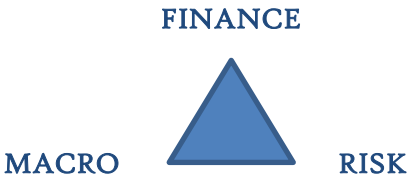

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Safe Asset Demand: A Review

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Safe Asset Demand: A Review

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September 14, 2015

Abstract

We survey the emerging literature on safe assets, built upon novel insights on a strong segmentation between safe savings and speculative investment markets. We review the recent evidence on a time-varying safety premium that suggests a demand for safety quite distinct from demand for liquidity. Next we look at the theoretical work on private safe asset creation by financial intermediaries and its effect on financial stability. Novel concepts such as maturity races, information sensitivity, risk-intolerant debt and induced runs reinforce the liquidity risk externality associated with private quasi safe assets. These new foundations have significant implications for macrofinance research on credit cycles and for prudential policy.

1 Introduction

The recent banking crisis was largely unanticipated, and has forced a major reassessment of views on risk creation during credit cycles. The macro finance research agenda is seeking a more integrated framework to describe the evolution of aggregate endogenous

risk. There appears to be a clear division of tasks. New macro models study the dynamics of economic propagation of financial shocks under financial constraints. Financial research looks at how risk incentives shape the distribution of shocks and how contracts redistribute their impact. Novel concepts such as maturity races, volatility spirals, information sensitivity, induced runs and correlated risk strategies have come to enrich our understanding of excess risk creation over the financial cycle. These new insights complement the established notion of the liquidity risk externality associated with banking.

A distinct novel insight is a recognition of a fundamental demand for safety, distinct from liquidity and money demand, with a major role in shaping contracting and the structure of financial intermediation. This survey focuses on the nature and consequences of safe asset demand, in particular how it shapes the behavior of financial intermediaries, and encourages the private supply of (quasi) safe assets. This enables to understand financial innovation during the credit boom, when novel forms of tranching, funding and hedging were developed to satisfy a strong demand for safety. Ultimately, a critical issue is whether pressure for safety contributes to aggregate risk.

1.1 A Growing Demand for Safety

Considerable evidence has emerged on a strong demand for financial safety. Krishnamurthy and Vissing-Jorgensen (2012) find long-term evidence of a distinct safety premium for Treasury debt from its liquidity premium. The premium is especially elevated at times of lower public debt supply. This is consistent with the evidence of a strong and historically very stable demand for safe assets in US household portfolios (Gorton et al., 2012). These results indicate a structural demand for safety rather than a new phenomenon. Investors appear to have strong preferences for absolute safety, distinct from the traditional need for money and liquidity. This implies a sharp market segmentation between safe and speculative asset markets. [1]

A consequence of this stable demand for safe assets is that a period of low supply of

[1] A discontinuity at the zero risk boundary may explain low empirical estimates of CAPM market beta.

government debt tends to boost (in fact, crowd in) the creation of private safe assets such as repo and short-term financial debt. Time variation in safety and liquidity premia induces changes in the volume and stability of bank and shadow bank credit and funding structure. Abundance of inexpensive savings relative to the supply of public safe assets appears to be associated with credit expansion and an increase in net long-term investment by intermediaries (Krishnamurthy and Vissing-Jorgensen, 2015), increasing maturity transformation. Its impact on aggregate liquidity risk needs to be understood by macro finance research, so as to inform preventive prudential policy. As an introductory illustration, we discuss the evidence on a strong component of demand for safety with a global dimension.

1.2 Safety Seeking Capital Flows

An influential view holds that the credit boom in 2002-2007 was driven by the recycling of large global imbalances (Bernanke (2005), Caballero et al., 2008). While historically capital flowed from rich to developing countries, since 1998 net capital flows have reversed (Prasad et al., 2007). Emerging countries have invested their trade surpluses in safe assets in developed countries (Gourinchas and Rey, 2007), especially dollar assets. The stock has grown steadily, with foreign holdings representing circa 20 per cent of US debt securities, and over 50 per cent of the Treasury market. US treasuries are mostly bought by central banks and sovereign funds, which seek dollar reserves as a precautionary measure against sudden capital outflows. As foreign demand for safety has grown faster than US public debt, US intermediaries have issued more "safe" claims to foreign private investors, who by some measures account for 80 per cent of total foreign inflows by 2007 (Forbes, 2010). The common explanation is that emerging country investors do not have safe asset markets at home, as local assets are exposed to enforcement risk (Quadrini et al., 2009) or expropriation risk (Ahnert and Perotti, 2015). The consensus view is that such a scale of inflows into the US (estimated at $\$7.8$ trillion in 2002-2007) lowered rates and increased intermediary funding, in turn boosting credit volume. In equilibrium, the direct effect of safety seeking inflows is a higher risk concentration for US residents and

intermediaries (Caballero and Krishnamurthy, 2009). [2] In this early literature, safety seeking foreign flows are assumed to be stable, so they induce higher risk concentration in domestic portfolios but do not contribute to aggregate risk (Caballero and Krishnamurthy, 2009). This is a critical assumption, as huge inflows are bound to reshape the scale and risk profile of credit. A better understanding is needed on whether pressure to create safe assets ultimately contributes to aggregate instability.

The remainder of the survey is structured as follows. Section 2 defines some useful concepts of safe assets we adopt for the review. Section 3 reviews the empirical evidence on demand and supply of safe assets. Section 4 discusses possible fundamental causes of safety demand by investors, while Section 5 looks at theoretical models of private (quasi) safe asset creation, identifies the main contractual forms and their effect on risk creation. Section 6 discuss some policy implications. Section 7 concludes.

2 Definitions

We offer some simple definitions to distinguish safety, liquidity and money demand. Safety demand is aimed at risk avoidance, liquidity demand seeks assets easily converted into money quickly, and money demand seeks claims that may serve as immediate form of payment.

Naturally, no asset is absolutely safe. We define *safe assets* as unconditional financial promises with no credit risk, whose nominal repayment is certain. As a benchmark, we define as safe any debt issued or guaranteed by a government in a country with good protection of property rights. A central bank can always honor any nominal debt in domestic currency by expanding outside money.[3] A *liquid asset* can be converted into cash quickly and at low cost. Asset liquidity is valued as it can satisfy contingent needs for consumption or investment. Safe assets are typically very liquid.[4] A private *quasi safe assets* arise in the process of inside money creation by private intermediaries. The main forms are short term

[2] Govillot et al. (2010) show that the US provides insurance to the rest of the world, in the form of a lower yield during normal times, and a transfer of wealth to foreign investors in crises.

[3] This literature ignores inflation risk, an open topic for future research.

[4] Government debt might be more liquid than claims with a government guarantee, whose repayment may be delayed.

financial debt and secured debt. We define these privately issued claims as *quasi-safe*, as they have no credit risk outside of major crises. At time of systemic distress, these private assets lose their perceived safety and become rapidly illiquid.

Finally, the classic notion of *money* is a medium of immediate payment, which can also serve as a low return store of value. It is the ultimate liquid and safe asset, with zero interest-rate risk.

