can operate with less inside liquidity. These adjustments may occur naturally, but they may also be encouraged by financial regulation that will for example reduce leverage.[6]

Second, it is not clear to which extent the accumulation of international reserves by emerging market economies reflects a genuine demand for safe assets. The increasing demand for reserves can be explained in part by a precautionary motive (dealing with volatile capital flows, especially those involving cross-border banking, as in Bruno and Shin, 2012). The underlying friction, in this case, is the lack of global financial safety nets or international lending-in-last-resort arrangements to insure countries against shocks to their balance of payments and international financial contagion. A reasonable case can be made, however, that some countries accumulate reserves also to resist the appreciation of their currencies (especially for China). Resisting real appreciation can be achieved by a public accumulation of foreign assets but there is no particular compelling reason that these assets should be held in a very liquid or safe form (Jeanne, 2012a).

On the supply side, the problem is not so much an insufficient quantity of safe assets as

[6]Regulatory reform may also increase the demand for safe assets. For example, the move of over-the-counter derivatives to centralized markets may spur the demand for high-quality collateral (International Monetary Fund, 2012, chap 3).

the fact that the frontier between safe and unsafe assets has shifted over time. Assets that were supposed to be safe turned out to be unsafe (private-label safe assets in the US and periphery government debt in the euro area). Financial markets being forward-looking, it is of the essence of a safe asset that it remains safe in the future. The best way of ensuring that the supply of safe assets is appropriate, thus, is by a credible official commitment to what constitutes a safe asset. Clarity in the commitment may be much more important than the quantity of assets itself. To which extent can claims on the private sector (as opposed to government debt) play the role of safe assets? What should be the involvement of central banks in backing (backstopping, underwriting) the safety of a particular class of assets?

Finally, the analysis should not stop at considerations on supply and demand, one must also think of the general equilibrium mechanisms by which demand and supply are equalized. We now turn to a general equilibrium perspective on safe assets.

3 Safe Asset Shortage: a General Equilibrium Perspective

This section presents a general equilibrium analysis of the effects of a shortage of safe assets. The analysis is based on an extension of Caballero et al. (2008)'s model of global stores of value in which we introduce default risk.

3.1 Assumptions

Consider the following adaptation of the continuous time model of Caballero et al. (2008). We consider the world economy as a closed economy. Global GDP is an endowment that is received in quantity X_t and grows at a constant rate g. The demand for stores of value arises from the *asynchronicity* between income and consumption decisions. The focus on consumption-saving decisions is done mostly for modeling simplicity. One could equivalently focus on the asynchronicity between sales and investment decisions in a production economy, or on a precautionary motive due to liquidity shocks (as in Holmström and Tirole, 1998). In this endowment economy, the simplest way to model a demand for stores of value is to introduce a discrepancy between the timing of income receipts and the timing of expenditure decisions.

We implement this as follows. Every period, a fraction θ of the total population is born. The same fraction θ dies, leaving total population constant. Each newborn generation receives some income at birth. However, it only consumes when it dies. Birth and death are metaphores for respectively receiving and spending an income. Income received at the beginning of life needs to be saved, which generates a demand for stores of value. We further assume that agents are risk neutral, so all assets must offer the same expected rate of return.

What stores of value are available? To start with, assume that there is a single financial asset with market value V_t. All households currently alive invest their wealth in this asset. Households about to die sell their asset holdings to the new-born generation in exchange for the current GDP flow. To fix ideas, let's assume that the financial asset is a perpetual claim to a fraction δ of global GDP.

Assume also that with a flow probability α, this asset 'defaults.' What that means is that the current holders of the asset are expropriated and the asset is transferred to the new-born generation. We can offer three possible interpretation of this default. First, it can be interpreted as a forceful transfer of ownership from old to young, a 'revolution' where the owners of wealth are expropriated to the benefit of the non-owners. Alternatively we can interpret the default as a 'debt crisis', if we think of the financial asset as a government security (a claim to future tax revenues). The default on existing public debt hurts current holders of government securities (the old), to the benefit of future taxpayers (the young). Lastly, we could stretch the interpretation of the model and interpret a crash as the outcome of a 'counterparty crisis.' In this rendition, a crisis occurs when the current holders of the asset are unable to find potential buyers. This could be the case, for instance, if the buying agents need to obtain some financing which they cannot secure. At that point, a firesale occurs since the asset becomes worthless to the sellers, and agents with the most 'cash in the market' are able to acquire it for a fraction of its original price. In the limit, the cash-rich newborn generation is able to acquire the asset at no cost. Hence, this simple framework can be interpreted in a variety of ways, from a counterparty risk/firesale crisis, to a full-blown debt crisis.[7]

To summarize, in the model a financial asset is characterized by two parameters: δ and α. Parameter δ captures the extent to which the asset represents a claim on physical output, i.e., the *fundamental* value of the asset. In particular, if $\delta = 0$, the asset has no fundamental value since it never pays any income. Parameter α measures the *riskiness* of the asset. A *safe* asset is an asset for which α is equal to zero or very low. Taken together, these parameters determine the value of the financial asset: $V_t = \delta X_t / \left(r - g + \alpha\right)$.[8] Everything else equal, higher risk α reduces the value of the asset because this lowers the expected return on the asset.

3.2 Safe asset shortage and real interest rate

We are used to think that the value of an asset decreases with its default risk. However, this is a partial equilibrium result in which the riskless real interest rate is taken as given. Things are quite different in general equilibrium, as we show in this section.

First, let us derive the equilibrium level of the real interest rate. Since agents are risk neutral, the arbitrage equation for the value of the asset is:

$$r_t V_t = \delta X_t + \dot{V}_t - \alpha V_t,$$

[7] One notable oversimplification is that these different 'crises' have no implications on the path of aggregate output X_t. This could be relaxed by assuming that aggregate output, or its growth rate is also affected by the crisis.

[8] To see this, note that under risk neutrality $V_t = E_t \int_t^\infty \delta X_s e^{-r(s-t)} ds$ where $E_t \left[X_s\right] = X_t e^{(g-\alpha)(s-t)}$. When there is no default risk, this reduces to Gordon's formula for a stock whose dividend grows at rate g.

where r_t represents the riskfree rate. This equation states that the riskfree interest rate r_t is equal to the expected return on the financial asset. The expected return on V_t comprises two terms. The first term, $\left(\delta X_t + \dot{V}_t\right)/V_t$ is the return on the financial asset if there is no default. The last term, $-\alpha$, represents the rate of capital loss in a default times the flow probability of default α. The expected valuation loss in case of default lowers the expected return on the asset. In equilibrium this must be compensated by either a lower value of the asset, or a higher expected valuation gain $\dot{V}_t/V_t$.

Denote by W_t the aggregate financial wealth of the population at time t. By construction, the following must hold at any instant:[9]

$$V_t = W_t = X_t/\theta.$$

The first equality simply states that financial wealth must equal the market value of the financial asset. The second equality is the equilibrium condition for the good market: consumption (θW_t) must be equal to output (X_t).

Combining these equations, one can solve for the equilibrium interest rate in this economy:

$$r_t = \delta\theta - \alpha + g.$$

A key implication is that *the riskless real interest rate decreases with the default risk in the global store of value*. The intuition behind this result is straightforward. The demand for the global store of value is inelastic and its value must equal a fraction$1/\theta$ of global GDP irrespective of the default risk. So when the default risk increases, the equilibrium real interest rate must decrease so as to keep the value of the asset constant.

Although simple to understand, this result marks a significant departure from conventional intuition about the impact of default risk on asset prices. Conventional intuition—

[9]This condition must also hold when a default occurs, since a default is a wealth transfer between households that leaves total wealth unchanged.

which tends to be in partial equilibrium—takes the riskless real interest rate as given. Higher default risk, then, lowers the price of the asset and increases its yield. In general equilibrium, however, it is the real interest rate that adjusts to a change in default risk. Higher default risk for one financial asset lowers the price of this asset, but higher default risk *for all financial assets* lowers the real interest rate.[10]

One can capture the notion that safe assets "disappear" (i.e., become unsafe), in the model, by assuming that at a given point in time, the default risk α unexpectedly increases from zero to a positive level. The impact, then, will be a fall in the real interest rate, which may have both positive and negative consequences. On the positive side, the fall in the real interest rate mitigates the wealth loss caused by the default risk. More generally, the real interest rate adjustment reduces the price volatility induced by a volatile default risk. In addition (stepping outside of the model), the lower interest rate may help debtors stay solvent, which tends to increase the supply of safe assets in equilibrium.

A fall in the real interest rate, however, may also cause problems. As we know from the literature on the zero-bound constraint, an economy tends to fall in a liquidity trap when the Wicksellian, or natural, real rate of interest that would obtain in a flexible price environment becomes negative. Our model tells us that this could result from a global shortage of safe assets.[11] If the world economy had a single monetary authority, absent inflationary pressures, the natural rate would represent the relevant target for monetary authorities (Woodford,

[10] This is consistent with the fact that, for instance, the yield on US Treasury securities did not change much following the downgrading of US public debt in 2011.

[11] If α is sufficiently high, the natural real interest rate in the model could well turn negative (note that since α is a flow probability, it is not constrained to be smaller than 1). The model, thus, brings a new answer to a question that is actively researched in the current literature about the kind of shocks that may lead to a persistent liquidity trap. Large and persistent falls in the natural rate of interest are difficult to obtain in standard models, and the literature on the liquidity trap often resorts to technical tricks in order to make the liquidity trap persistent, such as assuming a recurrent negative demand shock (Eggertsson and Krugman, 2012). Some recent contributions explore more realistic explanations, for example based on precautionary savings (Guerrieri and Lorenzoni, 2011). Our extension of the Caballero et al. (2008) model suggests that an economy could fall into a liquidity trap because of a decrease in the supply of safe assets, and could stay trapped as long as the safe asset shortage persists.

