A Crash Course on the Euro Crisis

by

Markus K. Brunnermeier, Princeton University
Ricardo Reis, LSE

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Markus K. Brunnermeier
Princeton University

Ricardo Reis
LSE

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Abstract

The financial crises of the last twenty years brought new economic concepts into classroom discussions. This article introduces undergraduate students and teachers to seven of these models: (i) misallocation of capital inflows, (ii) modern and shadow banks, (iii) strategic complementarities and amplification, (iv) debt contracts and the distinction between solvency and liquidity, (v) the diabolic loop, (vi) regional flights to safety, and (vii) unconventional monetary policy. We apply each of them to provide a full account of the euro crisis of 2010-12.

*Contact: markus@princeton.edu and r.a.reis@lse.ac.uk. We are grateful to Luis Garicano, Philip Lane, Sam Langfield, Marco Pagano, Tano Santos, David Thesmar, Stijn Van Nieuwerburgh, and Dimitri Vayanos for shaping our initial views on the crisis, to Kaman Lyu for excellent research assistance throughout, and to generations of students at Columbia, the LSE, and Princeton to whom we taught this material over the years, and who gave us comments on different drafts of slides and text.

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1 Introduction

The macroeconomic crises of the past twenty years have been predominantly macro-financial crises. Both the 2001-02 and the 2007-09 U.S. recessions started with shocks to domestic financial markets, while crises in emerging markets, from Argentina to Turkey, typically had sudden stops of capital flows and changes in sovereign yields. Unsurprisingly, new economic concepts have been developed to understand these crises. These ideas are familiar to researchers, but they have not yet seeped through to textbooks. As a result, policymakers and students often have some vague familiarity with several of these models but lack an understanding of how they precisely work, how they can be applied, and how they fit together. The goal of this paper is to introduce these ideas at the intersection of macroeconomics and finance. Together they provide a richer, and more accurate, account of past and future macro-financial crises.

We apply the concepts to the euro crisis of 2010-12. It serves this role well for a few reasons. First, because it features both a deep banking sector and large capital flows, two defining features of crises in developed and developing countries, respectively. Second, analyses of the euro crisis using traditional concepts, like optimal currency areas, downward rigid wages, or fiscal multipliers are already well-covered in textbooks. Applying the modern concepts to the euro crisis makes clear what traditional accounts are missing.[1] Third, avoiding a new crisis in the euro area is a priority, but institutional reforms have been slow and remain incomplete. Building a good understanding of what was behind the crisis in the first place can help guide the efforts to prevent another crisis.

With these goals in mind, this paper neither covers traditional ideas that are already well-covered in the textbooks, nor provides a full historical account of the sequence of events of the euro crisis.[2] Instead, each section introduces one important concept in macro-finance aided by one novel diagram, and then applies this concept to a stage in the euro crisis illustrated with one new figure with data. Each section is mostly self-

[1] A summary of the traditional account goes as follows: following the introduction of the euro, the small open economies in the euro area's periphery ran current account deficits in response to a fall in the costs of borrowing. The world financial crisis in 2008-10 brought about a reversion of these capital flows, which required inflation and wage growth to be lower (and even negative) in these countries relative to the core of the euro area. Sticky wages and prices implied instead a prolonged recession. The need to fix long-term budget imbalances amplified the recession through fiscal austerity, while the zero lower bound limited what monetary policy could do. Note that this account is almost entirely macroeconomic, with finance showing up only as a triggering shock. In our concepts, financial institutions and markets play a central role.

[2] See, for instance, Baldwin and Giavazzi (2015), de Grauwe (2016).

contained, and assumes familiarity only with economics at the intermediate level. It pedagogically illustrates economic concepts rather than present them in their generality. Alternative ways to present the material are to either skip the euro crisis applications, for a more theoretical primer on the ingredients of macro-financial crises, or instead to put the euro crisis application together for a full and uninterrupted account of those events.[3]

2 Capital inflows and their allocation

Before a crash, usually there is a prolonged time during which credit finances investment booms. Partly due to optimistic expectations by borrowers and lenders, credit is cheap and plentiful, and financial markets grow to intermediate the large flow of capital from savers to borrowers. Poorer regions typically have more investment opportunities, and richer regions have more savers, so internationally and regionally, the capital tends to flow from developed to developing regions. Housing is often at the center of these flows since it is one of the largest risky assets available that is owned by many people. The increase in demand for construction and real estate services drives up economic activity and raises employment. A benevolent (and common) view of the run-up to a crisis focuses on the benefits from these large capital flows. They make financial markets become integrated, economies boom, and incomes converge across regions.

A modern view of capital flows focuses instead on how they are allocated between sectors and firms. Poorer countries not only have fewer resources and more investment opportunities, but they are also worse at allocating capital to their most productive uses. Their financial markets, broadly defined as markets that allocate capital across uses, are not deep enough. This is a result of both political interference, with myriad taxes, regulation, and corruption that favors some sectors and firms at the expense of others, as well as because of banks and financial markets that are riddled with governance problems and are unsophisticated in evaluating projects. While sudden financial integration increases the capital stock, it also intensifies this misallocation. With abundant resources, bank managers become more lax at screening projects, and politicians are less eager to make structural reforms and enforce competition and smaller rents. Even if investment and production can boom, productivity falls.[4]

[3] We keep references to a minimum, but more references, as well as slides for teaching with figures from the literature, the data sources and calculations behind each figure, and other materials are available on our websites.

[4] Reis (2013) is the original statement of this misallocation hypothesis for the euro crisis, Diaz-Alejandro

2.1 A model of misallocation

To understand the phenomenon of investment booms tied to acute misallocation, consider a simple model. The economy has two sectors, and several firms in each of them, so that there is scope for two types of misallocation: between and within sectors. One sector, call it T, produces goods that are traded in international markets subject to fierce competition. Manufacturing is an example to keep in mind. The other, call it N, produces goods for the domestic market, which are protected from competition by natural and political barriers. Construction and real estate are good examples.

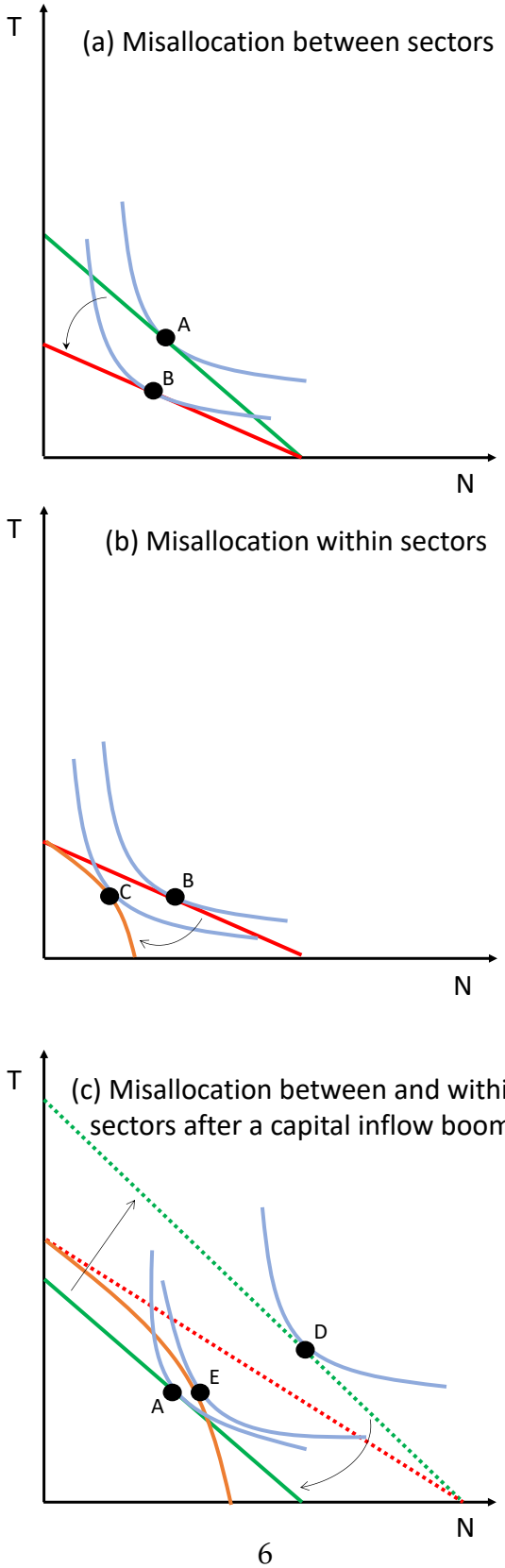
The economy has to allocate its scarce capital between the two sectors. The top panel of figure 1 shows the production possibilites frontier as a downward-sloping line: one more unit of output of good N must come with shifting some capital towards it and away from sector T, thus lowering its output. Preferences for the two goods are represented by indifference curves that are convex to the origin. The efficient ideal economy would operate at point A.