Outside money is the stock of claims on central banks (Gurley and Shaw, 1960). Its defining feature is that it is statutory legal tender at face value for any obligation. In the form of currency, it is held mostly by households and small firms for transactions and as a low yield store of value, while banks hold central bank reserves for current payment flows. *Inside money* can be defined as short-term debt issued by the financial sector that can be used for immediate payment by households and firms.[5] Inside and outside money enjoy a convenience yield due to their immediate use as payment. Still in need of elaboration is the concept of a *safe haven asset*. Its basic feature is that it tends to appreciate in a financial crisis. Next to gold, safe haven assets need to be supplied by a government with strong property rights, large fiscal capacity and low inflation risk such as the US.[6]

Figure 1 maps different assets in terms of their safety, liquidity or moneyness.[7] There is a clear positive correlation between safety and liquidity though the two concepts remain distinct. [8] On the top right are money assets, safe and always liquid, whose issuers benefit from a convenience yield. Claims with a government guarantee (including insured deposits) are safe and liquid. In contrast, private quasi-safe assets are safe and liquid only outside of systemic crises. The safest among these claims are repos, ranked by the quality of their collateral, followed by short term financial debt and government money market fund shares. In the lower left quadrant are senior tranches of asset backed securities. [9] In

[5]Also savings deposits and retail money-market funds are typically considered money, as they may be quickly converted in money.

[6]He et al. (2015) model the endogenous emergence of a dominant safe asset. Strikingly, they show how market size plays a significant role next to fundamentals, favoring large country currencies such as the dollar versus the Swiss Franc.

[7]For non-marketable claims, liquidity here equals maturity.

[8]For instance, term repo on safe assets are quite safe but illiquid.

[9]These assets were not very liquid even during the credit boom, as they were mostly held for their yield.

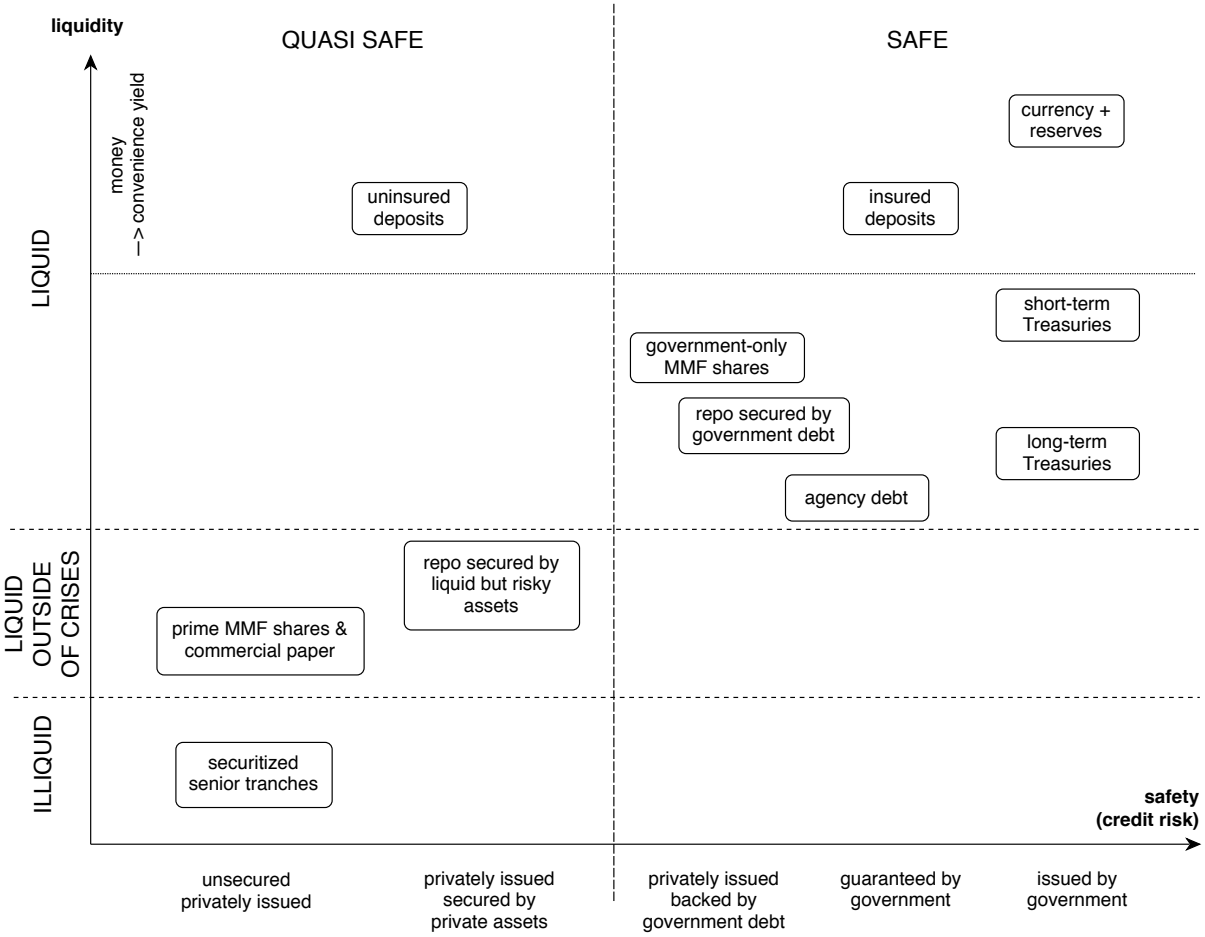

Figure 1. Asset safety and liquidity under our definition.

a crisis, the liquidity and perceived safety of private quasi safe assets drops sharply, leading to sharp changes in their yields and a limited chance of rollover.

We now turn to the evidence on the demand and supply for (quasi) safe assets.

3 Demand and Supply for Safe Assets

3.1 Evidence on Safety and Liquidity Premia in Safe Assets

Krishnamurthy and Vissing-Jorgensen (2012) show long term evidence of a strong price sensitivity of safe assets to demand and supply shocks. The yield spread between highest rated corporate and Treasury bonds, adjusted for default risk, is strongly negatively correlated with the ratio of privately held government debt to GDP. A similar relationship exists for the yield spread of commercial paper over Treasury bills. Whenever the supply of public debt is low, investors are willing to pay a higher safety premium. This evidence is inconsistent with the classical portfolio theory, where asset prices are determined exclusively by the discount factor (pricing kernel), and are independent of their supply.[10] It strongly suggests that the riskless rate is determined on a segmented market, whose size is scaled by a measure of aggregate income and wealth. The effect is stronger for lower rated corporate bonds (Baa vs Aaa) and commercial paper (A2/P2 vs A1/P1), suggesting that highly-rated (quasi safe) private debt claims have some safety qualities that investors value. This insight allows to decompose the premium on Treasuries into a liquidity (46 bp) and safety premium (27 bp). To identify the liquidity premium, they regress public debt on the yield spread between 6 months insured certificates of deposits (CDs) and Treasury Bills. This spread captures the liquidity premium, as both assets are equally safe but CDs are illiquid until maturity. Thus a measure of the short-term safety premium is the spread of lower (A2/P2) and higher (A1/P1) rated commercial paper with 3 months maturity since they are both illiquid. This spread has a significant negative relation with the stock of public debt. Finally, a measure of long-term safety premium is the yield spread of Baa and Aaa

[10] If changes in Treasury supply reflects more fiscal expenditures and a structural change in future output, in principle the pricing kernel will change, though the effect is hard to predict.

rated corporate bonds, whose liquidity is quite similar (Chen et al., 2007).