2003).[12] A sharp decline in the natural rate would thus require a similar drop in the policy rate, so as to prevent the global economy from sliding into recession. Hence, the model provides a natural rationale for the fact that policy rates should decline rapidly and in a coordinated fashion when a global safe asset shortage emerges. This policy easing does not generate inflationary pressure, as long as the real interest rate remains equal to the natural rate. In that case, global monetary authorities may find themselves constrained by the zero-lower-bound on nominal interest rates. The observed low nominal interest rates (close to zero) could still be contractionary since they would implement a real interest rate in excess of the natural rate.

We now discuss another problem that may result from a shortage of safe assets, the fact that it makes the economy prone to develop risky asset price bubbles.

3.3 Bubbles

A bubble is an asset that never yields an income ($\delta = 0$), so that its fundamental value is 0. However, one can see from the equilibrium conditions that the asset will be traded in equilibrium and its value will still be X_t/θ, while the natural interest rate will equal $r = g - \alpha$.

The existence of bubbles in overlapping generations models is well-known since Samuelson (1958). The value of a bubble comes from the liquidity and storage services it provides to young and old. Newly born are happy to purchase this financial claim even if it does not pay any dividend, simply because they know that future newly born will want to purchase it from them. The existence of bubbles illustrates that the economy exhibits strong *endogenous* forces to create '*sui-generis*' stores of value.

In Samuelson (1958)'s model, the bubble was a safe asset and it was interpreted as "money". But there is nothing in the model to guarantee that bubbles are safe. Indeed, as

[12] We abstract here from domestic considerations. Of course the latter may imply that monetary conditions vary across countries. But global monetary conditions would nonetheless need to be consistent with the world natural rate of interest. So if some countries adopted a more contractionary monetary policies than described above, this would have to be offset by more expansionary conditions elsewhere.

we now show, riskier bubbles tend to crowd out safer ones, so that the natural state of an economy with pure bubbles should pretty volatile.

To see this, let us consider an economy with two bubbles, one riskier than the other. The bubbles are denoted by $i = 1, 2$ and we assume, without loss of generality, that bubble 2 is more risky than bubble 1 (i.e., $\alpha_2 > \alpha_1$). We denote the value of the bubbles by B_1 and B_2 to distinguish them from an assset with a positive fundamental value (which we reintroduce in a moment). The arbitrage equation for bubble i is:

$$\dot{B}_{it} = (r_t + \alpha_i) B_{it}.$$

Then the arbitrage equations, together with the market clearing conditions $W_t = B_{1t} + B_{2t} = X_t/\theta$ characterize the equilibrium. Defining $b_{it} = B_{it}/X_t$, the market clearing conditions imply:

$$r_t = \theta b_1(g - \alpha_1) + \theta b_2(g - \alpha_2).$$

The real interest rate is the average of the interest rate of the bubble-1 only economy ($r = g - \alpha_1$) and the interest rate of the bubble-2 only economy ($r = g - \alpha_2$) weighted by the share of each bubble in total financial assets. The equilibrium interest rate, thus, decreases with the size of the riskier bubble.

Using the expression for the real interest rate, one finds that the value of the riskier bubble obeys the following differential equation,

$$\dot{b}_{2t} = (\alpha_2 - \alpha_1)(1 - \theta b_{2t}) b_{2t} \geq 0.$$

This implies that there are only two possible steady states. In the first one $\bar{b}_2 = 0$ so that the economy never uses the riskier bubble. However, it is easy to see that this equilibrium is unstable. As soon as $b_{2t} > 0$, then $\dot{b}_{2t} > 0$ and the riskier bubble expands relative to the safer one. The other steady state is $\bar{b}_2 = 1/\theta$. That steady state is stable, meaning that all paths starting with $b_{2t} > 0$ converge to it. In that steady state, the riskier bubble crowds out entirely the safer one, a sort of '*Gresham-law*' for bubbles.

Why does the riskier bubble crowd out the safer one? The answer is that the rate of growth in the value of the riskier bubble needs to be higher, in equilibrium, to compensate for the fact that it is more likely to collapse.[13] It follows that the safer bubble becomes smaller and smaller relative to the riskier one, and that its size in terms of GDP converges to zero.

An economy with bubbles is likely to exhibit a very volatile boom-bust cycle in its asset market assets. While asset crashes have no aggregate consequences in this model, it is easy to imagine extensions where they would generate bank failures, financial instability, and real volatilsity. So the risk that the financial sector might endogenously load on risky bubble assets as stores of value should be a source of concern. Preventing the emergence of risky bubbles is a reasonable objective for policymakers.

3.4 Safe asset prophylaxy

We now show that a sufficient supply of safe assets creates an environment in which it is more difficult for bubbles to emerge. Safe assets have, so to speak, a prophylactic role: they *immunize* the economy against the eruption of risky bubbles.

To see this, let us introduce a safe asset into an economy with bubbles. We now assume that the economy has two assets, an asset V that has some fundamental value and virtually no default risk ($\delta > 0$ and $\alpha \simeq 0$) and a bubble B with the opposite characteristics ($\delta_B = 0$ and $\alpha_B > 0$). Since risky bubbles crowd out safer ones, one might be tempted to conclude that the same will be true here: that the bubble will crowd out the safe asset. In fact, the opposite is true: it is the safe asset that eliminates the bubble. Going through the same steps

[13] Remember that the collapse of the asset, in our model, means that the asset is transferred, not that it disappears. The riskier bubble, thus, never disappears, but its owners are expropriated more often than for the other bubble.

as before, the equilibrium conditions yield:

$$r_t = g + \delta\theta - \alpha + (\alpha - \alpha_B)\theta b_t.$$

Then note that in the long term, the growth rate of the bubble must be smaller than the growth rate of the economy, $r + \alpha_B \leq g$. Otherwise the bubble would become infinitely large relative to GDP, which is not possible since the demand for financial assets is a fixed fraction of GDP. By backward induction, the bubble could not take off the ground. Using the expression for the real interest rate, this implies that a bubble is possible only if

$$\delta\theta \leq (\alpha - \alpha_B)(1 - \theta\bar{b}),$$

where $\bar{b}$ is the long-run bubble-value-to-GDP ratio. If $\alpha \leq \delta\theta$, this expression cannot be satisfied for positive values of α_B and $\bar{b}$. This expression can be satisfied for positive values of $\bar{b}$ and α_B only if $\alpha > \delta\theta$, and in this case bubbles can exist. Thus we have the following result.[14]

Result 1. (Prophylactic role of safe a ssets) Bubble assets cannot exist in equilibrium if there is a safe asset V such that $\alpha < \theta\delta$.

The condition $\alpha < \theta\delta$ says that the risk in the safe asset must be small enough relative to its fundamental value. If this condition is satisfied, the real interest rate $r = g + \delta\theta - \alpha$ is larger than the growth rate and bubbles cannot arise because the economy is dynamically efficient. It is well-known from the literature that bubbles can exist only in environments that are dynamically inefficient (i.e., in which the real interest rate is lower than the growth rate).[15] A safe asset makes the economy inhospitable to bubbles by making the economy

[14] See the appendix for a formal proof that fully characterizes the bubble dynamics.

[15] The link between dynamic inefficiency and the possibility of rational bubbles is discussed at length in the literature (e.g. Tirole, 1985, Blanchard and Weil, 2001, Ventura and Martin, 2011 and Farhi and Tirole, 2011). Several recent contributions emphasize that it is possible for an economy to sustain bubble even if the economy is dynamically efficient. The key observation is that the market interest rate may be low (which

dynamically efficient, and it does so immediately, not asymptotically. As soon as the safe asset is introduced, the interest rate rises sufficiently to destroy the value of the bubble asset.

This discussion offers a way to think about the different stages of the crisis in the real world. Initially, the world experienced a decline in its global δ, due for instance to the consequences of the Asian financial crisis, or the collapse in the dotcom bubble (see Caballero et al. (2008) for an analysis of global imbalances along these lines). Interest rates declined. With a low δ, the condition for the elimination of fragile bubbles ($\delta\theta > \alpha$) was not satisfied, so 'private label' assets could emerge, both in the US and European financial sectors. The low interest rates also fueled leverage, and therefore an increased demand for safe asset 'internal' to the financial sector.

With the onset of the financial crisis, some fragile bubbles collapsed and there was a general re-assessment of the fragility of all financial claims, i.e., an across the board increase in α. Increased financial fragility further reduced interest rates, opening the door to more 'private label' bubbles to emerge. In this context, the low-α assets, such as US Treasuries, capture a premium.

3.5 Quantitative illustration

What is the appropriate supply of safe assets? If we take the model literally, the size of the supply does not matter provided that the asset is perfectly safe (if $\alpha = 0$, then the condition $\alpha < \delta\theta$ is satisfied for any δ). So in principle, the model says that it is possible even for a tiny issuer of an assets (in the limit of $\delta = 0$) to stabilize the global financial system as long as $\alpha = 0$. This is unrealistic as it implies that a country like Switzerland can underwrite the entire supply of safe assets to the world. But this limit result does not survive in the more realistic case where there is some incompressible amount of risk $\underline{\alpha}$ for any asset, i.e.

is needed to sustain bubbles) while the social return to capital may be high (which is what is needed for productive dynamic efficiency). The wedge between the market and the social rates of return to capital can in turn arise from financial or informational frictions. In short, one can study set-ups where bubbles can arise even if rates of return to capital exceed the growth rate. In these settings too, lower interest rates increase the likelihood that bubbles can emerge and survive.