Yet, sector N is protected by local politicians. They are sensitive to the number of voters that construction employs, to the visibility of public works in showing a job done, or perhaps even to the eventual corruption that a close proximity between local politicians and local developers can engender. In turn, local bankers favor loans to construction, where collateral is available and is easy to price. Large construction companies often have important shareholder stakes in local banks pressuring the bank managers to favor them in allocating credit. Finally, construction and other non-tradable sectors, being protected from foreign competition, can more easily form local cartels and coordinate political contributions.

Because the mirror image of effectively subsidizing one sector is to tax the other, firms in sector T now face a relative tax over their output reducing the marginal product of capital. The production frontier is now flatter since diverting one unit of capital from the N to the T sector gives a lower return. This process of favoring sector N creates rents to those well-connected. Effort and resources are diverted to capturing those rents. These activities directly lower resources to all in the economy leading to a production frontier closer to the origin. For simplicity, the figure assumes that all of the taxes on sector T are lost this way. The new equilibrium, with misallocation between sectors, then occurs at point B.

(1985) is an early classic for emerging economics, and Castillo-Martinez (2018) is a recent empirical application to the euro area.

Figure 1: Misallocation between and within sectors



At the same time, within sector N, the lack of financial depth shows itself in a complementary way. Immune to foreign competition, this sector can more easily lobby for local regulations that restrict competition by making entry difficult or by putting barriers on firms growing too large. Politicians are especially receptive to the virtues of small firms because entrepreneurship is seen as a path to income mobility and because small firms employ a large share of the population. In turn, banks in underdeveloped financial markets lack the managerial talent and the tools to diversify their credit portfolio, so they are weary of giving large loans to a few firms. This leads to within-sector misallocation, as the distribution of firm size becomes left-skewed, biased towards the smaller firms.

A simple way to model this phenomenon is to consider a limit on firm size of 1 unit of capital. Imagine then that there are many potential firms to produce good N, and that the demand for this good is 3 units when the economy is running efficiently. One firm, the most productive, can produce all 3 units using 3 units of capital, as its productivity is 1. Yet, facing the upper bound, it can only produce 1 unit of output. The next best firm, which in an efficient world would be out of business, finds itself with a demand to satisfy. However, it is only half as productive, needing 3 units of capital to produce 1 unit of output. A third firm is able to operate, needing 5 units of capital to supply the last unit of output. In the end, the 3 units of output are produced using $1 + 3 + 5 = 9$ units of capital. Aggregate productivity is $3/9 = 1/3$, in contrast with the productivity of $3/3 = 1$ without the barriers to firm growth within the sector. A sign of this misallocation is the increase in the dispersion of productivity across firms in operation, as the market is prevented from driving the less productive ones out of business.

The middle panel of figure 1 shows the result of this misallocation within the sector. Each additional unit of good N is now produced with lower productivity, so that the distorted production frontier becomes concave to the origin. The economy operates at a point C, and welfare is lower.

The bottom panel of figure 1 combines these elements to show what happens after a sudden and large capital inflow. The abundance of funds worsens the misallocation between and within sectors. In the political sector, with abundant funds, the pressure to reach agreements and make structural reforms is relaxed. In the financial sector, abundant credit going to many recipients makes it harder to distinguish the productive projects from those that are not. There is a third reason why large capital inflows can worsen misallocation. Because some of the funds get directed to assets that are inelastically supplied, they create capital gains that can feed through the expectations of future gains to spur

asset price bubbles. Since these assets are then used as collateral for credit, the bubbles spur further credit in particular sectors, even if they are not particularly efficient. This is especially true in construction, which uses factors of production, like land, that are in fixed supply and are commonly used as collateral, and in credit to the smaller firms that use their owners' private residence as collateral for business loans.

Before the inflow, the poor capital-scarce region may be in points similar to B and C in the the middle panel, but the distance between these and the efficient point A in the top panel might be small. In this blown-up version of the economy, seeing the economy at first in a point A is approximately right. With more inputs available, the economy expands. If this new capital was allocated efficiently through deep financial and political markets, the economy would move from point A to point D. Economic activity would be higher, and so would welfare. In this simple economy, productivity would be unchanged or may even rise as some of the capital is devoted to adopting new technologies.

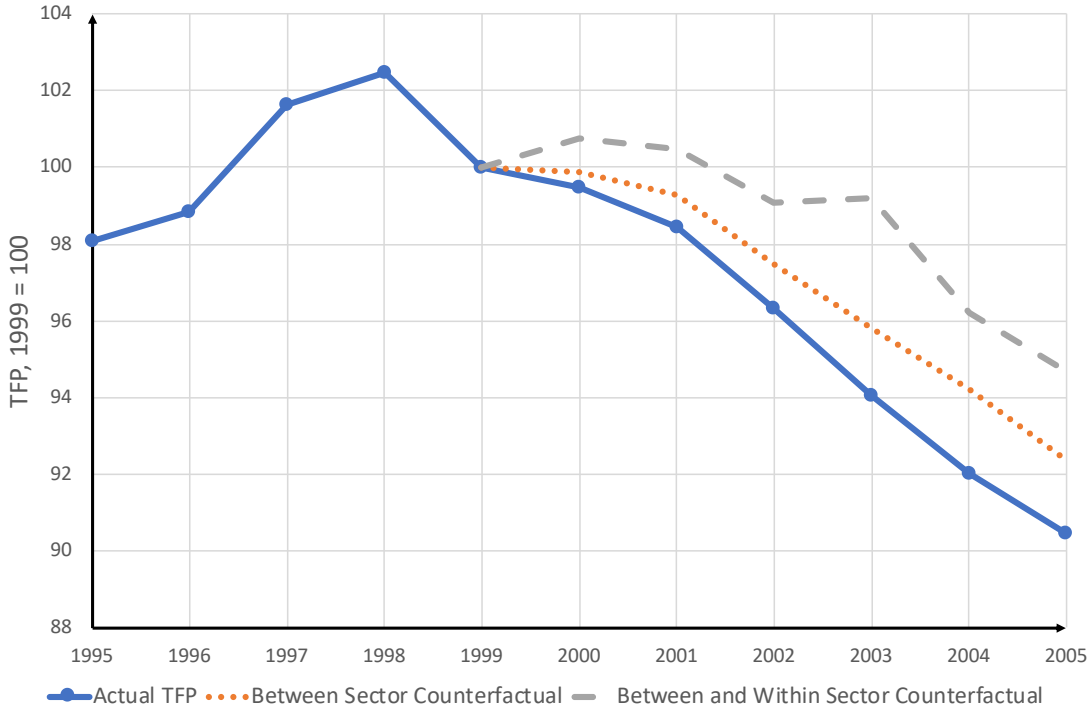
With financial shallowness instead, the inflow of capital exacerbates the misallocation. The economy ends up in point E, very far from D, and potentially close to A so the economic boom is moderate or may even barely happen in spite of all the capital inflow. Aggregate productivity slumps and dispersion of productivity rises, as the new capital is misallocated. Moreover, the run-up of foreign funding has to be repaid at some point it the future.

2.2 The seeds of the Euro crisis: the investment boom in Portugal

On January 1st of 1999, twelve countries of the European Union adopted a common unit of account, the euro. Following the 1992 Maastricht Treaty, the goal was to deepen the single market for goods and services and to create institutions that eliminated barriers to the free flow of capital across European regions. With the euro, the risk from exchange rates changing when sending capital abroad disappeared. The risk of sovereign default remained, as the Maastricht Treaty forbid European institutions from bailing out sovereigns in trouble, but optimistic investors seemed to ignore this as they were willing to lend to countries in the European periphery with a history of default and fragile public finances at quite low interest rates.

The combination of no exchange-rate risk and close to zero perceived default risk led to a large capital flow within the euro area. From the start of 2000 to the end of 2007, Germany and France ran a cumulative current account surplus (a measure of savings sent abroad) of €638 bn; Greece, Ireland, Portugal and Spain had a matching cumulative

Figure 2: Actual and counterfactual TFP in Portugal



current account deficit of €668 bn. As a whole, the euro area neither saved nor borrowed, but within it, the core region sent vast amounts of capital to the periphery region. For the periphery, this was a very large flow: the GDP of the four countries in 2007 was a mere €1,635 bn, and their external debt by then had risen to €5,507 bn.

Capital markets and political institutions in the periphery lacked the depth to channel these large flows of capital. Construction and wholesale trade sectors boomed at the expense of tradable sectors, even though productivity growth was higher in the latter and stagnated in the former. The dispersion of productivity within sectors continuously rose since the start of the euro, just as aggregate TFP stagnated in all of the periphery countries. GDP grew due to additional labor and capital input rather than productivity improvements. Indeed, productivity might have declined as economic activity shifted from more productive to less productive sectors.

Figure 2 illustrates these common facts across the periphery region for the case of Portugal. The figure plots actual TFP growth before and after the euro, showing the significant slump that the euro brought to the country. Also in the figure is a counterfactual TFP measure that keeps the relative size of each economic sector at its 1999 level. A second counterfactual shows productivity if the misallocation within sectors had stayed at

its 1999 levels as well.[5] The Portuguese productivity slump is partly accounted for by the misallocation that we described.