Nagel (2014) questions whether the liquidity premium on Treasuries is determined by supply and demand effects. He argues that money (reserves, deposits) and near-money assets (Treasuries) are substitutes in providing liquidity, so liquidity premia and convenience yield must be linked. Thus it is necessary to control for the opportunity cost of holding money (such as the federal funds rate) when estimating the impact of Treasury supply on the price of liquidity. [11] Indeed, the federal funds rate is strongly correlated with this liquidity premium, and has a better fit than the highly persistent Treasury supply. Vissing-Jorgensen (2015) reports that the effect of Treasury supply on the safety premium remains significant, just as its impact on the AAA-Treasury yield spread, a combined measure for safety and liquidity.

Earlier research has documented a segmentation between short-term and longer-term Treasuries at high frequency. A priori it is unclear whether this spread reflects superior liquidity or a lower interest rate risk.

Duffee (1996) provides some early evidence of a segmented demand for short-term T-bills. He finds a unique common component in Treasury bill yields not shared by Treasury notes and bonds, nor private claims of equal maturity in monthly data from 1975 to 1994. Also, when changes in yields of bills close to maturity are regressed on changes in yields of bills further from maturity to filter out time-varying common components, the residuals are positively correlated with changes in the supply of short-term bills. Interestingly, his results are stronger since the 1980s.

Greenwood et al. (2015) seek to explain the spread over 1983-2009 of actual T-bill yields over fitted Treasury yields. Bill yields closer to maturity (less than 3 months) to maturity are significantly lower than expected. A reduction in the supply of T-bills further decreases the spread, which in contrast is unaffected by the supply of longer maturities Treasuries.[12]

Carlson et al. (2014) observe how the average excess one-month holding return to

[11] As a measure of liquidity premium he uses the general collateral (GC) repo - t-bill yield spread. As GC repo is collateralised by government debt it is fully safe, but the investment is locked in until maturity.

[12] They exploit time variation in short-term government financing patterns associated with seasonal tax receipts to address endogeneity concerns.

buying Treasury bills from 1988 to 2007 increases sharply at the short end of the maturity spectrum and then falls. An increase in Treasury bill supply decreases the average excess return, more so for short maturities.

Summarizing, the evidence suggests a segmented and inelastic demand for Treasuries due to their safety and liquidity. While their safety premium is subject to supply and demand shocks, their liquidity premium is correlated with the federal funds rate (and thus by the convenience yield on money assets) at the business-cycle and long-run frequency. There also is evidence for a a segmented and inelastic demand for Treasury bills with less than 3 months to maturity. [13]

3.2 Supply of (quasi-) safe assets

The evidences points to a role for the private supply by the financial sector of (quasi-) safe assets as a substitute to scarce government debt. Krishnamurthy and Vissing-Jorgensen (2015) find in a long time-series from 1875 to 2014 a strong negatively correlation of privately held government debt/GDP with the net supply of financial short-term debt. The magnitude is quite large, a one dollar increase in Treasury debt decreases financial short-term debt by 50 cent. Interestingly, intermediaries appear to expand long-term lending one for one with short-term debt issuance. Thus a scarcity of privately held government debt increases not just credit supply but also the degree of maturity mismatch, allowing banks to earn a larger spread. Krishnamurthy and Vissing-Jorgensen argue for a causal relationship as government debt supply is in part driven by war financing and the business cycle. As a robustness check they seek to rule out a standard crowding out of investment via higher rates. They also use gold inflows in the 1930s and increased foreign official holdings from the 1970s as exogenous supply shocks. [14]

[13] Some evidence suggests that this segmentation increased since the 1980s, perhaps reflecting an increasing importance of foreign demand for safe dollar assets.

[14] Interestingly, safe asset demand can explain a puzzling behavior of monetary aggregates ("missing money") since the 1980s. Money balances (M1) rose very slowly as interest rates dramatically fell. Krishnamurthy and Vissing-Jorgensen argue that massive foreign demand for safe dollar assets reduced net supply of Treasury in this period. The effect was an increase in the convenience yield, as Treasuries are needed to back demand deposits. Households thus shifted to savings deposits, counteracting the effect of lower interest rates on demand deposits.

Financial short-term debt may be a closer substitute for T-bills rather than for Treasuries of longer maturities due to their money-like characteristics. In other words, Treasury bills enjoy a pricing benefit from their safety, liquidity and convenience quality. Greenwood et al. (2015) regress the supply of bills and non-bills on the supply of financial commercial paper, scaled by GDP. Unlike longer-term Treasuries, T-bill issuance crowds out commercial paper. A common measure for liquidity/money demand is the spread between T-bill yields and the overnight indexed swap rate (OIS).[15] Sunderam (2014) shows how ABCP issuance positively responds to variation in the T-bill-OIS yield spread, while it is crowded out by T-bill supply.[16] ABCP and T-bills appear to be substitutes as they provide money-like services, in addition to their liquidity. [17]

Summarizing, the evidence suggests a strong crowding out effect of Treasury supply on financial sector short-term debt at low and business-cycle frequency. The channel is likely via changes in the price of safety, which affects the spread financial intermediaries earn by issuing short-term debt. At high frequencies, short-term government debt crowds out short-term financial sector debt whose issuance are rather flexible, for example commercial paper. The main channel here is likely to be via changes in the liquidity premium.

4 Origins of safe asset demand

Traditional money demand implies a low convenience yield on means of payments such as cash, reserves and demandable debt as the price for immediate payment capacity (Stein (2012)). This view was at first formalized in the "money in the utility function" approach (Sidrauski (1967)). In contrast, liquidity premia reflect a demand based on contingent

[15]The OIS rate represents the expected average of the federal funds rate over a given term. OIS contracts carry little credit risk and are a good proxy for risk-free rates purged of liquidity and credit risk premia Sunderam.

[16]ABCP was a dominant form of short-term funding for banks outside of the regulatory perimeter in the run-up to the recent financial crisis Krishnamurthy et al. (2014).

[17]Krishnamurthy and Vissing-Jorgensen (2015) do not find a stronger crowding out effect of short-term financial debt over short-term government debt in their historical sample.

needs to transact in the future, either for consumption (Diamond and Dybvig (1983), Gorton and Pennacchi, 1990) or productive purposes (Holmström and Tirole, 1998, 2001, Brunnermeier and Haddad 2015). Holding liquid or unencumbered pledgeable assets enable firms and intermediaries to avoid costly frictions to access external finance caused by asymmetric information or moral hazard.
Liquid assets may also be held for speculative reasons. When some assets may trade at fire-sale prices in the future, hoarding liquidity is profitable (Allen and Gale (2004), Diamond and Rajan (2011), Gale and Yorulmazer (2013), Malherbe, 2014). In conclusion, a hedging or speculative demand for liquidity can justify a lower yield for liquid assets (Vayanos and Vila, 1999).

However, the safety premium identified since the crisis appears to result from a separate demand for an absolutely safe store of value. We consider the emerging literature on the nature of this demand.