$\alpha \geq \underline{\alpha} > 0$. Then the requirement that $\delta\theta > \underline{\alpha}$ has important implications for the 'size' of the issuers.

Let us assume, for the sake of the discussion, that the safe asset is government debt (more on this later). Suppose that the fiscal authority in country i issues debt with the minimum level of risk $\underline{\alpha}$. The asset is a claim to future tax revenues $\tau^i X^i$ where τ^i is the implicit average rate of taxation and X^i is the output of country i. If country i were under autarky, the supply of this public asset would be enough to root out risky bubbles as long as $\tau^i\theta > \underline{\alpha}$. Suppose that this condition is satisfied. Now ask the following question: can country i provide a sufficient quantity of safe assets for the global financial system? The public asset of country i represents a claim to a share $\delta = \tau^i\omega^i$ of the world output, where ω^i is the share of country i in world output: $\omega^i = X^i/X$. The condition for financial stability becomes

$$\tau^i\omega^i\theta > \underline{\alpha}.$$

This condition imposes a minimum size on country $i : \omega^i > \underline{\alpha}/\left(\tau^i\theta\right)$. For instance, with an average tax rate of 20 percent, a marginal propensity to consume out of wealth θ of 5 percent and a lower bound probability of collapse of 0.2 percent per period (one collapse every 500 periods), the minimum size of the supplier of safe assets is equal to 20 percent of world output. Whether the asset risk is strictly equal to zero or simply close to zero can make a large difference for the quantitative implications of the model.

Consequently, safe assets should provided by large economies with a sufficiently high fiscal capacity (high $\tau^i\omega^i$), or to put it differently, a deep and liquid market for Treasury securities backed by the power to tax a substantial share of world output. This helps understand why countries like the United States can play that role, while Switzerland or even Germany might be too small. Whether the euro area can do it is a question that is discussed in the following section.

4 Safe Assets and Central Banking

One lesson from the previous section is that it is important to maintain an appropriate supply of safe assets for the stability of the global financial system. We discuss in this section the role that central banks can play in maintaining this supply. As noted before, central bank liabilities are the safe asset par excellence (in an environment with low and stable inflation) since they are composed of currency or can be repaid by creating new currency.[16] By extension, a central bank can make any domestic-currency debt asset safe by providing it with a "monetary backstop", i.e., by committing to provide the issuer with the currency required to repay the debt or to buy the asset itself at the no-default price. It is difficult to think about the supply of safe assets, thus, without taking into account the behavior of the central bank in a crisis.

One could indeed try and develop a history of central banking from the perspective of the supply of safe assets. Central banks such as the Bank of England or the Banque de France were originally created to be the banks of the sovereign and the managers of the sovereign's debt.[17] Central banks then assumed the responsability of maintaining banking stability during the nineteenth century, with the development of the lending-in-last-resort doctrine by Walter Bagehot—a conception of central banking that inspired the creation of the US Federal Reserve in 1913. Thus, one could argue (at the risk of oversimplifying) that central banks were created to make government debt a safe (or at least, safer) asset, and that this role was later extended to the liabilities of private banks. This would be an oversimplification, of course, because central banks had other important goals, most notably garanteeing the convertibility of their liabilities into gold or silver at a fixed parity. As a result, the central banks' ability to make the liabilities of the government and of other banks

[16] We are assuming that central bank liabilities are denominated in domestic currency. Conceivably a central bank could default on its foreign-currency denominated liabilities.

[17] To quote the history page on the Bank of England web site, "The Bank of England was founded in 1694 to act as the Government's banker and debt manager." (http://www.bankofengland.co.uk/about/Pages/history)

safe had to be limited and conditional. For example, lending-in-last-resort was meant to make banks' liabilities safer against the risk of illiquidity but not that of insolvency.

After the link between money and commodity was severed in several steps during the twentieth century, the focus of central banking theory shifted to the choice of the best nominal anchor to replace gold. This effort culminated, at the end of the twentieth century, with a view of central banking that is best represented (again, at the risk of oversimplifying) by the inflation targeting doctrine. Inflation targeting focuses on the macroeconomic objectives of central banks and does not seem to concern itself with the supply of safe assets. One important theme of the last three decades of monetary theory is that the pursuit of low inflation supposes that central banks do not use seigniorage to fill a gap in the government's intertemporal budget constraint, a regime that Sargent and Wallace (1981) called *monetary dominance*. But monetary dominance, in the limit, may imply that the central bank let the Treasury default if it is unable to roll over its debt, and thus to sacrifice the objective of making government debt safe.

We see the tension between the pursuit of a nominal anchor and the supply of safe assets now at play in the European debt crisis. Because of the time and the conditions in which it was created, the European Central Bank (ECB) is perhaps the best incarnation of the late 20th century view of central banking—even though the ECB is not, strictly speaking, an inflation-targeting central bank. It is more likely in the euro area than elsewhere that the monetary authorities will let the fiscal authorities default rather than taking the risk of debt monetization and as a result, the debt of certain euro area governments has become less safe. There are calls for the ECB to play its role of "lender of last resort" for governments, based on a theory that the current government debt problems are self-fulfilling and not due to insolvency (de Grauwe, 2011). However, whether a crisis is due to insolvency or illiquidity is always a probabilistic judgement call, and one can never completely exclude that what starts as lending in last resort later turns out to be the first step in the monetization of an insolvent government.

We propose in this section a model that sheds light on these issues.[18] The model features a government that must roll over its debt and may be faced with a rollover crisis. The central bank may avoid (or not) the default of the government by lending to it. The central bank's decision is taken in the context of a trade-off between maintaining the safe-asset status of government debt and taking the risk of debt monetization.

4.1 Assumptions

The model has three periods, $t = 0, 1, 2$. The riskless real interest rate is normalized to zero and investors are assumed to be risk-neutral. The government must roll over some debt d in period 0 by issuing new debt that comes due in period 1 and bears a nominal interest rate i. There is no fiscal income in period 1 so that the government must roll over its debt $(1+i)d$ again until period 2. Debt is repaid with real fiscal income y in period 2, the level of which is not known in period 0. A signal about the government's solvency becomes public in period 1, and for simplicity we assume that it is perfectly informative—that is, the level of fiscal income, y, is revealed in period 1. The central bank can buy some government debt in period 1 to avoid a default but this increases the price level in period 2. The price level responds to an increase in money supply with a lag because of nominal stickiness.[19]

The nominal fiscal income in period 2 is $p'y$, where p' is the price level in period 2 (remember that y is the *real* level of fiscal income). The price level in periods 0 and 1 is normalized to $p = 1$. The price level in period 2, p', is also equal to 1 if the central bank sticks to its zero-inflation target but it could be higher if the central bank creates money to rescue the government from a default.

There is a debt rollover crisis in period 1 if the fiscal income turns out to be insufficient

[18] The analysis in this section is based on Jeanne (2012b).

[19] Alternatively, we could assume that the economy is in a liquidity trap in period 1, so that quantitative easing is not immediately inflationary.

to repay the government debt conditional on zero inflation. In this case, two things may happen: either the central bank buys the government's debt to prevent a default (monetary backstop), or it lets the government default. We take the probability that the central bank lets the government default (conditional on a debt rollover crisis) as exogenous and denote it by μ. Variable μ is a measure of monetary dominance.[20] For simplicity, we assume that there is no repayment in a default (the haircut is 100 percent).

The model is summarized by the following three equations:

$$(1+i)d = d' + m' - m,$$

$$p' = \frac{m'}{m},$$

$$\frac{1}{1+i} = \Pr\left(y > d(1+i)\right) + (1-\mu)\Pr\left(y < d(1+i)\right) = 1 - \mu F(d(1+i)).$$

The first equation is the government's budget constraint in period 1. In the absence of fiscal income, the debt coming due in period 1, $(1+i)d$, is rolled over either by issuing new debt, d', or by issuing new money, $m' - m$. The second equation says that the price level increases proportionately with money supply with a one-period lag. The third equation gives the equilibrium value of the nominal interest rate i between period 0 and period 1. The nominal interest rate could be higher than zero because of the default risk (which is the only risk to consider since there is no inflation between period 0 and period 1). This equation says that the period-0 value of a promise to pay one dollar in period 1, $1/(1+i)$, is equal to the probability that this dollar will be repaid. This probability, in turn, is equal to the probability that the fiscal income is sufficient to repay the debt without money creation ($y > d(1+i)$) plus the probability that the government is rescued from a default by money creation. In the second equality $F(\cdot)$ denotes the cumulative distribution function of y.

[20] In Jeanne (2012b) a distinction is drawn between *hard* monetary dominance (letting the government default in a rollover crisis) and *soft* monetary dominance (a proactive fiscal effort by the government to avoid a debt rollover crisis). Variable μ is a measure of hard monetary dominance.

If it is revealed in period 1 that $y < (1+i)d$, the government cannot roll over its debt without money creation.[21] The central bank may then rescue the government from a default by creating money to repay some of the debt. The monetary backstop avoids a default if the fiscal income is sufficient to repay the residual debt that is rolled over between period 1 and period 2, that is if:

$$d' \leq y.$$

Assuming that the central bank creates the minimum amount of money to avoid a default we have:

$$m' = m + (1+i)d - y.$$

4.2 Lending in last resort

The advocates of stronger ECB intervention in government debt markets often present this policy as a form of lending in last resort (see, e.g. de Grauwe, 2011). The underlying diagnosis of the crisis is that it is essentially self-fulfilling and due to an adverse feedback loop in which high spreads lead to unsustainable debt dynamics—a type of self-fulfilling crisis that was modeled by Calvo (1988).