This allocation of capital and fall in productivity have implications for international competitiveness. The misallocation of capital spills over to labor by raising the wages of workers in the construction and public-service sectors. With abundant capital, non-tradable sectors pay higher wages and attract more workers. In Portugal, the average earnings of construction and public-sector workers relative to manufacturing workers increased significantly. This raised the costs of firms in tradable sectors, so that the competitiveness of Portuguese firms fell, and trade deficits resulted. Between 2000 and 2007, the Portuguese real exchange rate, a measure of the price of Portuguese goods vis-a-vis foreign goods, appreciated by 12%. The cumulative trade deficit of the country between 2000 and 2007 was 47% of 2007's GDP.

3 Channels of funding and the role of (shadow) banks

In the traditional view of a bank, its balance sheet is simple. On the asset side are holdings of mortgages and business loans as well as some financial assets, mostly government bonds. Banks perform the important role of monitoring domestic borrowers in order to reduce the chances of default. On the side of liabilities are primarily demand deposits from individual households. The assets are typically long-term and have little market liquidity, since they cannot be easily sold. In contrast, the banks' funding liquidity, made up of demand deposits, is short term and can be withdrawn at a moment's notice. Banks perform a second useful role: transforming maturity and liquidity, from illiquid assets to liquid liabilities. This allows depositors to have access to funds when they need them for individual private reasons, while at the same time using their pooled funds to finance long-term investments.

At the same time, this transformation leaves banks exposed to runs. If all the depositors were to demand to have their deposits redeemed at the same time, the bank would not be able to liquidate its assets to honor its promises. Moreover, if one depositor expects the others to run to the bank, she wants to run as well to try to be ahead in the line and to be able to withdraw funds before they run out. Policy, in the form of deposit insurance backed by fiscal authorities, or lender of last resort by monetary authorities, can eliminate the incentive for depositors to run, thus preserving the bank's socially beneficial role of

[5] Using the estimates of Dias, Marques and Richmond (2016).

transforming maturity. If depositors know that their deposits will always be honored, they no longer need to run. Combined with inertia by households, this policy has been successful at making demand deposits a relatively stable funding source for banks. In turn, monitoring takes effort that the banker would rather not do, so she must have some skin in the game in case loans are not repaid. Keeping an adequate amount of capital is important for banks to exert this effort and not take too many risks with the funds of the depositors.

The flow of capital across countries rarely happens directly between households and corporations, nor though a single bank across the two countries. Rather, it is intermediated by financial markets and institutions, as savers in core regions deposit their savings in banks there, and these banks proceed to lend them to banks in the periphery. Moreover, the modern financial system has changed over the previous decades, and looks different from the description above. Modern banks are different in ways that are prone to financial crises when intermediating large capital flows.[6]

3.1 Modern and shadow banks

On the asset side, modern banks securitize a significant share of their loans, especially mortgages. This involves combining them in a pool to remove the idiosyncratic risk, and selling the future revenue stream that comes from the total payments of the mortgages in exchange for a payment today. Previously hard-to-trade mortgages become, at least apparently, tradable securities. Despite now being tradable, the risk primarily stayed within the banking system. As a result, in the balance sheet of a modern bank, the share of traded assets that are constantly marked-to-market is considerably larger than in a traditional bank. This makes banks' balance sheets more transparent but also more volatile. In the run-up phase, marking-to-market boosts balance sheets even when capital gains are illusionary. Price overreactions during market down-turns exacerbate bank losses.

On the liability side, modern banks rely on a new source of funding beyond deposits or shareholder capital: the wholesale funding market. Instead of borrowing from households, funding is obtained from other financial institutions, mostly through two vehicles. The first is short-term borrowing in the unsecured interbank market. Unlike depositors, other financial institutions are well-informed and quick to withdraw their loans before demand depositors. Inertia can no longer be counted on to prevent runs, and their ability

[6]See Admati and Hellwig (2014) and Gorton (2010) on modern banks and their funding, and Santos (2017) on the Spanish banking sector.

to suspend funding before depositors gives them effective seniority.

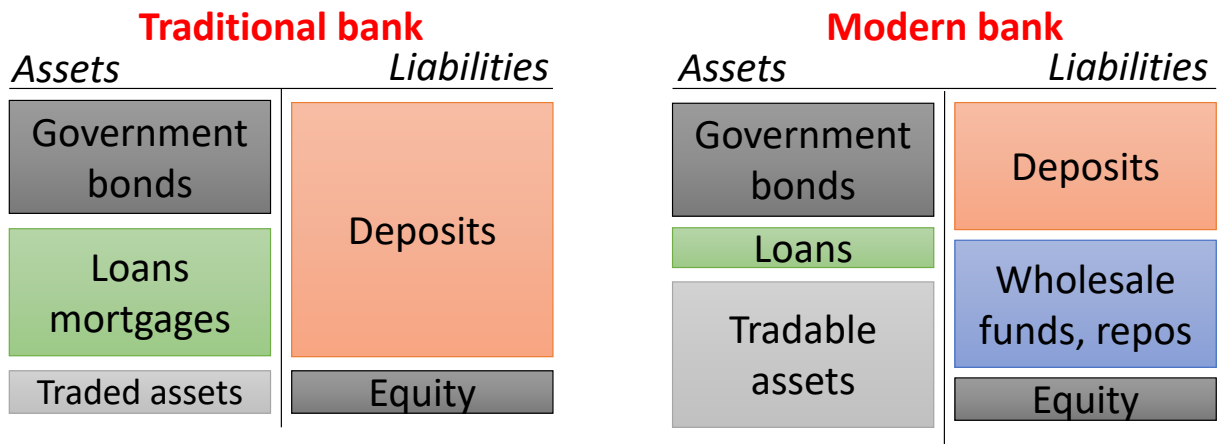
The second source of wholesale funding is repurchase agreements, or repos, where securities are temporarily sold to other financial institutions to be later repurchased at a pre-agreed price. These repos have three features that have important implications for banks' funding features. First, a security is sold in a repo transaction for a price below its market value, the difference being a haircut (or margin) that the borrower retains as a safety cushion for the case that the value of the collateral changes. Banks therefore are exposed to a new funding risk: that haircuts are suddenly raised. Second, repos typically have short durations and must be rolled over frequently, so they can quickly disappear as a source of funding. Finally, repos are collateralized borrowing and hence they enjoy seniority over demand deposit holders and unsecured interbank loans. As a consequence, interbank funding becomes more fickle and risk is pushed onto deposit holders or deposit insurance facilities.

Figure 3 contrasts the composition of the balance sheets of traditional and modern banks. Assets and liabilities interact, as banks securitize loans to transform them into tradable assets, and then use these as collateral to obtain repo funding, allowing them to give out more loans. As such, modern banks are able to grow rapidly. Both wholesale funding and repos can be obtained more quickly than deposits can be collected. Borrowing from financial markets can be done overnight, while raising deposits requires a slow and costly process of opening branches and attracting customers. Creditors are willing to fund these quick expansions of banks protected by their effective seniority, and of the collateral given by repos. Because wholesale markets work across borders, fragmented regulation across multiple jurisdictions struggles to keep this growth in check.

Modern banks are riskier than traditional banks on three accounts. First, because they grow quickly supported on wholesale borrowing, the share of net worth that funds the assets and provides skin in the game is lower. Thus, the incentives for banks to exert effort to monitor the quality of their loans and to be prudent in risk-taking become weaker.

Second, funding liquidity risk is higher. Unlike deposit retail funding, wholesale funding can be fickle since the lenders are quick to exit at the first sign of trouble. More generally, some institutions do not take deposits at all, and so avoid the government regulation that comes with them, funding themselves entirely through wholesale funding and repos. They continue to use short-term funding to make long-term investments, so they are prone to bank runs, but they do not benefit from any government insurance on their funding. Mutual funds, bond funds, and others form a "shadow banking" sector

Figure 3: Traditional and modern banks' balance sheets



with modern features.

Third, modern banks amplify asset-price cycles. When the price of houses (or other collateral) rises, the marked-to-market assets on banks' balance sheets increases right away. This increase in the value of collateral makes it easier to obtain wholesale funding in the repo market. This in turn allows for further lending by banks, lowers the cost of mortgages, increases the demand for houses, and therefore leads to a further appreciation.

3.2 The buildup towards the crisis: Spanish credit boom and the Cajas

Banks were at the center of the capital flows in the euro area. Measures of the claims of core banks on periphery banks closely match the evolution of capital flows in the 2000-07 period. In turn, these capital flows almost entirely were accounted for by interbank debt, as there was little equity or physical property that exchanged hands.