4.1 Modelling demand for safety

Demand for safety may originate from a subset of agents who are infinitely risk-averse, leading to an inelastic and segmented demand for safe assets (Barro and Mollerus, 2014). Investors with extreme risk intolerance are prone to runs when new information suggests even a minimal chance of loss (Gennaioli et al., 2013), (Ahnert and Perotti, 2015).

Infinite risk aversion may also arise episodically in response to shocks to beliefs. In some extreme contingencies, agents may no longer be able to assess the risk return tradeoff of assets or the allocation of losses across counterparties, a form of Knightian uncertainty. Krishnamurthy (2010) and Caballero and Farhi (2015) describe a sudden shift to extreme defensive strategies triggered by such episodes. Sudden flights to safety can explain the scale of runs in a panic, although it requires an extreme degree of uncertainty.

A more general view is that all investors have a structural demand for safety in the context of their portfolio choice. Ahnert and Perotti (2015) model directly a structural safety demand by assuming Stone-Geary preferences, developed in the context of development economics. Under such preferences, individuals have a need for a minimum subsistence (survival) level of wealth. A minimum stock of resources needs to be attained in all states

to avoid a huge loss in utility. Thus a safe storage of value needs to be secured before agents absorb any risk in their residual portfolio.[18] When investors choose some assets to ensure this subsistence level, they may act very risk intolerant at the zero risk boundary. Extreme risk intolerance creates a segmented demand for safety, so that scarcity of safe assets significantly affects their yield.

Demand for safety may vary across investors, as they may differ in their access to safe assets (Caballero and Krishnamurthy, 2009). Investors from emerging markets have a particularly strong demand for safety, as domestic assets suffer from weaker property rights (Mendoza, 2000). While poor contractual enforcement reduces the value of local investment, savers in these countries are exposed to political risk that may result in full expropriation. This creates an acute need to find safety in developed markets, often in anonymous form. The massive role of off shore centers in transferring wealth across borders is explained by their essential role to anonymize holdings.[19]

Institutional motives for safe assets include reserve accumulation by central banks and sovereign funds from emerging countries. The Asian crisis in 1997 led them to build large precautionary holdings in reserve currencies for self insurance (Prasad, 2014). Public investors may have a strict mandate to avoid risk, with the effect of reducing the available supply of public debt for private investors. At present public foreign institutions hold over half of the entire US Treasury bond supply, while foreign private inflows target claims issued by US-based intermediaries. [20] Some private intermediaries may also have rigid demand for safe assets. The prime MMF industry is restricted to liquid, highly rated assets. Yet while these regulatory and industry requirements based on credit ratings contribute to some segmentation, they do not explicitly target absolute safety and may affect mostly the liquidity premium. In general, bank regulatory norms focus on the liquidity of reserves. A regulatory inducement for banks to hold safe assets is the zero capital requirement for sovereign debt holdings.

[18]The subsistence level may be subjective and depend on wealth. A dynamic version of these preferences (habit formation) that implies a strong reluctance to adjust consumption downward are standard in recent asset pricing models.

[19]Anonymity may also be sought to avoid prosecution or taxation.

[20]A reason may be their need for anonymity, as foreign holdings of US Treasury are recorded.

5 Safe Asset Creation

We next look at the contractual forms through which the financial sector creates quasi-safe assets to take advantage of the safety premium. As we focus on the funding side, we only briefly consider intermediaries' asset choice targeted at safety. Diversification through loan securitization during the credit boom contributed to redistribute credit risk. An unintended consequence was a major increase in correlation across intermediaries, which reinforce systemic runs in a panic (Allen et al. (2012), Gennaioli et al., 2013). Correlated risk strategies may emerge as a strategic choice to shift losses to aggregate default states, undermining the safety of privately issued claims.[21]/ The ability of intermediaries to issue a safe claim requires some essential conditions. First and foremost is a reliable enforcement of property rights. Next, a safe asset needs to be an unconditional promise, thus a debt claim. But debt safety may be further strengthened by contractual terms, such as

- collateralization (secured debt)
- short term maturity (time priority)
- seniority (contractual priority at default)

Seniority is a weak form of contractual protection, as its priority is dominated by maturity and collateralization. We will accordingly focus on the latter two features.

5.1 Debt as a safe claim

The safest claim written on any asset is debt, as it is the least sensitive to value fluctuations. The corporate finance literature has further justified a risk reduction effect of debt contracts in an agency context subject to adverse selection and moral hazard.

[21] Perotti and Suarez (2002) study how regulation may counter strategic risk complementarity by rewarding prudent banks by temporarily increasing their market share when other banks fail. This "lone bank standing effect" enables Martinez-Miera and Suarez (2014) to model endogenous risk creation in a dynamic macro model.

Under the asymmetric information view, debt is most liquid from a security design perspective.[22] The information insensitivity of debt reduces adverse selection, as it weakens incentives to gather superior information about the underlying asset (Dang et al. (2012), Yang, 2013). Thus it commands a premium due to its high liquidity, similarly to money (Gorton and Pennacchi, 1990). The absence of adverse selection implies that 'ignorance is bliss' for liquidity provision in most states.

However, relying on opaqueness for liquidity provision may create occasional sharp crises. When bad news arrives, investors have incentives to learn about risk, so in principle all quasi safe claims may become illiquid (Gorton and Ordonez, 2014). This forces sharp deleveraging, in order to restore an information-insensitive payoff structure.

It is hard to compare the scale of frequent small gains with larger losses in a crisis. To the extent that losses in a crisis are socialized to avoid financial distress, private incentives to issue quasi safe claims tend to create a risk externality.
Finally, the distinct case for debt arise under incomplete contracting, as the associated threat of asset repossession is effective at extracting repayment (Hart and Moore, 1998).

5.2 Safety through debt contractual design

A short maturity or the pledge of collateral are more effective to protect the value of debt claims than de jure seniority. Short-term creditors can demand repayment ahead of more senior debt when default appears imminent, while secured debt is insulated from violations of absolute priority (Auh and Sundaresan, 2015). [23] We accordingly focus on these contractual forms.

[22] There is a large literature on optimal security design under adverse selection, e.g. DeMarzo and Duffie (1999), Biais and Mariotti (2005), DeMarzo (2005) and Farhi and Tirole (2014).

[23] In bankruptcy a judge may deem efficient to violate absolute priority among unsecured debtors, e.g. to ensure proper continuation incentives.

5.2.1 Safety through short-term debt

In principle, debt of shorter maturity is safer because asset risk is less likely to materialize during a short interval.[24] However, there are more subtle reasons why short-term debt is safer. Demandable debt may discipline value creation by intermediaries by the threat of a run (Calomiris and Kahn (1991), Diamond and Rajan, 2001). Yet recent insight suggests that if safety-conscious investors trigger runs even in solvent states, exposure to withdrawal risk becomes very costly.

Intermediaries have incentives to issue short-term debt to promise safety and liquidity and capture the associated premium, even when it creates a liquidity risk externality (Perotti and Suarez (2011), Stein, 2012). In general, rollover risk may lead to higher refinancing costs when rates increase. Its effect on stability is even stronger in distress states, when refinancing might become impossible as lenders refuse to assume any risk.