Lending in last resort to governments is easy to rationalize in our model. To see this, note that the nominal interest rate i satisfies the following equation,

$$[1 - \mu F(d(1+i))]\,(1+i) = 1. \tag{1}$$

Let us assume that the government is solvent in period 0, in the sense that it is able to repay its debt even for the lowest realization of its fiscal income if it rolls over its debt at the

[21] The government is solvent if the nominal debt repayment is lower than the nominal fiscal income in period 2, i.e., $(1+i')d' \leq p'y$,where i' is the nominal interest rate between period 1 and period 2. The real interest rate being equal to zero, the Fisher equation implies $1 + i' = p'/p = p'$. Using this equation and $d' = (1+i)d$ to substitute i' and d' out of $(1+i')d' \leq p'y$ shows that the government can roll over its debt without money creation only if $d(1+i) \leq y$.

riskless interest rate ($F(d) = 0$). Then $i = 0$ is a solution of equation (1), i.e., there is an equilibrium in which the government rolls over its debt at a zero interest rate and remains solvent without debt monetization. This may not be the only equilibrium, however. In the absence of monetary backstop ($\mu = 1$), the equation above could also admit another solution with a positive interest rate $i > 0$ because its left-hand side may be decreasing with i. The intuition for this multiplicity is exactly the same as in Calvo (1988)'s model of self-fulfilling debt crises. A higher level of interest rate implies a higher burden of repayment in the future, which increases the probability of default and thus becomes self-validating.

The bad equilibrium disappears if the central bank pins down the interest rate spread to zero by committting to provide a monetary backstop to a government debt crisis ($\mu = 0$). The only solution to equation (1), then becomes $i = 0$. The monetary backstop removes the default risk without creating an inflation risk. The default risk is not replaced by an inflation risk because—we assume—debt monetization leads to inflation with a one-period lag and so does not generate an inflation risk premium between period 0 and period 1. The promise to monetize debt removes the bad equilibrium and never has to be implemented in the good equilibrium. As a result, there is neither a default risk nor an inflation risk in the good equilibrium. Lending in last resort delivers a policymaking "free lunch."

The case with $F(d) = 0$ thus delivers a stark conclusion. By providing a monetary backstop, the central bank can make government debt a safe asset in all dimensions: it removes the default risk in government debt without creating an inflation risk. The monetary backstop, in this case, can truly be called a form of lending in last resort.

4.3 The trade-off between default risk and inflation risk

The case $F(d) = 0$ delivers stark conclusions but it may be more realistic to consider the case where the government is not solvent with probability 100 percent conditional on not paying a spread, i.e., where $F(d)$ is perhaps small but not strictly equal to zero. In this case, whether or not to provide the monetary backstop involves a trade-off between default risk and inflation risk. We explore in this section the terms of this trade-off.

Let us respectively denote by P_{def} and P_{inf} the probability of default and the probability of inflation viewed from period 0. Setting $d = 1$ to alleviate the algebra, we have

$$P_{def} = \mu F(1+i),$$
$$P_{\text{inf}} = (1-\mu) F(1+i).$$

Using equation (1) the interest rate on government debt can be defined as an increasing function of the probability that the central bank will not provide a monetary backstop,[22]

$$i = i(\overset{+}{\mu}).$$

Increasing μ raises the probability that there is a debt rollover crisis with either default or inflation,

$$\frac{d(P_{def} + P_{\text{inf}})}{d\mu} = f(1+i)i'(\mu) > 0,$$

where $f(\cdot) = F'(\cdot)$ is the probability distribution function of y.

It would be wrong, thus, to assume that the monetary backstop simply replaces the risk of default by a risk of inflation. Enhancing the monetary backstop (reducing μ) raises the probability of inflation by less than it reduces the probability of default because this lowers the probability of the event leading to either default or inflation (a debt rollover crisis). Conceivably, reducing μ could lower the probabilities of both default and inflation. This is the case if $dP_{\text{inf}}/d\mu > 0$, that is if

$$i'(\mu) > \frac{F(1+i)}{(1-\mu)f(1+i)}.$$

[22] i is increasing with μ if the l.h.s. of equation (1) is increasing with i, i.e., if the equilibrium is on the efficient part of the debt Laffer curve. This must be the case in a good equilibrium.

If the interest rate spread is very responsive to the probability of monetary backstop, then raising this probability might *reduce* the risks of *both* default and inflation.

To illustrate, Figure 8 shows how the probabilities of default (blue line) and inflation (green line) depend on the probability of monetary backstop, $\alpha = 1 - \mu$. To construct the figure, the initial debt was set to $d = 1$, and the fiscal income was assumed to be normally distributed with mean 1.3 and standard deviation 0.2, implying that the government is solvent with probability 93 percent if it does not pay a default risk premium on its debt. However, in the absence of a monetary backstop ($\mu = 1$) the government has to pay a default risk premium that raises the debt repayment and endogenously reduces its solvency. For these parameter values, the government is in fact unable to refinance its debt in period 0 in the absence of monetary backstop, and must default with probability 1. The probability of monetary backstop must be higher than 43 percent for the government to be able to roll over its debt in period 0. When this is the case, the probability of inflation remains relatively small. For a full monetary backstop ($\mu = 0$), the probability of inflation is equal to the probability that the government is insolvent conditional on not paying a risk premium, which is about 7 percent.

The monetary backstop, thus, does not simply replace a bad outcome (default) by another (inflation), it reduces the probability of a bad outcome altogether by allowing the government to roll over its debt at a low interest rate and mitigating the risk of explosive debt dynamics. A monetary backstop replaces a high probability of default by a low probability of inflation, and might be a necessary condition to maintain the safe asset status for government debt.

4.4 Incentives

The model, as it stands, does not capture what is perhaps the main argument against providing a monetary backstop to the government debt market, which is that it gives bad fiscal incentives to governments. We now look more closely into this argument.

Let us assume that the economy pays a welfare cost C_{def} for a government default and a cost $C_{\inf}$ for monetizing the debt. The cost of government default could involve a banking crisis, a capital flight or a loss of reputation.[23] The costs of monetizing the debt are not very different, especially if the inflation rate is high and the size of the debt to be monetized is such that inflation should be accompanied by banking and financial repression.[24] Jeanne (2012b) argues that since government debt in advanced economies is a large multiple of base money, the welfare cost of monetization would indeed be high and perhaps not much smaller than that of an outright default.

Viewed from period 0, the expected welfare cost of either default or inflation (i.e. the expected welfare cost of a debt rollover crisis) is given by

$$\begin{aligned} C &= P_{def}C_{def} + P_{\inf}C_{\inf}, \\ &= F(1+i)\left[C_{\inf} + \mu(C_{def} - C_{\inf})\right]. \end{aligned}$$

In order to study fiscal incentives, let us assume that the government has the choice in period 0 between a "good" fiscal policy and a "bad" fiscal policy. Fiscal income tends to be higher with the good policy than with the bad one. More formally, the probability that fiscal income falls below any level is higher with the bad fiscal policy, that is $F_b(y) > F_g(y)$ for any y. The choice of the fiscal policy is made after the government has borrowed at interest rate i.

Assuming that the government is benevolent, the incentives to implement good fiscal policy are captured by the welfare cost difference,

$$C_b - C_g = \left[F_b(1+i) - F_g(1+i)\right]\left[C_{\inf} + \mu(C_{def} - C_{\inf})\right], \tag{2}$$

where C_g and C_b are the expected welfare cost of a debt rollover crisis under the good fiscal

[23] There is a large literature on the costs of defaulting on sovereign debt. See Borensztein and Panizza (2009) for a review.

[24] See Reinhart and Sbrancia, 2011.

policy and the bad fiscal policy respectively.

If defaulting is more costly than monetizing the debt, the second factor on the right-hand side of equation (2) is increasing with μ. That is, monetary dominance gives the government an incentive to implement the good fiscal policy. This is the effect that the opponents of the monetary backstop have in mind. However, there is another effect involving the nominal interest rate. The monetary backstop could enhance the fiscal incentives if it reduces the interest rate more under the good fiscal policy than under the bad one.[25] If the cost difference $C_{def} - C_{\inf}$ is small, it is not clear which effect dominates.

The model also explains why the relationship beween monetary policy and government debt is more problematic in the euro area than elsewhere. In currency areas where there is one single fiscal authority (such as the US, the UK or Japan), this auhority fully internalizes the welfare costs of debt monetization. In the euro area, by contrast, the cost of debt monetization are shared among the member countries. This may be captured in the model by assuming that the cost of debt monetization is $C_{\inf}/n$ instead of $C_{\inf}$ where n is the number of member countries. This reduces the right-hand side of equation (2), an effect that may be offset by increasing μ, i.e., by enhancing monetary dominance. That is, the incentives to choose a good fiscal policy are weakened in a currency union, and it becomes more important to keep the incentives aligned by not providing a monetary backstop.

Another implication of the model is that it might be more desirable to provide the monetary backstop for government debt than for private debt. The reason is that private borrowers, being small relative to the whole economy, do not internalize their contribution to the monetization risk and are therefore more likely to undertake excessive risk in reponse to the monetary backstop. More formally, for a small private borrower the relevant action is an effort that improves the future cash flow. Denoting with a lower-case letter the variables of a small atomistic borrower, the welfare benefit of making the effort is the same as in equation

[25]The monetary backstop enhances the fiscal incentives if $F_b(1+i) - F_g(1+i)$ is decreasing with i. The variations of $F_b(1+i) - F_g(1+i)$ with i are not signed in general.