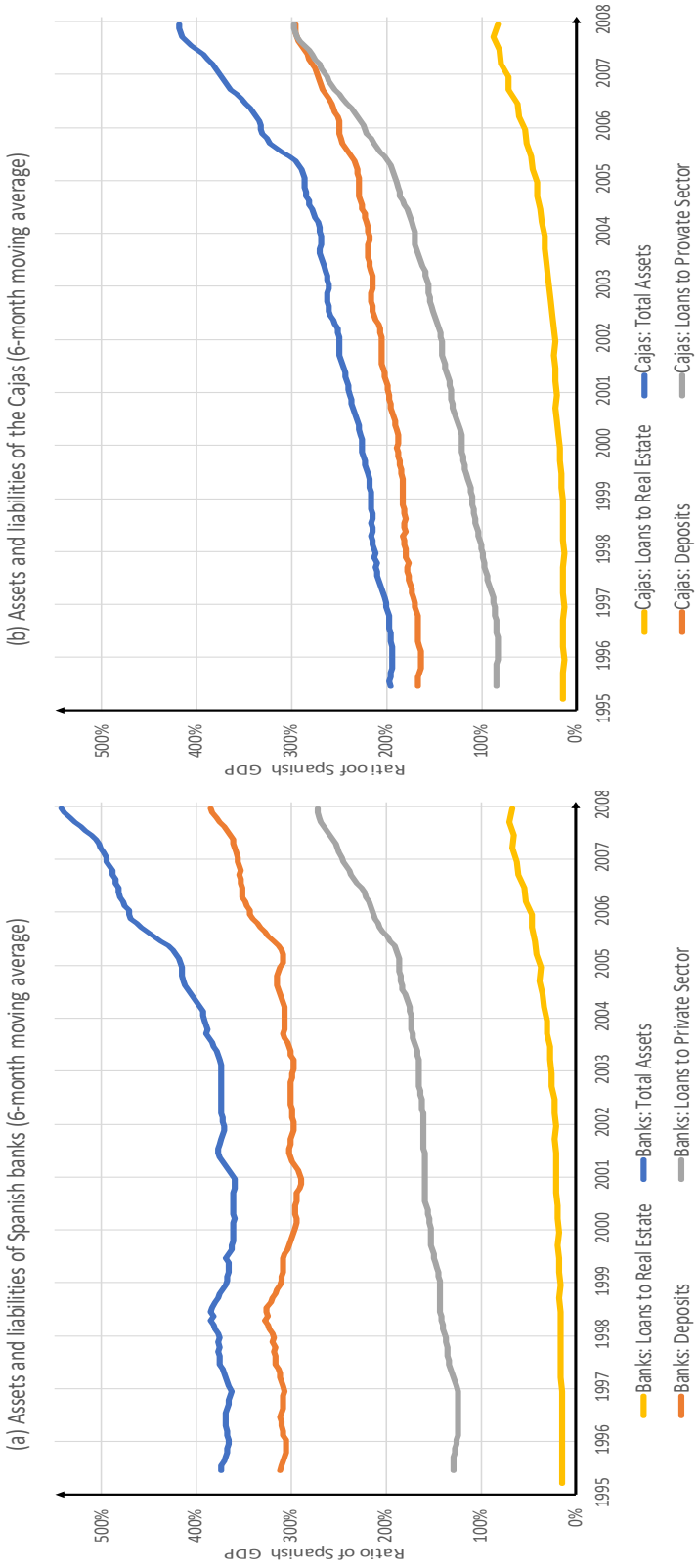
A rough account of the cross-border flows of capital in the lead-up to the euro crisis is that savers in the core regions made short-term deposits in core financial institutions. These institutions sent the capital through the wholesale market as short-term loans to periphery financial institutions. The periphery banks lent funds to projects, privileging sectors, like housing, that have tangible collateral and deep securitization markets, providing a new dimension of misallocation beyond the one described in the previous section. Part of these loans were used to pay for wages in the periphery that were then used to pay for imports of intermediate inputs from the more productive and competitive core countries. Firms in the core countries deposited their cash inflow in core banks, which

through wholesale market lent it back to periphery banks, closing the cycle. Through this cycle, the modern banks in the periphery relying on short-term funding grew quickly providing loans that spurred the misallocation between sectors and further enhancing the capital flows (or current account imbalances) across borders.

Figure 4 illustrates this phenomenon for the Spanish banking sector by plotting data from the balance sheet of Spanish banks as a ratio of GDP. The figure separates between traditional banks and the local savings and loan banks, the "Cajas", which had traditionally been small banks, with strong ties to local politicians, specialized in holding mortgages in their regions. Starting around 2002, the Spanish banking sector starts expanding at a quick rate (the blue lines). For the Cajas, this growth happens in spite of little growth in deposits (the orange lines). The new ability to securitize and sell their mortgages and to have access to the wholesale market allowed them to become modern banks and grow quickly. With this, they were able to fund an increase in credit to real estate, at a significantly faster rate than that of the other banks. By 2007, the Cajas accounted for 52% of all loans to the private sector in Spain, and its loans to the real estate sector had increased by a factor of 4.9. Ten years later, all of the Cajas had been dismantled or absorbed by other banks as a result of their high losses and mismanagement.

European banks have three distinctive features. First, the size of bank credit relative to total GDP is significantly larger in Europe than in the United States. On the other side of the Atlantic, the corporate bond market is roughly equally important as a source of funds to firms, whereas bank financing is dominant in Europe. Second, the banking sector is concentrated within countries. Therefore, the largest few banks in each European country are very large relative to their countries, with total assets often in excess of annual GDP. If a bank becomes insolvent, its national host country has to solve the problem of bailing it out or compensating depositors. But European banks are so large that any individual country would have trouble doing so. Third, the flows of capital happened across multiple regions in Europe, involving countries with different deposit insurance mechanisms, different resolution authorities for troubled banks, and different fiscal authorities and legal systems behind these. These do not combine to serve as a substitute to the roles that deposit insurance and lender of last resort played in traditional banking. Altogether, the advent of rapidly growing modern banks implied that banking sector problems would have a larger impact on the European economy, and at the same time the sovereign safety net of the financial sector was unreliable.

Figure 4: The growth of the Spanish Cajas versus Banks



4 The financial crash and systemic risk

An individual bank that is funded through short-term debt tied to collateral from securitizing its investments and that misallocates capital towards non-tradable sectors and projects with low returns is vulnerable to sudden losses of funding. When combined with many other similar banks, this leads to a modern financial system prone to instability. Because adverse feedback loops amplify initial exogenous triggers, seemingly small events can cause large changes in credit and asset prices. If these amplifying forces are strong enough, multiple equilibria can arise, so the system self-generates systemic risk. The focus of this section is on the financial system as a whole, and its spillovers to the real economy.[7]

4.1 Strategic complementarities, amplification, multiplicity, and pecuniary externalities

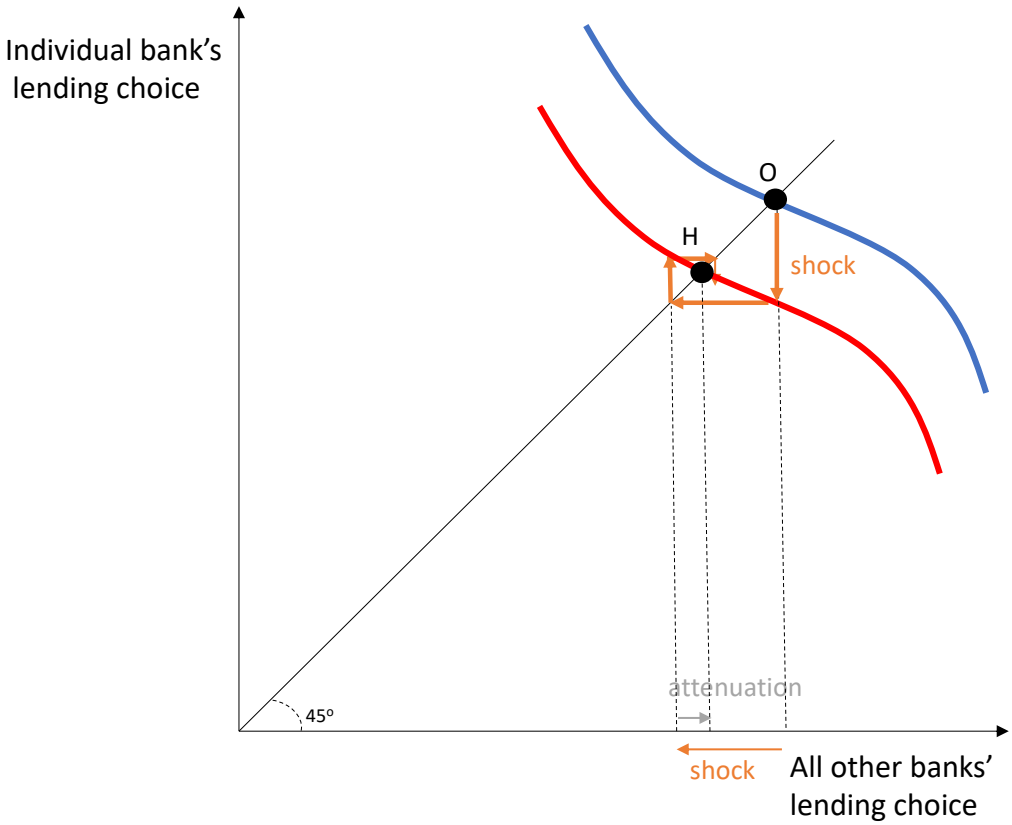
Modern financial markets depend critically on how each individual market participant reacts to the behavior of others. Figure 5 presents a graphical model of these interactions. On the vertical axis is the choice of how much to lend by an individual bank, and on the horizontal axis is the lending of other banks, which for simplicity are all identical, so they all face the same problem. More generally, the diagram represents the actions by participants in financial markets, whether these are choices to hold an asset or to roll over a repo. The blue curves give the best response of a bank to the others' actions: how much it will choose to lend given the others' behavior. Where the individual's best response curve coincides with the market's response, at point O, i.e. where curve crosses the 45 degree line, there is an equilibrium in that every single individual chooses to do what the group is also doing.