As debt becomes more short term its rollover risk increases. In the extreme case of demandable debt, a coordination problem may occur even when fundamentals are sound. Essentially, the sequential service format of immediate payments makes it impossible to reprice claims so as to encourage rollover, which creates strategic complementarity among investors (Diamond and Dybvig, 1983). As withdrawals force costly liquidation of assets and reduces the value left for those who roll over, inefficient runs may occur even in solvent states Rochet and Vives (2004) and Goldstein and Pauzner (2005).Bank runs may also be triggered by temporary asset liquidity risk, even when fundamental risk is arbitrarily small (Matta and Perotti, 2015).

A novel, supply-driven motivation is advanced in Brunnermeier and Oehmke (2013). Short-term debt has de facto higher priority than long term debt, as they can adjust their claim at the rollover date to new information on the probability of default, diluting long-term creditors.This creates a spiral of increasing shorter term funding, even if all agents are risk neutral. [25]

Runs may also reflect large shocks to beliefs, such as in a sudden emergence of Knightian uncertainty (Caballero and Farhi, 2015), or sudden recognition of an unanticipated

[24]Risky debt is analogous to safe debt minus a put option, so its value decreases in its maturity.

[25]When the maturity structure of debt is staggered (He and Xiong, 2012), higher volatility, apart from directly increasing default risk, also increases the chance of future runs, leading lenders to run in advance.

loss state (Gennaioli et al., 2012, 2013). Introducing extremely risk averse agents using demandable debt may reinforce aggregate runs. Safety-seeking investors are particularly susceptible to any hint of default risk, and run more easily. Beyond some scale, they potentially induce runs even by less risk averse agents (Ahnert and Perotti, 2015).
In conclusion, ensuring absolute safety for some by issuing short term debt may increase aggregate instability. Yet because of its low cost, safety seeking funding is privately attractive to intermediaries that accept more instability in exchange for a higher return in good states.

5.3 Safety via secured debt

The credit boom saw a massive expansion in the creation of financial collateral. Banks increased their effective leverage by securitizing loans and shifting their senior tranches off balance sheets, funded by inexpensive short term debt. Shadow banks sought to replicate the safety and liquidity of bank liabilities by relying on collateralized financial credit (repos as well as margins on derivatives). This funding source grew enormously in 2002-2007 (Gorton and Metrick, 2012), until shadow bank credit surpassed total assets held by traditional intermediaries.

Thanks to the pledge of tradeable securities, repo debt can largely eliminate credit and counterparty risk.[26] Short term repo adjusts haircuts on a frequent basis, so it can be designed to be virtually riskless. Crucially, its absolute priority derives from its exemption from automatic stay in bankruptcy. Repo lenders can immediately take possession of collateral upon default and sell it. It is impossible to achieve such propriety by contract alone, as the exemption grants a proprietary right that holds in all contingencies against any third party. Secured debt provides the most safety to creditors, and is preferred over (uninsured) short term debt by risk avoiding investors.
Hanson et al. (2015) argue that shadow banks can replicate the inexpensive funding enjoyed by banks by pledging liquid assets with secured debt, while banks invest in less liquid

[26] In general, collateral reduces credit frictions caused by limited verifiability, moral hazard or asymmetric information. For a review on collateral in corporate borrowing, see Coco (2000).

projects thanks to their stable funding. Martin et al. (2014) argue that issuing only secured lending is stabilizing as it eliminates panic-based runs when payoffs are "first come, first serve". [27] However, a critical issue is its indirect effect on other debt, as the collateral pledge leads to more risk concentration on unsecured lenders. Matta and Perotti (2015) consider explicitly this interaction, and show that the unregulated private choice of secured lending tend to increase the frequency of inefficient runs by unsecured demandable debt. Thus while repo is so safe that it never chooses to run, it makes other debt less secure and thus run-prone. While a social planner may reduce inessential runs by leaving high rollover rents to unsecured creditors, a private intermediary will tend to minimize funding costs. As a result, the private choice of repo debt results in more inefficient runs and default risk than the social optimum.

This direct risk effect adds to the known externality associated with repo's fire sales of seized collateral upon default. On the incentives to quickly resell seized collateral, see Perotti and Suarez (2011) and Duffie and Skeel (2012) While most of the literature focuses on repo debt, the role of derivatives in safe asset creation is still underexplored, hampered by limited data availability. Margins pledged on derivatives also enjoy the bankruptcy privileges of secured debt. Bolton and Oehmke (2014) show how this may induce risk shifting at the cost of unsecured lenders, and the associated higher cost of funding contributes to more frequent default.

6 Implications for financial stability

The review suggests that financial intermediaries have incentives to issue quasi-safe claims such as short-term or secured debt to take advantage of their low cost. As investors value safety and liquidity, a private supply of (quasi) safe assets (as short-term or secured claims) is socially beneficial. However, incentives to supply claims promising liquidity and safety may create a risk externality. Private quasi safe assets are liquid in normal times, when they are thought to be safe. As the scale of promised safety and liquidity becomes

[27] They show that some market structures (trilateral repo market without "unwind") are more stable than bilateral repo transactions.

too large, the potential for instability increases. A drop in perceived safety, even minimal, will lead to self protective actions by safety seeking investors. Once doubts arose in 2007 over the safety of the senior ABS tranches of securitized claims, their liquidity evaporated. This had an immediate impact on unsecured funding to banks and shadow banks ran, while the price drop on financial collateral reduced secured debt capacity. The net result was a dramatic shrinkage in inside money, forcing central banks to intervene by outside money creation.

When there is uncertainty over the credit risk of asset classes or counterparties, short term debt may not be rolled over and access to new funding may freeze as a result of increased adverse selection, as more information sensitive assets promote private information gathering (Gorton and Ordonez, 2014).

Defensive action by risk avoiding agents may be reinforced if they trigger maturity shortening by other investors, widening maturity mismatch (Brunnermeier and Oehmke, 2013). Beyond some scale, runs may occur even among less risk averse agents as they seek to avoid dilution (Ahnert and Perotti, 2015). While short term financial debt suffers runs in any banking panic, repo debt played a distinct role in the crisis. While most repo debt was rolled over even in the depth of the crisis, it was scaled sharply down as financial collateral lost value and liquidity, drastically decreasing in the flow of secured credit (Gorton and Ordonez (2014), Moreira and Savov, 2014). Increased collateralization is a form of a repo run in the language of Gorton and Metrick, 2012) As Matta and Perotti (2015) show, higher haircuts increase the inclination of unsecured investors to run. Its effect on financial stability needs to be better understood, as its importance has further expanded since the crisis relative to traditional funding sources Duffie and Skeel, 2012.

While intermediaries may use unencumbered assets to raise repo debt in an emergency without selling them, once a default is triggered secured lenders have strong incentives to immediately resell collateral (Perotti (2013); Duffie and Skeel, 2012).[28] Correlated fire sales depress asset prices, inducing more runs. While runs on some intermediaries may be justified by fundamental risk, withdrawals may become self reinforcing as agents seek to

[28]They might be unwilling or unable to hold the asset, have incentives to front-sell (Oehmke, 2014), and may need to sell to avoid any legal challenge on their priority.

avoid dilution (Goldstein and Pauzner, 2005), an effect reinforced by secured debt (Matta and Perotti, 2015).