(2) but excluding the cost of inflation, which is taken as exogenous by the borrower,

$$c_b - c_g = [F_b(1+i) - F_g(1+i)]\, \mu c_{def}.$$

We observe that the incentives to avoid a default are directly proportional to the monetary dominance index and disappear if $\mu = 0$. This is a classical example of moral hazard induced by a financial safety net. In this case, furthermore, the financial safety net is endogenous to the actions of the private borrowers who do not internalize their collective impact on policy.[26] By contrast, the government, as a large borrower that cares about social welfare, internalizes the welfare cost of debt monetization when setting fiscal policy.

4.5 Discussion

For government debt to remain a safe asset, the government must remain solvent. This leaves open the question of how the monetary authorities can help the fiscal authorities to st ay solvent. The conventional view is that the monetary authorities should focus entirely on price stability and let the government adjust fiscal policy conditional on low seigniorage. The alternative would be to monetize the government's debt, which would replace a bad outcome (default) by a worse one (high inflation). This view of the relationship between central banking and government debt is widely accepted in policy circles and it is supported by the academic literature on monetary policy. But it implies, in the limit, that the monetary authorities should stand ready to let the government default in the event of a debt rollover crisis.

The model that we have just presented suggests that the conventional view misses a few subtle but important things about the relationship between central banking and government debt. First, in a situation with multiple equilibria, a promise by the central bank to backstop a debt rollover crisis removes the bad equilibrium without creating an inflationary risk. The

[26] This is a version of the common agency problem modeled by Tirole (2003).

central bank's monetary backstop makes government debt default-free without making it more risky in terms of inflation.

Second, even if the government is not solvent for sure conditional on the monetary backstop, the trade-off between the default risk and the inflation risk might be such that it is possible to reduce the default risk a lot at the cost of a small risk of inflation. The monetary backstop stabilizes the dynamics of government debt by preventing negative shocks from raising the interest rate and the ensuing feedback loop between high interest rates, rising debt and pessimistic expectations. Given the terms of the trade-off, it is not clear a priori that it is preferable to minimize the risk of inflation rather than that of default.

Coming back to the crisis, one puzzle is why the government debt turmoil started in the euro area rather than the US, the UK or Japan even though the fiscal fundamentals seemed better on average in the euro area than in the latter countries before the crisis.[27] Although other factors are certainly at play, we would suggest that this is due primarily to a difference in the relationship between central banking and government debt. There is an expectation in most economies (including those with an inflation-targeting regime) that the central bank would intervene to avoid a government default in a rollover crisis. This expectation does not exist in the euro area because of the way it was designed. As we have argued, there are reasons that the euro area was designed in this way: in particular, the multiplicity of fiscal authorities makes it more important to enforce monetary dominance in the euro area than elsewhere—at least until the appropriate fiscal incentives are provided by mechanisms other than spreads on government debt. But other things equal, this puts the euro area at a disadvantage in the production of safe assets.

What is the implication for the future of safe assets? One (pessimistic) view is that the euro area debt crisis reflects a trend of safe asset extinction. Private-label safe assets became

[27]As shown in Jeanne (2012b), in 2009 the levels of government debt and of primary deficit relative to GDP were lower on average in the euro area than in the US, the UK or Japan (which were comparable to the average worse four or five countries in the euro area).

unsafe, after which it was the turn of advanced economies government debt, starting (but this is only the beginning) in the euro area. We are skeptical that these two events (the US mortgage crisis and the euro area government debt crisis) should be extrapolated in this way. The euro area debt crisis is generated to a large extent by factors that are specific to the euro area and come from the way it was designed. In most advanced economies outside the euro area, the attitude of central banks toward government debt is such as to ensure a low default risk at the same time as a low inflation risk.

Finally, the problem with the supply of safe assets does not seem to be that the quantity was insufficient, but rather that the definition of safe assets has been elusive and shifting. In the old times, safe assets were defined as central bank liabilities (cash) and government debt. With securitization and tranching, new classes of assets came to be used as safe assets (e.g., senior tranches of MBS) in the US, but they turned out to be not so safe. Their fragility comes from the unavoidable fact that private assets are poorly designed to withstand aggregate shocks. More recently in Europe, certain government debts have lost the status of safe assets. As a result of those shifting lines of demarcation, the definition of what truly constitutes a safe asset became blurry, leading to a sentiment that no asset is safe any more.

Against this backdrop, we would argue in favor of coming back to the basics. It is of the essence of a safe asset that it should not become unsafe. The supply of safe assets has a key impact on the the financial sector and the real economy and so the definition of the safe asset universe should not be left entirely to the private sector. The authorities should commit themselves to a clear definition of safe assets and back it with a policy regime that makes those assets credibly safe. Claims on the private sector are inherently risky and should stay so to limit moral hazard: for this reason they may not provide a good basis to produce safe assets. Besides money, government debt remains the best candidate for the status of safe asset.

5 Safe Assets in the Global Economy

The previous analysis has a number of implications for the global economy. First, it suggests that global banking will naturally take place in the currency that offers an appropriate supply of safe assets. This role is fulfilled now primarily by the US dollar. As is explored in great detail in Bruno and Shin (2012), this implies that global banks play a powerful role in transmitting dollar monetary and credit conditions to the rest of the world.

Second, we have argued that there are important distinctions to be made between inside and outside liquidity and between public and private liquidity. In tranquil times, these different forms of liquidity are close substitutes and trade at similar prices. In times of global stress, however, private and inside liquidity dry up, as counterparty risk rises. The only relevant form of liquidity comes from the public sector, through liquidity injections of the monetary authorities, or the injection of public funds in troubled financial institutions. Our analysis in section 3 indicates that the disappearance of 'safe assets' can unleash financial instability as the global economy searches for alternate stores of value. The general equilibrium signature of a decline in the supply of safe assets is a decrease in real interest rates. While this mechanism is in general stabilizing (increasing the supply of existing stores of value), it can push the economy in a fragile state where financial instability increases further. The solution, we argued, is to ensure that the world economy is supplied with a sufficient quantity of *public safe assets*. Section 4 argues that this requires a careful coordination between monetary and fiscal policy, to ensure that public assets remain safe, even in the face of a global crisis.

One could imagine a future where this global provision of safe assets is decentralized.[28] Under the 'house in order' doctrine, each major economy could ensure the safety of their domestically-issued public debt instruments through sound fiscal policy –ensuring that the

[28] See Farhi, Gourinchas and Rey (2011) for a more in-depth analysis.

present value of future real primary surpluses is sufficient to cover outstanding real liabilities in most states of the world– and monetary/fiscal coordination –immunizing public debt against roll-over crisis and extreme events. In such a 'multi-polar' world, the global supply of safe assets would grow more or less in line with the world economy, ensuring a globally adequate provision of safe assets, and the excess return accruing to the issuers of the safe assets are likely to be more evenly shared. A corollary is that we can expect the central role of the dollar to eventually decline.

We are far, however, from such an environment. Of the four major world economies –the U.S., the Eurozone, Japan and China– only two – the U.S. and Japan– are currently providing global safe (and public) assets, with the addition of smaller economies such as Switzerland, Germany or to some extent the U.K.. China's current state of financial development and closed capital account imply that it is far from being able to play that role. As for the Eurozone, we discussed in the previous section how the common pool problem that lies at the core of that region's crisis prevents the European Central Bank from offering an effective backstop to publicly issued liabilities, opening the door to liquidity and solvency sovereign crises. In the short to medium term, it is clear that the fiscal-monetary nexus seems more conducive to the production of safe assets in the US than in the euro area. One corollary is that the role of the dollar is likely to be comforted, rather than weakened, by the latest crisis. The current environment of safe asset scarcity, low real interest rates, and financial volatility is therefore here to last.

Going forward, the global scarcity of safe assets is bound to increase as the global demand for safe assets—-tied to global economic growth—-outstrips the supply—tied to US economic growth and fiscal sustainability. This is the modern version of Triffin (1960)'s dilemma. This problem might be solved, in the long run, by the emergence of new safe assets. One area of uncertainty, however, is how multiple safe assets will compete on a global stage. We have outlined above one possibility: that by increasing the supply of safe assets, a multipolar world will remove some sources of financial instability. But the virtuous feedback loop that supports the status of safe assets may also turn vicious, and the arbitrage between safe assets might generate rather than reduce volatility. In other words, the transition to a more multipolar world may not be monotonous, nor smooth, if and when it occurs. A multipolar world may therefore itself need a global backstop. As Farhi et al. (2011) discuss, this is a role that could be played by the International Monetary Fund, in coordination with the monetary authorities or Treasuries of the global issuers of safe assets.

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Appendices

A Proof of Result 1.

The dynamic equation for the bubble can be written

$$\dot{b}_t = \frac{\dot{B}_t}{X_t} - gb_t = (r_t + \alpha_B - g)b_t = (\alpha_B - \alpha)\theta\left(\frac{1}{\theta} + \frac{\delta}{\alpha_B - \alpha} - b_t\right)b_t. \tag{A.1}$$

This equation shows that if $\alpha_B > \alpha$, starting from any positive value b_0 the bubble value converges towards

$$\bar{b} = \frac{1}{\theta} + \frac{\delta}{\alpha_B - \alpha}.$$

But this means that the bubble value will exceed $1/\theta$, which is not possible since the demand for the store of value is inelastically fixed at $1/\theta$. Thus, it is not possible to have a bubble with $\alpha_B > \alpha$.