If the best response function slopes downwards, like in the top panel, then the bank's incentives or constraints would be such that it decreases lending whenever others increase their average lending. In game theory terms, actions are strategic substitutes. This may have been an adequate description of traditional financial markets. When a traditional bank expands credit, there are fewer good projects looking for financing, so other banks cut loans. Or, when more loans to buy a house are given out, this raises the price of houses, so that fewer further borrowers find it desirable to ask for credit from other

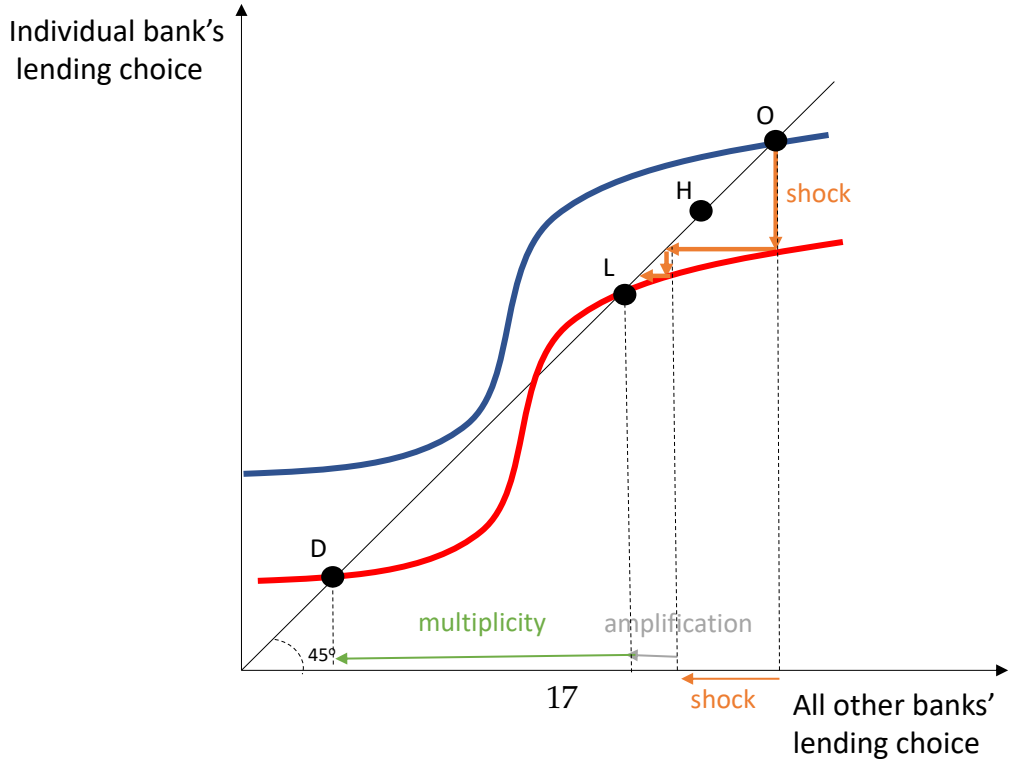
[7] For more on the modeling of fire sales and liquidity, see Shleifer and Vishny (2011) and Brunnermeier and Pedersen (2009), and for more on the ΔCoVaR estimates, see Adrian and Brunnermeier (2016).

Figure 5: Amplification and multiplicity

(a) With traditional banks



(b) With modern banks



banks.

In this case, the system is stable in two senses. First, there is a unique equilibrium at point O. Second, shifts in the best response function lead to moderate changes in this equilibrium. When the best response shifts down to the red-colored curve, perhaps because banks became better aware of risks, or investors had fewer funds to buy assets with, the individual bank wants to cut lending. As other banks cut their lending as well, the individual bank now wants to respond by raising lending. Other banks then raise, the individual bank now wants to cut, and so on in a cob-web process that leads to a new equilibrium at point H. As the figure shows, the initial shock is attenuated by the strategic interaction between the banks.

With a modern banking system, we have the situation in the bottom panel of the figure. When other banks cut lending and this lowers the price of housing, then the value of these traded securities fall. Because modern banks grow quickly, they are under-capitalized, in that they have little equity capital relative to their large credit funding. Hence, their leverage (the ratio of the latter to the former) is already at the limits that regulators and funders will accept. Therefore, they cannot take advantage of the low asset prices to buy assets, as traditional well-capitalized banks might have. Instead, because its own tradable assets fall in price, the bank suffers a loss in its equity value.[8] Its leverage ratio increases, so the under-capitalized bank must shrink its balance sheet by shedding assets.

When the entire financial sector is trying to sell assets at the same time, there is little *market liquidity*. That is, it is hard to sell the assets, or to redeploy them to other uses. *Fire sales* result in that the price has to fall considerably before demand meets supply again. Because each bank anticipates that all other banks will be shedding their assets, each will have an incentive to be the first one to sell, so the fall in asset prices is quick.

Low asset prices then reduces the *funding liquidity* of the banks, understood as their ability to roll over their funds with creditors so the banks can keep their assets. In part, this happens because of a *losses spiral*: the fall in the collateral value of assets leads to cuts in funding, and thus cuts in loans. In another part, it happens because of a *margins spiral*: as collateral values fall, lenders raise the margins in anticipation of the fire sale drop in prices. A collateral asset worth €100 can now be used to raise only €80 instead of €95 as before, so again lending must be lower.

[8]The banks could issue fresh equity capital. Yet, new equity holders want to be compensated for eventually having to absorb hidden losses. The evidence shows instead that existing equity holders try to channel funds out of the banks during crisis times.

These two funding liquidity spirals combine to make the best response curves slope upwards, represented by the blue curve in the bottom panel. When average actions increase, the participant chooses a more aggressive action. The actions of the banks are now *strategic complements*.

The change from a traditional to a modern banking sector, that is from the top to the bottom panel, or from downward-sloping to upward-sloping best response curves, would not be immediately apparent. The initial equilibrium would be at point O in both cases. But the system is now unstable in two ways after a shock that shifts the best response curve down. First, the same shock that shifts the curve by the same vertical distance, now leads instead to a change in actions captured by the equilibrium at point L. After the initial cut of the individual, others cut as well, and the individual wants to cut more. Whereas before the initial individual cut led to an attenuating rise in reaction to others towards the new equilibrium, now it leads to *amplification* of the initial shock. When house prices fall, one bank's collateral is worth less, it has to repay some of its funding, and so it lends less. But as it lends less, house prices fall more making other banks also suffer losses and forcing them to lend less as well. In the end, the fall in lending and in house prices gets amplified from the initial shock to point L.

Second, there may be a new (stable) equilibrium indicated by the bottom-left D point. If people simply stop believing in the outcome with high lending, and think that all others will lend less, this is sufficient to lead to an outcome with less lending instantly materializing. There is *multiplicity* of equilibrium. If each bank anticipates that others will cut lending, it anticipates the resulting fire sales and price drops, as well as the losses spiral and margins spiral. It will cut lending beforehand, triggering the depressed-lending equilibrium.

To conclude, after a bad shock, three outcomes are possible. With traditional, well-capitalized banks that hold few traded assets and little collateralized borrowing subject to margins that must be rolled over all the time, the financial market ends up in the top-right H equilibrium after a shock with respect to lending, as well as to asset prices or bank capital. But, with modern banks, fire sales and liquidity spirals amplify the shock via a system-wide fire sale and deleveraging, and the financial market moves to the the middle low-lending L equilibrium. In the worst case, the economy can jump to the bottom-left D equilibrium, where volatility and margins are high due to a shift in beliefs and lending is depressed.

These new outcomes are due to strategic complementarity between banks. A related,

but distinct concept, is that of *pecuniary externalities*. When some banks sell assets, this pushes their prices down, causing other banks to face tighter collateral constraints on their borrowing, and thus realizing losses. The actions of the first banks cause losses to the other banks, an externality, This is not the same as the strategic complementarity from before, which is about the other banks wanting to change their actions in the same direction. While strategic complementarities lead to amplification and multiplicity, externalities lead to *systemic risk* since losses in some financial institutions spill over to losses across the whole financial system.