Large scale fire-sale sales have welfare implications, as they lead to pecuniary externalities by creating quantity constraints on access to credit and thus do not just imply a wealth transfer.[29] Arbitrage opportunities arising from fire sales increase the hurdle rate for new investment (Diamond and Rajan (2011), Shleifer and Vishny (2010) and Stein, 2012). A reduction in market values that forces rapid deleveraging may force further sales of illiquid collateral, and result in asset misallocation when the best users become financially constrained (Gromb and Vayanos (2002), Brunnermeier and Pedersen, 2009).

Losses that reduce financial intermediary capital will tend to have a prolonged effect on the economy (Brunnermeier et al., 2012), as tighter financial constrains lead to reduced investment (Lorenzoni (2008), Ivashina and Scharfstein, 2010). When banks lack sufficient capital to credibly monitor, bank-dependant firms may be unable to raise unmonitored finance (Holmstrom and Tirole, 1997). Public intervention that minimizes fire sales may thus have a role. Inevitably, any ex post intervention affects ex ante risk incentives.

When trust in quasi safe assets is lost, it represents a drastic decline in the stock of safe assets and will have persistent effects. An excess demand for safe assets can lead to disequilibrium in the goods market (Caballero and Farhi (2015)). While the market for safe assets usually clears via a reduction in the safe rate if there is an excess demand for safe assets, this is not possible when it is at the zero lower bound, a situation called the safety trap. Insufficient safe assets available as collateral may depress lending (Gorton and Ordonez (2014), Moreira and Savov, 2014). Similarly to a Keynesian liquidity trap, where there is an excess demand for liquid assets, this leads to a reduction in output because of a lack of aggregate demand for goods. In these cases policy may play a role in providing public safe assets.

6.1 Preventive Policy

If an increasing amount of safe debt were simply a reflection of investor preferences, any policy intervention would involve a trade off between individual safety needs and ag-

[29] As a result, marginal rates of return are no longer equalized, leading to welfare losses (Lorenzoni, 2008).

gregate stability. But as risk intolerant investors may respond to even minimal risk by protective actions, they may trigger defensive action by more risk tolerant investors. Funding may become increasingly short term debt. Brunnermeier and Oehmke (2013) stress how short term debt demand may be self reinforcing. Once long term debt is issued, intermediaries are tempted to issue debt with a shorter maturity that dilutes the safety of existing debt. This produces a maturity race towards even shorter debt.

Macroprudential policy has the task to adjust the private choice of credit volume, as it may differ from the social optimum. Rules need to be adjusted over the credit cycle, targeting excessive creation of short-term debt.

Rules that limit borrowing (Lorenzoni, 2008) can be implemented via capital requirements. Other authors propose Pigouvian taxation of short-term liabilities, which forces intermediaries to internalize the social costs of short-term funding (Jeanne and Korinek (2010), Kocherlakota et al., 2010). While Pigouvian taxation can achieve the first best allocation when risk incentives are moderate, direct limits may become necessary when solvency incentives deteriorate Perotti and Suarez (2011). Stein (2012) argues for a cap-and-trade approach, where the regulator issues tradable permits for banks to issue short-term debt. In contrast to Pigouvian taxation, the regulator may remain uninformed about individual banks characteristics, since each of them optimally acquires the right amount permits in line with the quality of their loan pool. Such a policy can be implemented with countercyclical reserve requirements and interest on reserves Kashyap and Stein, 2012.

A systemic risk tax on non-core funding has also been suggested to manage unstable foreign inflows (Shin, 2011).[30]

Prudential policies also need to target risk creation outside of the regulatory perimeter, least new rules drive safe debt issuance into the shadow banking system. An expansion in government debt crowds out the creation of financial sector short-term debt via market prices. [31] The size and composition of government debt may also be used as a tool to

[30]Hahm et al. (2013) offer cross country evidence that more non-core bank liabilities (such as wholesale and foreign flows) is associated with erosion of risk premia and greater vulnerability.

[31]The government has a comparative advantage to the private sector in providing safe assets due to its power to tax, thereby being able to pledge more than private agents can (Caballero and Farhi (2015)). Gov-

manage financial sector short-term debt issuance. The amount of government debt should be traded off against the distortions from taxation (Gorton and Ordonez (2013)). Its ability to serve as a safe asset may be compromised when it approaches some fiscal limit (Farhi Gourinchas Rey 2011). It is however not clear that government debt should be expanded to satisfy the entire demand for safe assets. An interesting argument suggests that government should issue long term debt in good times. Long-term public debt is a rare case of a large scale asset with negative beta, i.e. it appreciates in time of distress when safe rates drop. This makes it a good hedge in a portfolio of riskier assets (Caballero and Farhi (2015), Moreira and Savov (2014)). By itself, however, improving portfolio diversification does not produce absolute safety. A key question is whether short-term government debt is a closer substitute for short-term financial sector debt. This implies that the Treasury should decrease its debt maturity to counter excess short-term debt creation (Greenwood et al., 2015). The effect on financial stability should be traded off against the fiscal risk associated with short-term funding.[32] Carlson et al. (2014) advocate that the central bank should maintain a large balance sheet, holding mostly less liquid or long-term safe assets and selling short-term Treasuries. A swap of short versus long term Treasury, a so-called twist operation, decreases the maturity of public debt held in private hands while absorbing some interest rate risk. At this stage it is unclear whether such a policy has an effect on risk premia (Krishnamurthy and Vissing-Jorgensen, 2011). The traditional approach employed during the recent crisis involves central bank purchase (or refinancing on favorable terms) of less liquid private assets, which has a direct effect on prices and increases the supply of safe bank reserves.

Greenwood et al. (2014) note that the Federal Reserve and the Treasury canceled each other out recently in supplying near-money assets. While the Federal Reserve lengthened the maturity of its assets (mainly due to quantitative easing), in the process providing more near-money assets, the U.S. Treasury was lengthening the maturity of it's debt (to reduce roll-over risk), thereby pulling in the opposite direction. Since the relevant amount and composition of government debt is the amount held in private hands, the Treasury and

ernment debt also serves as safe collateral. Issuing Treasuries against pools of privately produced collateral can reduce the information-sensitivity of privately produced collateral (Gorton and Ordonez (2013)).

[32]While interest-rate risk has welfare effects by inhibiting tax-smoothing, Greenwood et al. (2014) argue there is a net gain from shortening public debt maturity.

Federal Reserve policy should be coordinated to provide more safe assets. A deeper issue is whether public policy should ensure that any demand for safe assets should be fully satisfied. Encouraging the creation of quasi safe assets may be destabilizing, if it leads to a maturity race or induces more run vulnerability even by risk tolerant agents. In addition, it is questionable whether those governments able to issue safe debt should seek to provide insurance on a global scale, accepting any amount of safety-seeking inflows.