If $\alpha = \alpha_B$ then equation (A.1) becomes $\dot{b}_t = \delta\theta b_t$, and there is no admissible solution except $b_t = 0$.

Finally, if $\alpha_B < \alpha$, the dynamic equation for the bubble can be rewritten

$$\dot{b}_t = (\alpha - \alpha_B)\theta\left[b_t - \left(\frac{1}{\theta} - \frac{\delta}{\alpha - \alpha_B}\right)\right]b_t.$$

The only possible solution is that the bubble value stays constant and equal to

$$b = \frac{1}{\theta} - \frac{\delta}{\alpha - \alpha_B}.$$

Any different initial value would lead to the bubble value diverging to plus or minus infinity, which is not possible since the bubble value must stay positive and bounded by $1/\theta$. For this bubble value to be positive one must have $\alpha_B \leq \alpha - \delta\theta$. The default probability must be lower on the bubble than on the safe asset.

B Details on Data Construction.

- Figure 3:
  - Real sector demand for safe assets: from Flow of Funds Table L.100 (Households and NonProfit Organization) and Table L.101 (Nonfinancial Business). Household safe assets defined as the sum of Deposits (FL154000025), credit market instruments (FL154004005) minus Corporate and foreign bonds (FL15363005), Syndicated loans (FL153069803) and Mortgages asset (FL153065005). Nonfinancial business safe assets defined as the sum of Foreign deposits (FL103091003), checkable deposits and currency (FL143020005), Time and saving deposits (FL143030005), Money market mutual fund shares (FL143034005), Security repos (FL102050003) and Credit market instruments (FL144004005) minus Mortgages asset (FL143065005) and Consumer credit (FL143066005).
  - Real sector holdings of government securities from Flow of Funds Table L.100 and Table L.101, defined as sum of household holdings of Treasury securities including saving bonds (FL153061505), household holdings of Municipal securities (FL153062005), nonfinancial business holdings of Treasury securities (FL143061105) and nonfinancial holdings of Municipal Securities (FL143062005).

- Figure 4
  - United States: see Figure 3
  - United Kingdom: from Blue Book 2010, sum of households and non financial business safe asset holdings defined as:
    - Household and non-profit organizations: ESA sectors S.14 and S.15 unconsolidated, sum of Currency and deposits (AF.2), money market instruments (MMI) issued by UK central government (AF.3311), UK local authority bills (AF.3312), MMI issued by UK monetary and financial institutions (AF.3315), MMI issued by other UK residents (AF.3316), bonds issued by the UK central government (AF.3321), UK local authority bonds (AF.3322).
    - non financial business: ESA sector S.11 unconsolidated, sum currency and deposits (AF.2), MMI issued by UK general government (AF.3311), UK local authority bills (AF.3312), MMI issued by UK monetary and financial institutions (AF.3315), MMI issued by other UK residents (AF.3316), MMIS issued by the rest of the world (AF.3319), bonds issued by the UK central government (AF.3321), UK local authority bonds (AF.3322).
  - Germany and France: from OECD Financial Balance Sheets (non-consolidated); sum of currency and deposits (SAF2ASNC) and Securities other than shares, except financial derivatives (SAF33ASNC) for Households and nonprofit (sector S.14 and S.15) and non financial business (sector S.11).
  - European Area: from European Central Bank flow of funds.
    - Households and non-profit: sum of currency and deposits, securities other than shares, except financial derivatives, shares and other equity, minus shares and other equity excluding money market mutual funds
    - Non-financial business: sum of currency and deposits and Securities other than shares, except financial derivatives.
  - Japan: from Bank of Japan Flow of Funds. Constructed as sum of :
    - Households and Non-profit: sum of Currency and deposits (FFYS430A150 & FFYS440A100), Treasury discount bills (FFYS440A310), central government securities and FILP bonds (FFYS430A311 & FFYS440A311), local government securities (FFYS430A312 & FFYS440A312), public corporations securities (FFYS430A313 & FFYS440A313)
    - Nonfinancial corporations: sum of Currency and deposits (FFYS410A100), Deposits with the Fiscal Loan Fund (FFYS410A190), Bills purchased and sold (FFYS410A230), repos (FFYS410A280), Treasury discount bills (FFYS410A310), Central gov. securities and FILP bonds (FFYS410A311), local government securities (FFYS410A312), public corporation securities (FFYS410A313) and commercial paper (FFYS410A317).
- Figure 5:
  - Holdings of official safe assets by rest of the world from Flow of Funds Table L.106 (Rest of the World) sum of Special Drawing Rights (FL313111303), Treasury securities (FL263061105), Municipal securities (FL263062003) and Table L.204 (Checkable deposits and currency) Rest of the world currency;
  - Holdings of safe assets by rest of the world from Flow of Funds Table L.106 (Rest of the World) sum of SDR (FL313111303), US checkable deposits and currency (FL263020005), US time and saving deposits (FL263030005), US money market fund mutual shares

(FL263034003), repos (FL262050003), commercial paper (FL263069103), Treasury securities (FL263061105), agency and GSE-backed securities (FL263061705), municipal securities (FL263062003) and from Table L.203 (Net interbank transactions) sum of US chartered depository institutions interbank transactions due to foreign affiliates (FL763192603) and foreign banking offices interbank transactions due to foreign affiliates (FL753192603).

- Figure 6:
  - Real sector demand for safe assets from financial sector as in Figure [safe real assets].
  - Real sector supply of illiquid assets to financial sector: from Flow of Funds Table L.100 (Households and NonProfit Organizations), Table L.101 (Nonfinancial Business) and Table L.216 (Other loans and advances). Household supply defined as Credit market instruments liability (FL154104005) minus Municipal securities (FL163162003) and Other loans and advances (FL153169005). Nonfinancial Business supply defined as the sum of Commercial paper liabilities (FL103169100), Bank loans (FL143168005), Other loans (FL143169005) and Mortgages (FL143165005), minus U.S. government loans to nonfinancial corporate business (FL103169205) and nonfinancial noncorporate business (FL113169205).
- Figure 7:
  - From Flow of Funds Table L.107 (Financial Business) sum of Treasury securities (FL793061105) and Municipal securities (FL793062005) minus Table L.108 (Monetary Authority) Treasury securities (FL713061100), Table L.117 (State and Local Government Employee Retirement Funds) Municipal securities (FL223062003)
  - From Flow of Funds Table L.108 (Monetary authority) sum of Depository institutions reserve (FL713113003) and vault cash of depository institutions (FL763025005).

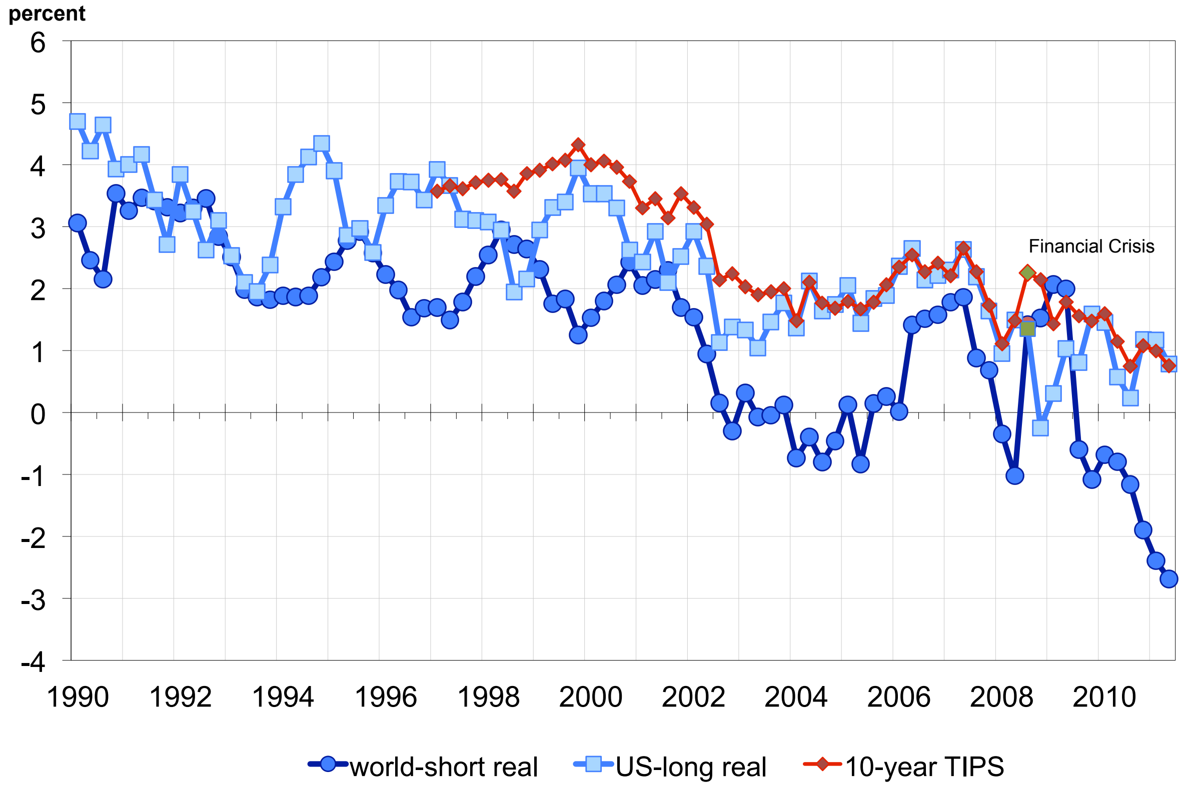

Figure 1: World Real Interest Rates, 1990Q1-2011Q3. Source: Global Financial Database, OECD, International Financial Statistics, Survey of Professional Forecasters.