In turn, systemic crises spread to the real economy through a *general-equilibrium propagation* of the initial shock. With a slight abuse of concepts, figure 5 can apply to different markets that are connected with each other in the overall economy. Consider, for illustration, the behavior of home builders and households. When banks cut credit and raise interest rates on their loans, home builders have to fire sell their housing stock. This erodes the market liquidity of houses in the same way as it did for financial securities. Worse, they have to abandon half-finished buildings, which destroys wealth as the earlier investments are irreversible. Since households cannot obtain mortgages so easily anymore and possibly face higher interest rates on their mortgages, any personal shock forces them to also fire sell their houses. As a result, construction activity falls and the real estate sectors enters a crisis. But, as construction companies suffer heavy losses and homeowners become delinquent in their mortgage payments, the value of securitized mortgage products also falls, which further hurts the banks, feeding back into further amplification in the financial system. Economic activity as a whole can be dragged down to the equilibrium with low or depressed activity.

As all agents in the economy realize that the economy's response to shocks is amplified and subject to multiplicity, they rightly perceive that these channels generate an endogenous increase in risk relative to the fundamentals. On the side of funders and financial markets, this higher risk causes even more reluctance to lend and higher margins, providing a further push towards the low-activity equilibria. Across all savers, the perception of this uncertainty leads to an increase in savings in safe assets as a precaution for the case that the economy shifts to bad outcomes. This lowers risky funding to banks, and it also lowers aggregate demand for goods, depressing activity and increasing endogenous macro risk: every agent tries to lower its individual risk, but in doing so they altogether increase overall endogenous macro-risk. This *paradox of prudence* has some similarities with the Keynesian paradox of thrift, whereby exogenously raising their

savings rate, consumers can trigger a recession that lowers actual aggregate savings. But here it is endogenous uncertainty and precautionary savings that trigger the rise in the savings rate, and that make the low activity equilibrium more likely.

4.2 Systemic risk in the Irish banking sector

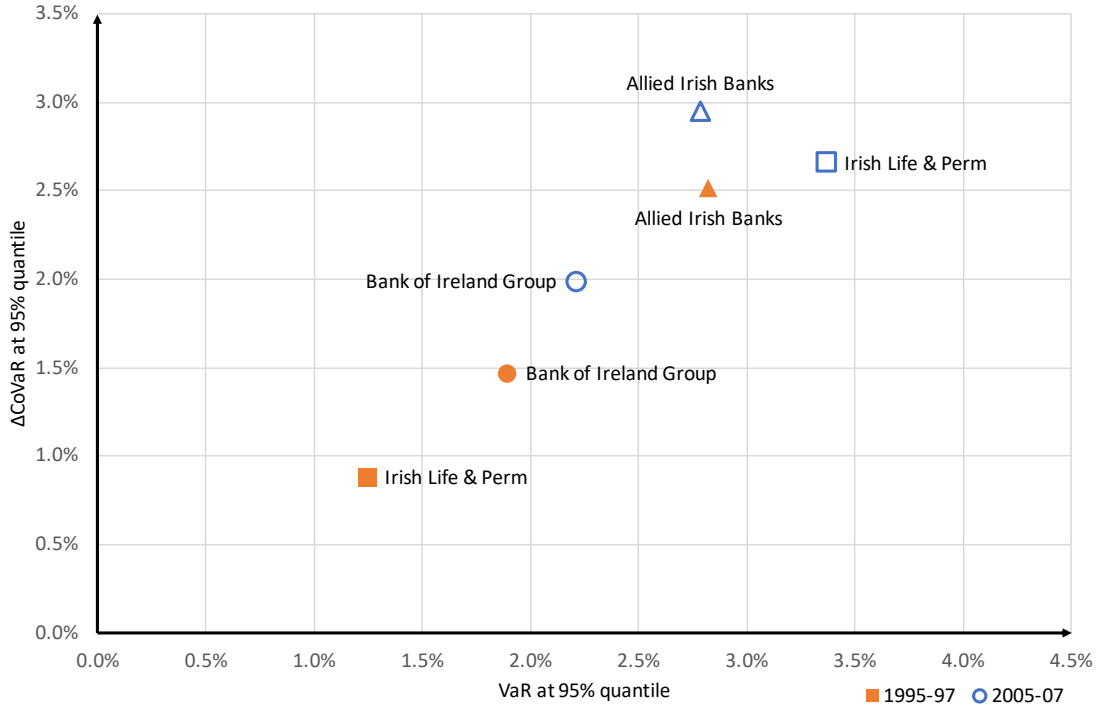
In the Summer of 2007, news of bad loans in the U.S. subprime market triggered losses in the American investments of some European banks, especially in the core regions. This led these banks to cut back their interbank lending as well as their repo purchases of securitized mortgages issued by the periphery countries' banks. At the same time, U.S. money market funds, which had been rolling over repos to European banks for years, withdrew from this market between 2007 and 2008 as a result of the growing U.S. financial crisis. Combined, these two forces led to a negative shock to the supply of funds in the wholesale and repo markets for bank funding.

Irish banks were particularly reliant on this foreign wholesale funding, and had also invested in American securities. Over the previous decade, they had transitioned from traditional to modern banks, and had correspondingly grown significantly, providing plentiful credit to the housing sector. The negative shock to the funds available triggered fire sales and liquidity spirals that led to a large fall in lending and in house prices. Their large losses spilled over to each other leading to a systemic banking crisis. Through the general-equilibrium propagation and the paradox of prudence, this financial shock spread to a deep recession in Ireland.

Figure 6 measures the systemic nature of the Irish banking sector as it moved from traditional to modern banking. In the horizontal axis is a measure of how individually risky a bank is, expressed in terms of the size of the losses in the value of its equity in the worst 5% of the weeks during a two-year period. This is known as value-at-risk (VaR). In the vertical axis is a measure of systemic risk, computed by calculating how much the value at risk of the banking sector changes when one particular bank is under distress. This measure is called ΔCoVaR. Orange points in the figure show these two measures for each of the three major Irish banks in the 1995-97 period.

In the ten years that followed, Irish banks transitioned from being traditional to modern banks. Their growth, concentrated in the real estate sector, led to an increase in their risk. For two of the three banks, VaR increased. At the same time, systemic risk measured by ΔCoVaR increased in all three banks, and significantly so. When the financial shock arrived from abroad, the strategic complementarities amplified it so much that credit to

Figure 6: Systemic risk in the Irish banking sector



private enterprises in the construction and real estate sectors fell an astounding 48% between the middle of 2008 and the end of 2010. Accompanying it was a propagation to the real economy reflected in a fall in residential property prices in Dublin of a record 35%. The systemic risk captured in the estimates in figure 6 revealed itself, and by the start of 2009 the private equity of all three banks had been almost entirely wiped out.

Faced with a systemic crisis, policymakers want to intervene to attenuate the amplification of the shocks to the real economy, and can be justified to do so if the externalities involved are large. One way to stop the funding spirals is for the central bank to lend to banks. Another is for governments to bail out banks through loans or recapitalizations that more or less explicitly nationalize the banks. Both were done in Ireland.[9] However, central bank lending requires the banks to have collateral, typically in the form of government bonds. Recapitalizations require trusting that, unlike the typical failing business, the banks remain economically solvent. Both of these interventions come with issues that

[9] A third policy intervention, aimed at preventing the jump in equilibrium with multiplicity, is to conduct public stress tests of banks' balance sheets so as to make it known to each individual bank that the other banks will not be compelled to cut their lending in the near future. This was done in Europe although with limited success, unlike in the U.S. where it seemed to be particularly effective.

the next two sections will explore.

5 Solvency versus liquidity

Most capital flows across borders take the form of debt contracts. This is true both of the flows between banks, which we have just discussed, but also of foreign investment in sovereign bonds. Debt contracts allow lenders to exert some discipline on borrowers because they must be rolled over with some frequency, and they save the lender the need to collect information on the exact payoffs of the borrower beyond their ability to meet the payments.

With debt contracts comes a discussion of solvency: whether the debtor has sufficient revenues in the present and in the future with which to repay the debt. Economic solvency is distinct from accounting equity. Because of its high leverage, a modern bank may have negative equity, and so appear to be insolvent, but still be economically solvent by relying on future revenues to pay for the present debts. For governments, only economic solvency is relevant as future tax and other fiscal revenues can be used to gradually pay down public debt.

The dependence of solvency on future revenues implies that the interest rate used to discount these future cash flows is tightly associated with an assessment of solvency. Any economic institution that has future revenues and some debt will be insolvent at an arbitrarily high enough interest rate.

With perfect and complete financial markets, there is a single interest rate that is relevant, no matter what the value of the debt or the financing structure of the economic institution is. With financial frictions, however, there may be more than one interest rate. For some of these rates, the institution can keep to its repayment schedule, but for some others, it does not have enough funds to pay its obligations.

Institutions can then be solvent, but illiquid. Interest rates spikes, in spite of unchanged fundamentals, make institutions unable to roll over and keep on servicing their debt. Policy can potentially help, but being able to distinguish between an insolvent and an illiquid institution becomes the key diagnosis of the crisis.[10]

[10] More on financial frictions and solvency versus liquidity is in Brunnermeier (2016) and Brunnermeier, Eisenbach and Sannikov (2013), while on the Geeek crisis see Gourinchas, Philippon and Vayanos (2016).