6.2 The Euro crisis

The experience of the European sovereign debt crisis in 2010-2011 offers some distinct insight on demand for safety. The rapid process of financial integration in the first decade of the euro monetary union led to a (perceived) increased solvency in the European periphery. It produced a common euro sovereign debt markets where yields converged to an extraordinary (and ultimately unrealistic) degree. As a result, the early phase of monetary unification massively boosted the supply of perceived safe assets. The Greek crisis of 2010 deeply shook the system, creating fear of contagion to several other country's sovereign debt. The sudden disappearance of "safe debt" on such a scale undermined also the public guarantee to deposits in national banks, exacerbating the loss in perceived safety. As euro area governments no longer could control monetary creation, the nominal safety of their debt was lost. Safety seeking savings flowed rapidly to the safer core countries, reaching a dangerous level in the summer of 2011. Only once the ECB made it clear that it would stand behind bank and sovereign debt (albeit on conditional terms), the panic stopped. In a sense, the ECB action had restored (nominal) safety to local government and bank debt, satisfying in one blow the aggregate demand for safety. The subsequent step to create a banking union was essential to create the basis for further stabilization. It restored credibility to the solidity of individual banks, recognizing legacy losses and forcing recapitalization while tightening supervisory standards . The ultimately successful goal was restoration of confidence in local banking systems, a final ingredient to ensure European-wide demand for safety. As evidence of this transition, when Greece nearly left the euro area sovereign and interbank markets in other periphery countries remained stable.

7 Conclusion

We review the recent literature on safe assets. The demand for safe assets appears historically quite stable. The financial sector endogenously creates "safe" assets to fill any "gap" left by insufficient government debt, as safety premia increase. Privately produced safe assets are mostly in the form of short-term or secured debt, issued by banks or the shadow banking system. While safe in most circumstances, they are vulnerable to inessential runs by risk avoiding investors. In addition, the contractual forms chosen to promise safety may lead to induced runs, when even risk tolerant investors run in response to the threat of dilution or increased adverse selection. In conclusion, the emerging literature highlights how demand for safety has the potential to explain credit cycles, maturity mismatch and ultimately aggregate risk.

References

Ahnert, T. and Perotti, E. (2015). Cheap but Flighty: How Global Imbalances create Financial Fragility. Tinbergen Institute Discussion Papers 15-036/IV/DSF89, Tinbergen Institute.

Allen, F., Babus, A., and Carletti, E. (2012). Asset commonality, debt maturity and systemic risk. *Journal of Financial Economics*, 104(3):519 – 534. Market Institutions, Financial Market Risks and Financial Crisis.

Allen, F. and Gale, D. (2004). Financial intermediaries and markets. *Econometrica*, 72(4):1023–1061.

Auh, J. K. and Sundaresan, S. M. (2015). Repo rollover risk and the bankruptcy code. Columbia Business School Research Paper No. 13-8.

Barro, R. J. and Mollerus, A. (2014). Safe assets. Working Paper 20652, National Bureau of Economic Research.

Bernanke, B. S. (2005). The global saving glut and the us current account deficit. Technical report, FED.

Biais, B. and Mariotti, T. (2005). Strategic liquidity supply and security design. *The Review of Economic Studies*, 72(3):615–649.

Bolton, P. and Oehmke, M. (2014). Should derivatives be privileged in bankruptcy? *The Journal of Finance*, page Forthcoming.

Brunnermeier, M. K., Eisenbach, T. M., and Sannikov, Y. (2012). Macroeconomics with financial frictions: A survey. Working Paper 18102, National Bureau of Economic Research.

Brunnermeier, M. K. and Oehmke, M. (2013). The maturity rat race. *The Journal of Finance*, 68(2):483–521.

Brunnermeier, M. K. and Pedersen, L. H. (2009). Market liquidity and funding liquidity. *Review of Financial studies*, 22(6):2201–2238.

Caballero, R. J. and Farhi, E. (2015). The safety trap. Working Paper 233766, Harvard University OpenScholar.

Caballero, R. J., Farhi, E., and Gourinchas, P.-O. (2008). An equilibrium model of "global imbalances" and low interest rates. *American Economic Review*, 98(1):358–93.

Caballero, R. J. and Krishnamurthy, A. (2009). Global imbalances and financial fragility. *American Economic Review*, 99(2):584–88.

Calomiris, C. W. and Kahn, C. M. (1991). The role of demandable debt in structuring optimal banking arrangements. *The American Economic Review*, pages 497–513.

Carlson, M. A., Duygan-Bump, B., Natalucci, F. M., Nelson, W. R., Ochoa, M., Stein, J. C., and Van den Heuvel, S. (2014). The demand for short-term, safe assets and financial stability: Some evidence and implications for central bank policies. *FEDS Working Paper*.

Chen, L., Lesmond, D. A., and Wei, J. (2007). Corporate yield spreads and bond liquidity. *The Journal of Finance*, 62(1):119–149.

Coco, G. (2000). On the use of collateral. *Journal of Economic Surveys*, 14(2):191–214.

Dang, T. V., Gorton, G., and Holmström, B. (2012). Ignorance, debt and financial crises. *Yale University and Massachusetts Institute of Technology, working paper*.

DeMarzo, P. and Duffie, D. (1999). A liquidity-based model of security design. *Econometrica*, 67(1):65–99.

DeMarzo, P. M. (2005). The pooling and tranching of securities: A model of informed intermediation. *Review of Financial Studies*, 18(1):1–35.

Diamond, D. W. and Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *The journal of political economy*, pages 401–419.

Diamond, D. W. and Rajan, R. G. (2001). Banks and liquidity. *American Economic Review*, pages 422–425.

Diamond, D. W. and Rajan, R. G. (2011). Fear of fire sales, illiquidity seeking, and credit freezes. *The Quarterly Journal of Economics*, 126(2):557–591.

Duffee, G. R. (1996). Idiosyncratic variation of treasury bill yields. *The Journal of Finance*, 51(2):527–551.

Duffie, D. and Skeel, D. A. (2012). A dialogue on the costs and benefits of automatic stays for derivatives and repurchase agreements. *U of Penn, Inst for Law & Econ Research Paper*.

Farhi, E. and Tirole, J. (2014). Liquid bundles. *Journal of Economic Theory*.

Forbes, K. J. (2010). Why do foreigners invest in the United States? *Journal of International Economics*, 80(1):3–21.

Gale, D. and Yorulmazer, T. (2013). Liquidity hoarding. *Theoretical Economics*, 8(2):291–324.

Gennaioli, N., Shleifer, A., and Vishny, R. (2012). Neglected risks, financial innovation, and financial fragility. *Journal of Financial Economics*, 104(3):452–468.

Gennaioli, N., Shleifer, A., and Vishny, R. W. (2013). A model of shadow banking. *The Journal of Finance*, 68(4):1331–1363.

Goldstein, I. and Pauzner, A. (2005). Demand–deposit contracts and the probability of bank runs. *the Journal of Finance*, 60(3):1293–1327.

Gorton, G., LeWellen, S., and Metrick, A. (2012). The safe-asset share. *American Economic Review*, 102(3):101–06.

Gorton, G. and Metrick, A. (2012). Securitized banking and the run on repo. *Journal of Financial Economics*, 104(3):425 – 451. Market Institutions, Financial Market Risks and Financial Crisis.

Gorton, G. and Ordonez, G. (2014). Collateral crises. *American Economic Review*, 104(2):343–78.

Gorton, G. and Pennacchi, G. (1990). Financial intermediaries and liquidity creation. *The Journal of Finance*, 45(1):49–71.

Gorton, G. B. and Ordonez, G. (2013). The supply and demand for safe assets. Working Paper 18732, National Bureau of Economic Research.