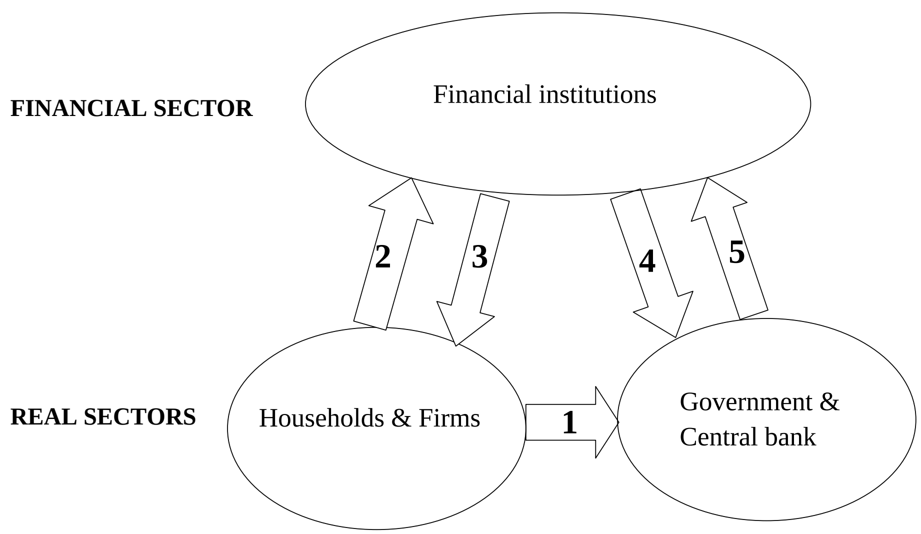

Figure 2: Debt claims in Real and Financial Sector.

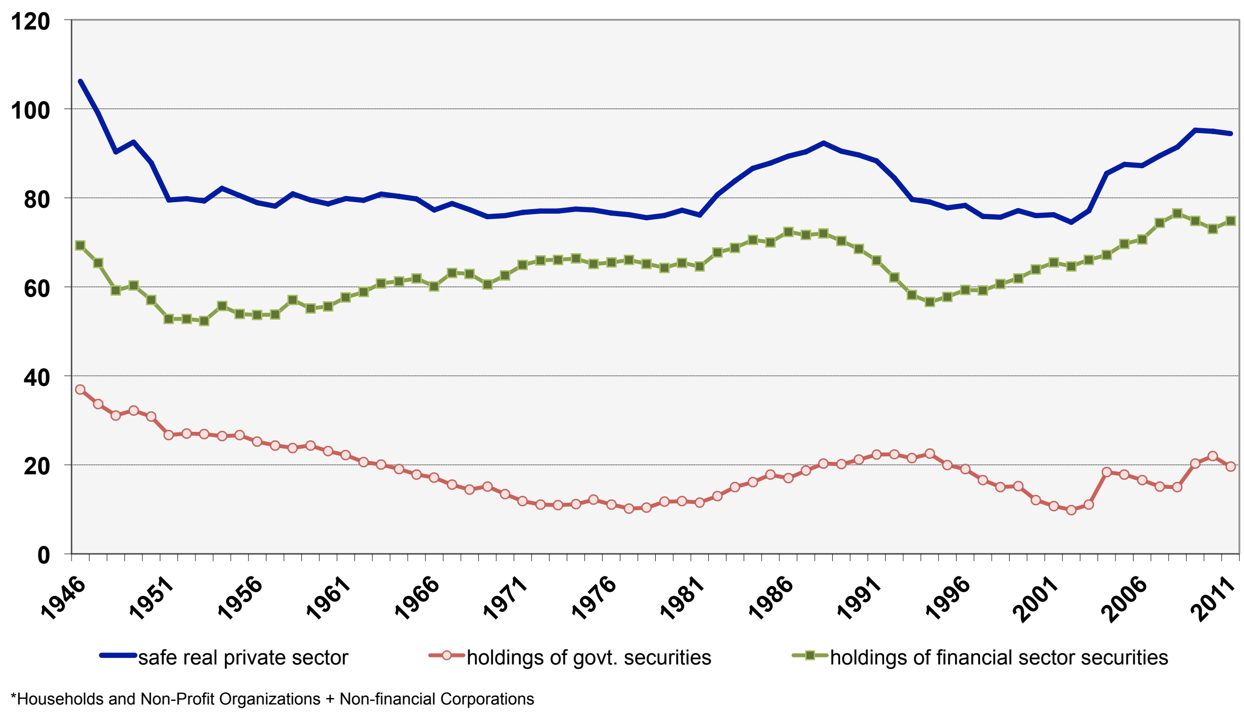

Figure 3: Holdings of Safe Assets by US Households and US Non Financial Business Sectors. Percent of US GDP. Source: Flow of Funds Accounts. See appendix B

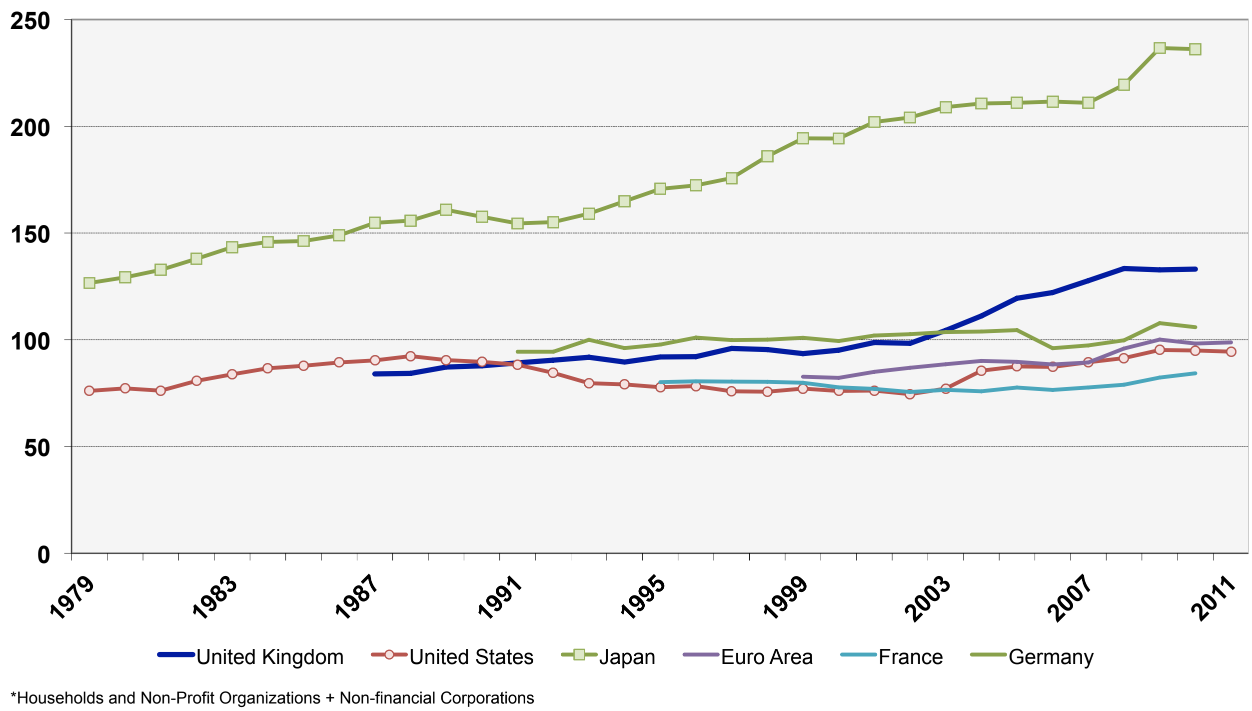

Figure 4: Holdings of Safe Assets by Households and Non Financial Business Sectors in Japan, the UK, Germany, France and the euro area. Percent of GDP. Source: Flow of Funds Accounts. See appendix B

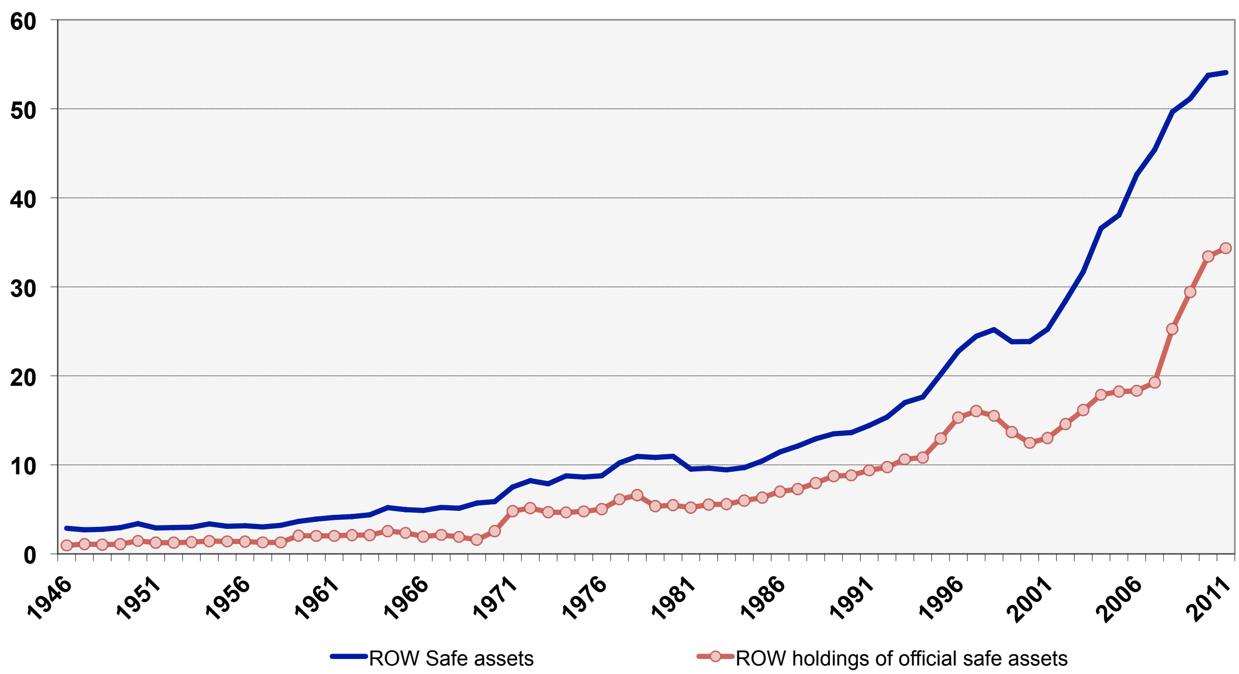

Figure 5: Holdings of Safe Assets by the Rest of the World. Percent of US GDP. Source: Flow of Funds Accounts. See appendix B