5.1 Debt and the challenging illiquidity-insolvency distinction

It is the combination of debt and financial frictions that creates the distinction between solvency and liquidity. To understand it, we present a simple model of project financing and use it to introduce debt contracts, financial frictions, liquidity and solvency.

Consider an institution that comes into the market needing to finance an amount q to keep a project going. This project has a random payoff z in the future.[11] The net return on the project is $z/q - 1$. If there is certainty about this payoff, and no financial frictions, then as long as the interest rate charged on the financing is lower than this net return of $z/q - 1$, the institution would be solvent. However, z is uncertain. In particular, it can take any value between 0 and 1 with equal probability, so that its expected value is $1/2$. The expected (net) return is therefore $1/2q - 1$. With perfect financial markets, where the financing structure does not matter, as long as this return is above the required return in the market, the institution would be solvent.

Consider now what happens with a debt contract. This contract stipulates that in exchange for q today, the creditor is entitled to a payment of F in the future. If the payoff turns out to be higher than the promised payment, then only x must be paid; the remainder stays with the entrepreneur as her profits. If the payoff is lower, then the most the institution can give its creditor is whatever z turned out to be.

The left panel of figure 7 illustrates this payoff by plotting the face value of the debt F in the vertical axis against the actual payoff of the project z in the horizontal axis. The upward-sloping line is the 45 degree line. If the promised payment is F_{low}, then the payoff of the debt is represented in solid blue. When z is below F_{low} then the payoff of the debt is equal to the 45 degree line, as the debt-holders get paid the whole residual value of the project, which is below what was promised. If the payoff z is above F_{low}, then the payoff of the debt is equal to the horizontal line as only F_{low} is paid.

Likewise, for a higher promised debt payment F_{high}, the payoff is given by the purple line. The default probability is higher for a higher F since now if the project's payoff z turns out to be below F_{high}, there is default. But, if there is no default, the payment is of course higher. The expected payoff to the lender is then equal to the expected payment when the borrower defaults plus the actual promised payment when the debt is paid in full. The expected payment when there is default is equal to the expected value of z when $z < F$, which is $(1 - F)F$, the product of the probability and the payment. The expected payment when the debt is paid in full is equal to the promised payment F times

[11] Note that the lender is assumed to be risk neutral.

the probability that $z \geq F$, which is $F(F/2)$. Their sum $F - F^2/2$ is the expected payoff of the lender. Graphically, it is the area below the blue line for F_{low}, or below the purple line for F_{high}. Alternatively, it is the sum of the shaded rectangle and the triangle to its left.

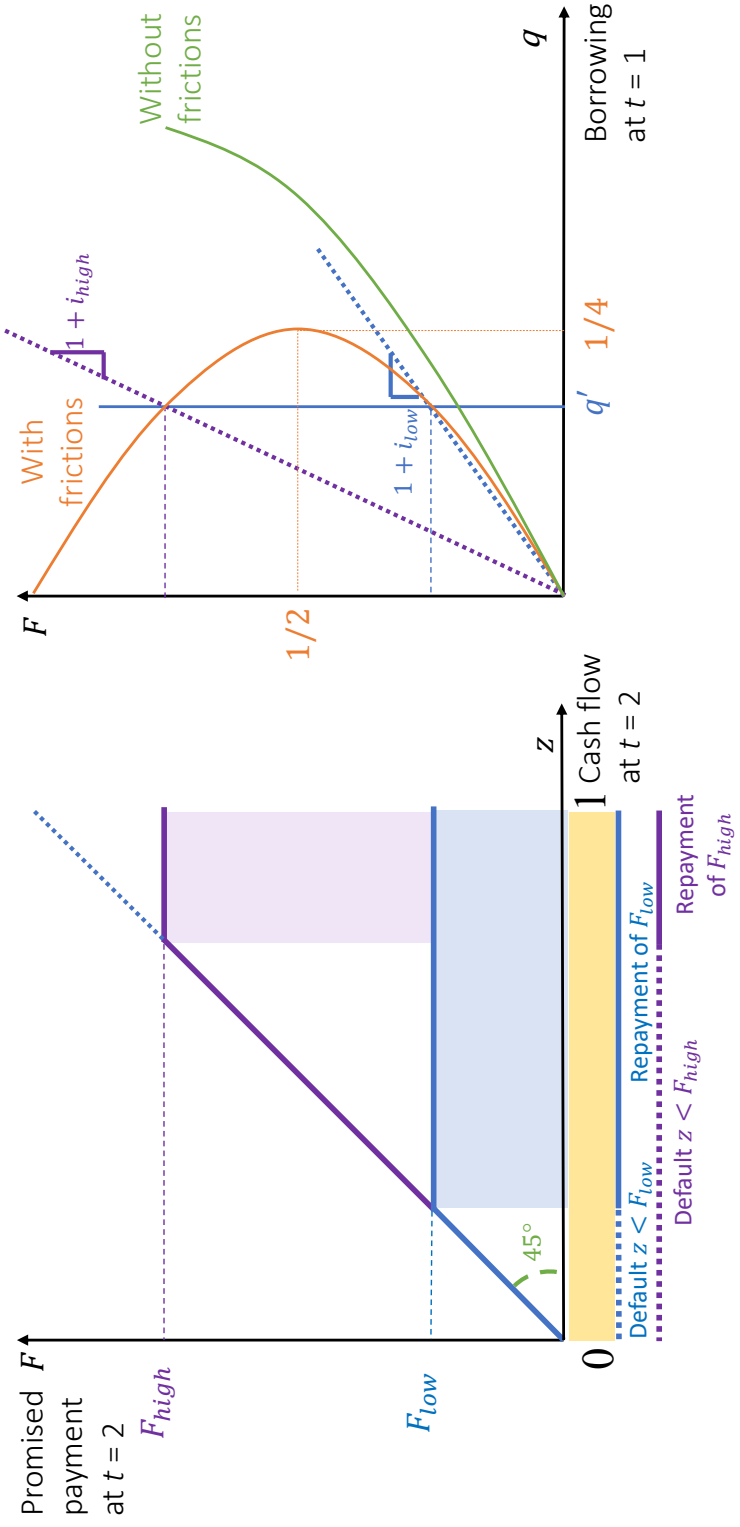
For the maximum amount of promised payment, $F = 1$, the firm always defaults, and the lender is effectively an equity-holder in that she keeps the whole value of the project. The expected (net) return of one unit of lending in this case is $1/2q - 1$. The condition for solvency is the same as before, namely that this return is at least as high as what the lender must receive to be willing to provide the financing.

Yet, there are *financial frictions*. When a firm defaults, value is lost in that some of the payoff from the project disappears. Insolvency is a costly process; when a creditor seizes an asset it cannot generate as much cash flow out of it as the entrepreneur would have done with her ideas and skills. More generally, we say there is a financial friction when the way in which the payoff from the project gets split between the institution and the creditor affects the overall final payoff of the project. We will consider an extreme and simple version of this friction: triggering default always leads to the entire value of the project being lost. Lawyers, bankruptcy court fees, and disgruntled borrowers tearing down the project before it is seized combine to eat away all of the payoff. With financial frictions, therefore, if $z < x$ then the lender and borrower both get nothing as the whole of z is lost.

The expected payoff of a promised debt of F is now given only by the probability it gets paid times the payment: $(1 - F)F$. Graphically, in the left panel of figure 7, this is the area of the shaded rectangles (the triangles are dropped). Now, compare the two debt contracts portrayed in the figure that have different promised repayments, F_{low} and F_{high}. They have the *same* expected payoff. Even though, in one contract, the face value of the debt is higher because this contract is more likely to lead to default, the expected value of the debt is the same. At the extreme, a debt contract that has a face value above 1 unit and one that has a face value of 0 are both worthless. The former because it is never paid back as it always triggers default, and the latter because it is always paid back but gives only 0.

The right panel of figure 7 then plots the amount borrowed q in the horizontal axis against the promised payoff on the debt in the vertical axis as a curve from the origin. Without financial frictions, the green curve is upward sloping. As we discussed in the left panel, a higher face value of the debt raises the expected payment of the debt. Thus, the amount that can be borrowed increases as well. The institution is solvent as long as

Figure 7: Solvency and liquidity with debt



the amount that it needs to borrow is less than $1/2$, which is the point on the curve when $F = 1$.

With financial frictions, the amount borrowed relative to the amount promised is instead a parabola with a backward-bending part. The right peak of the parabola is at the point when the promised payment is $1/2$, which, since it pays with probability $1/2$, gives an expected repayment of $1/4$. The institution is insolvent if it needs to borrow more than $1/4$, that is any amount to the right of the parabola, since borrowers would get a negative return from investing in the firm.