Gourinchas, P.-O. and Rey, H. (2007). From World Banker to World Venture Capitalist: U.S. External Adjustment and the Exorbitant Privilege. In *G7 Current Account Imbalances: Sustainability and Adjustment*, NBER Chapters, pages 11–66. National Bureau of Economic Research, Inc.

Govillot, N., Rey, H., and Gourinchas, P. (2010). US External Returns and the Exorbitant Duty. 2010 Meeting Papers 371, Society for Economic Dynamics.

Greenwood, R., Hanson, S. G., Rudolph, J. S., and Summers, L. (2014). Government debt management at the zero lower bound. Technical report, Hutchins Center Working Paper No. 5.

Greenwood, R., Hanson, S. G., and Stein, J. C. (2015). A comparative-advantage approach to government debt maturity. *The Journal of Finance*, page Forthcoming.

Gromb, D. and Vayanos, D. (2002). Equilibrium and welfare in markets with financially constrained arbitrageurs. *Journal of financial Economics*, 66(2):361–407.

Gurley, J. G. and Shaw, E. S. (1960). *Money in a Theory of Finance*. Brookings Institution Washington, DC.

Hahm, J.-H., Shin, H. S., and Shin, K. (2013). Noncore bank liabilities and financial vulnerability. *Journal of Money, Credit and Banking*, 45(s1):3–36.

Hanson, S. G., Shleifer, A., Stein, J., and Vishny, R. (2015). Banks as patient fixed-income investors. *Journal of Financial Economics*, page Forthcoming.

Hart, O. and Moore, J. (1998). Default and renegotiation: A dynamic model of debt. *The Quarterly Journal of Economics*, 113(1):1–41.

He, Z., Krishnamurthy, A., and Milbradt, K. (2015). A model of the reserve asset. *Working Paper*.

He, Z. and Xiong, W. (2012). Dynamic debt runs. *Review of Financial Studies*, page hhs004.

Holmstrom, B. and Tirole, J. (1997). Financial intermediation, loanable funds, and the real sector. *the Quarterly Journal of economics*, pages 663–691.

Holmström, B. and Tirole, J. (1998). Private and public supply of liquidity. *Journal of Political Economy*, 106(1):pp. 1–40.

Holmström, B. and Tirole, J. (2001). Lapm: A liquidity-based asset pricing model. *The Journal of Finance*, 56(5):1837–1867.

Ivashina, V. and Scharfstein, D. (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics*, 97(3):319 – 338. The 2007-8 financial crisis: Lessons from corporate finance.

Jeanne, O. and Korinek, A. (2010). Excessive volatility in capital flows: A pigouvian taxation approach. *American Economic Review*, 100(2):403–07.

Kashyap, A. K. and Stein, J. C. (2012). The optimal conduct of monetary policy with interest on reserves. *American Economic Journal: Macroeconomics*, 4(1):266–82.

Kocherlakota, N. et al. (2010). Taxing risk and the optimal regulation of financial institutions. Technical report, Federal Reserve Bank of Minneapolis.

Krishnamurthy, A. (2010). Amplification mechanisms in liquidity crises. *American Economic Journal: Macroeconomics*, 2(3):1–30.

Krishnamurthy, A., Nagel, S., and Orlov, D. (2014). Sizing up repo. *The Journal of Finance*, 69(6):2381–2417.

Krishnamurthy, A. and Vissing-Jorgensen, A. (2011). The effects of quantitative easing on interest rates: Channels and implications for policy. Working Paper 17555, National Bureau of Economic Research.

Krishnamurthy, A. and Vissing-Jorgensen, A. (2012). The aggregate demand for treasury debt. *Journal of Political Economy*, 120(2):233–267.

Krishnamurthy, A. and Vissing-Jorgensen, A. (2015). The impact of treasury supply on financial sector lending and stability. *Journal of Financial Economics*, page forthcoming.

Lorenzoni, G. (2008). Inefficient credit booms. *The Review of Economic Studies*, 75(3):809–833.

Malherbe, F. (2014). Self-fulfilling liquidity dry-ups. *The Journal of Finance*, 69(2):947–970.

Martin, A., Skeie, D., and Thadden, E.-L. v. (2014). Repo runs. *Review of Financial Studies*, 27(4):957–989.

Martinez-Miera, D. and Suarez, J. (2014). Banks' endogenous systemic risk taking. Technical report, Mimeo.

Matta, R. and Perotti, E. (2015). Secured vs unsecured. Working paper.

Mendoza, E. G. (2000). On the benefits of dollarization when stabilization policy is not credible and financial markets are imperfect. Working Paper 7824, National Bureau of Economic Research.

Moreira, A. and Savov, A. (2014). The macroeconomics of shadow banking. Working Paper 20355, National Bureau of Economic Research.

Nagel, S. (2014). The liquidity premium of near-money assets. Working Paper 20265, National Bureau of Economic Research.

Oehmke, M. (2014). Liquidating illiquid collateral. *Journal of Economic Theory*, 149:183 – 210. Financial Economics.

Perotti, E. (2013). The roots of shadow banking. CEPR Policy Insight 69, Centre for Economic Policy Research, London.

Perotti, E. and Suarez, J. (2011). A Pigovian Approach to Liquidity Regulation. *International Journal of Central Banking*, 7(4):3–41.

Perotti, E. C. and Suarez, J. (2002). Last bank standing: What do i gain if you fail? *European Economic Review*, 46(9):1599 – 1622. Symposium on Finance.

Prasad, E. S. (2014). *The Dollar Trap: How the US Dollar Tightened Its Grip on Global Finance*. Princeton University Press.

Prasad, E. S., Rajan, R. G., and Subramanian, A. (2007). Foreign capital and economic growth. *Brookings Papers on Economic Activity*, 38(1):153–230.

Quadrini, V., Mendoza, E., and Rios-Rull, V. (2009). Financial integration, financial deepness and global imbalances. *Journal of Political Economy*, 117(3).

Rochet, J.-C. and Vives, X. (2004). Coordination failures and the lender of last resort: was bagehot right after all? *Journal of the European Economic Association*, 2(6):1116–1147.

Shin, H. S. (2011). Macroprudential policies beyond basel iii. In for International Settlements, B., editor, *Macroprudential regulation and policy*, volume 60 of *BIS Papers chapters*, pages 5–15. Bank for International Settlements.

Shleifer, A. and Vishny, R. W. (2010). Unstable banking. *Journal of financial economics*, 97(3):306–318.

Sidrauski, M. (1967). Inflation and economic growth. *Journal of Political Economy*, 75(6):pp. 796–810.

Stein, J. C. (2012). Monetary policy as financial stability regulation. *The Quarterly Journal of Economics*, 127(1):57–95.

Sunderam, A. (2014). Money creation and the shadow banking system. *Review of Financial Studies*.

Vayanos, D. and Vila, J.-L. (1999). Equilibrium interest rate and liquidity premium with transaction costs. *Economic Theory*, 13(3):509–539.

Vissing-Jorgensen, A. (2015). Discussion of "the liquidity premium of near-money assets" by stefan nagel.

Yang, M. (2013). Optimality of debt under flexible information acquisition. *Available at SSRN 2103971*.