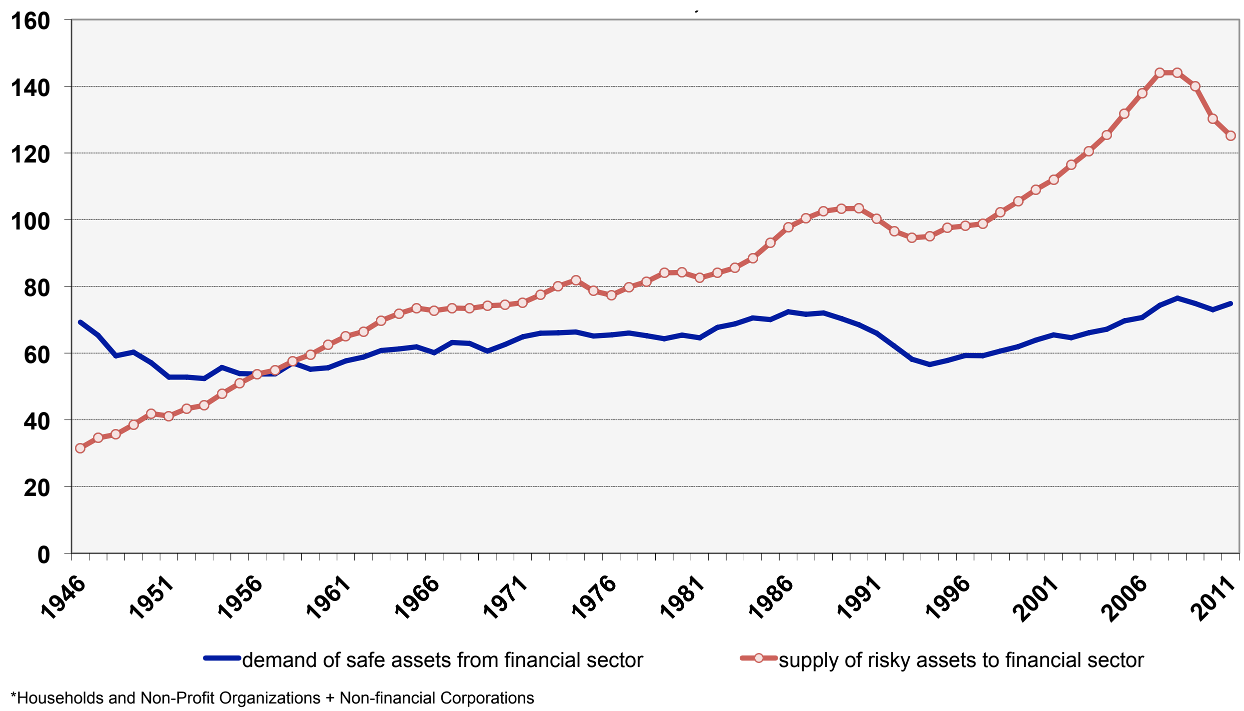

Figure 6: US Real Private Sector: Holdings of Safe Assets from Financial Sector and Supply of Risky Assets to Financial Sector. Percent of US GDP. Source: Flow of Funds Accounts. See appendix B

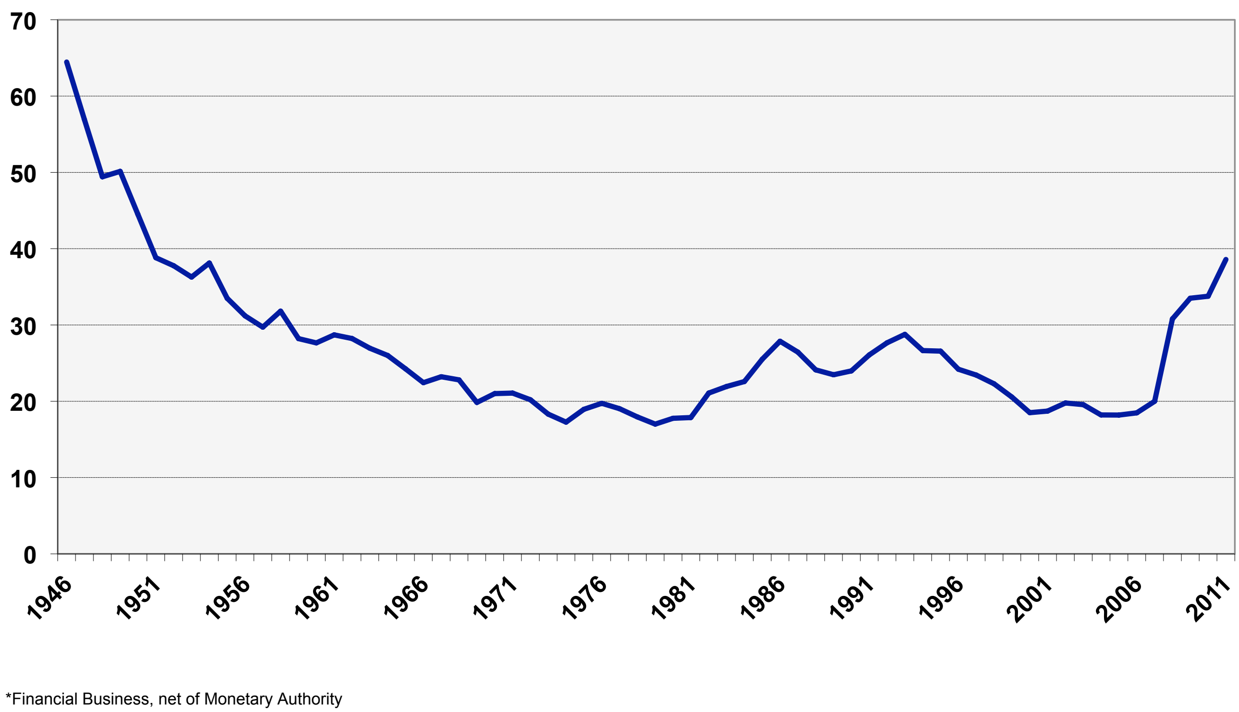

Figure 7: Holdings of Government Safe Assets by the US Financial Sector. Percent of US GDP. Source: Flow of Funds Accounts. See appendix B

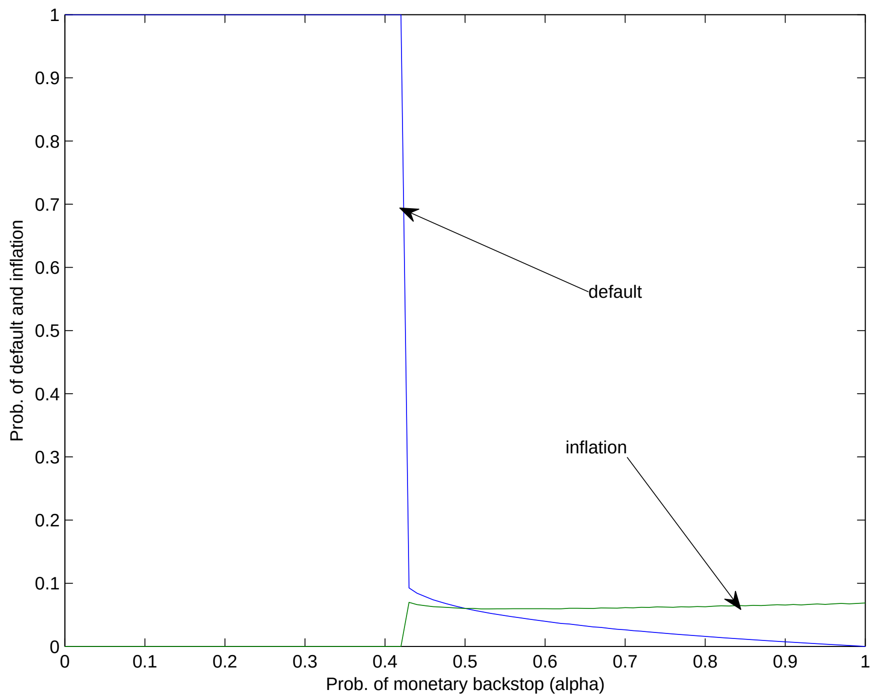

Figure 8: Variations of probability of default and inflation with probability of monetary backstop