The slope of a ray from the origin to the parabola gives the interest rate paid by the loan.[12] If interest rates are low at i_{low}, then by promising to pay F_{low} the institution can obtain the amount q it needs to finance. But, if interest rates are higher, at i_{high}, then by promising F_{high} the institution can also finance itself. Such a high interest rate would never be observed without financial frictions. But, with financial frictions, the economy can enter a *liquidity crisis*. Investors think the risk of default is high, and so they require a high interest rate to compensate them for lending. The institution must then promise a high payoff, but this in turn leads to a higher probability of default. The economy can suddenly jump from the low to the high interest rate equilibrium as the lenders are getting the same expected payoff. In sum, if the market believes that debt levels are sustainable and default is unlikely, it charges a small interest rate, and a higher debt level is sustainable. If instead the market believes that the probability of default is high, then the interest rate rises, this lowers the sustainable debt limit, and default is indeed more likely.

However, the borrower (and society) is worse off with high interest rates in a liquidity crisis. The default probability is higher, so it is more likely that the large social costs of default materialize. The triangles left of the shaded rectangles in the left panel of the figure measure the expected social costs of default due to the financial friction, which are the resources that are lost through the bankruptcy procedure. Alternatively, the horizontal distance between the green curve and the orange parabola in the bottom panel measures these expected losses. With a higher promised payment F_{high}, the costs are higher than with F_{low}.

This analysis applies whether the borrowing institution is a firm, a bank, or a country, as long as it issues debt. If its refinancing needs, q, exceed the borrowing capacity peaking

[12] Mathematically, if i is the interest rate on the debt, then $q(1+i)$ is equal to the expected payoff of the debt, which is $F - F^2/2$ without financial frictions and $F - F^2$ with financial frictions.

at $1/4$, the institution is insolvent. For lower refinancing needs, say $1/5$, the institution might not be able to raise enough funds or has to promise a high interest rate if it is stuck in the high interest rate illiquid equilibrium (in the backward-bending part of the parabola in the right panel of figure 7). In this equilibrium, default at $t = 2$ is likely, resulting in welfare losses. It is easy to figure out that the illiquidity and insolvency problem is less severe if the cash flow z is less risky, for instance if it is equally likely to be between $1/4$ and $3/4$, instead of between 0 and $1/2$ (as illustrated in the yellow box on the left panel).

If the borrowing entity is the government, future cash flows z are fiscal surpluses, which are particularly difficult to predict since they are affected by politics. There is a limit to the fiscal surpluses that a country can earn, both because there is a maximum to tax revenues, and because the government is committed to providing a minimum amount of services and paying pensions and public wages, but these commitments can change over time. This added political uncertainty also makes sovereign debt prone to liquidity and solvency crises.

Institutions like the IMF can provide foreign policy support to countries in trouble. Consider a negative shock to fundamentals so that the payoff z of the project, understood as the future fiscal surpluses, is now lower (the yellow box depicting the uniform distribution on left panel shifts to the left). The peak of the parabola is therefore now lower and interest rates rise. The country may have been close to the peak in the first place, so that even a small negative shock pushed it to insolvency justifying the extreme increase in interest rates. Or perhaps it was not, but the shock triggered a change in beliefs from the left to the right of the peak, so the rise in interest rates is due to a liquidity crisis. It is hard to estimate the peak of the parabola, and so to know insolvency from a illiquidity.

If the country is insolvent, then foreign help amounts to a transfer of funds. It lowers the required q that must be financed to below the peak. This solves the crisis in the debt country but, understandably, foreign taxpayers usually disagree with these transfers of value. If instead the country is illiquid, then a commitment to lend to it at a fixed interest rate, higher than i_{low} but lower than i_{high}, can be enough to eliminate the crisis. With the bad equilibrium off the table, since the country would go to the IMF instead of paying i_{high}, private creditors can coordinate on the good equilibrium. No wealth is transferred. From the domestic perspective, if the country is insolvent, it is best to default right away, renegotiate debt, and move forward. If it is illiquid, then it can try to withstand market turbulence and gain time to prove that its solvency can convince creditors to move to the good equilibrium. Which of the two is the crucial diagnosis that policymakers must

make.

5.2 The Greek sovereign debt crisis

In October of 2009, the Greek government revealed that its statistical agency had been under-reporting the level of public deficits and debt for as much as a decade. In the previous two years, the public deficit had been high as a result of the global recession, but the previous estimate of a deficit of 3.7% for 2009 was replaced with a new estimate of 12.5%. On January 12th of 2010, the European Commission released a harsh report stating that it had little faith even in the new numbers and pointing to problems in the financing of social security, hospitals, and public enterprises. The perceived capacity of the Greek government to pay its debts was now lower and, at the same time, all the publicity likely triggered a revision in the beliefs of the creditors.

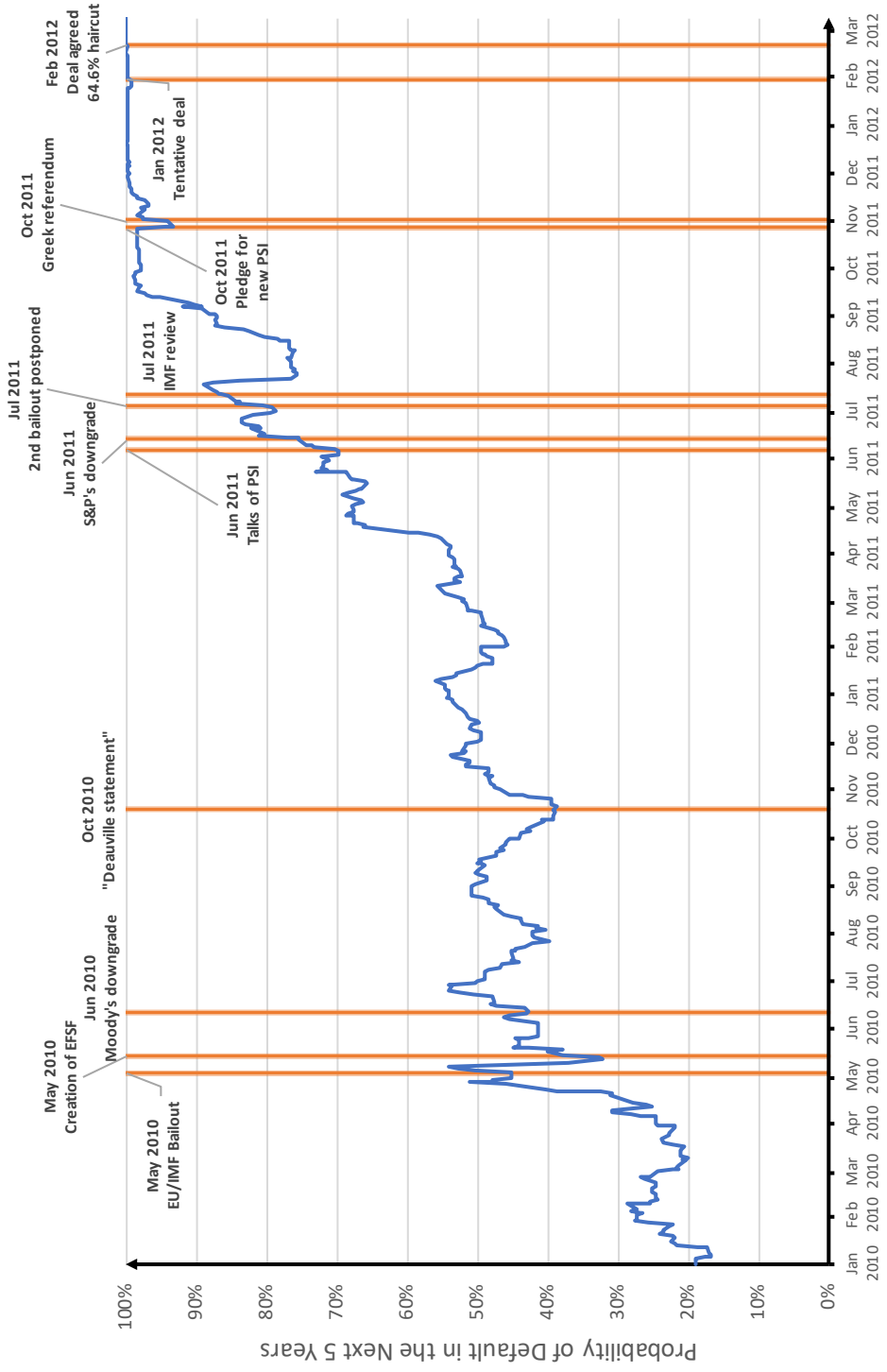
The interest rates on 10-year Greek sovereign debt was 4.5% at the end of September 2009. By the end of January 2010, it was 7.0%. By July it was in the double digits, and 24 months later, at the start of 2012, the interest rate was 26%. Was this the result of higher perceived insolvency of Greece, or rather the result of a liquidity crisis?

Figure 8 shows estimates of the market-perceived probability at each date that Greece might default at any time in the next 5 years. These are constructed from the insurance premia that investors were willing to pay in order to get insurance against this scenario.[13] In May 2010, after a spike in the perception of insolvency, the IMF and the EU announced a 3-year rescue package, which included a credit of up to €110 bn at the IMF's fixed interest rate. One week later, the EU created a new institution, the European Financial Stability Facility (EFSF), with a lending capacity of €440 bn, and the ECB announced a Securities Market Program (SMP) whereby it would buy sovereign bonds. All of these institutions had faith that Greece was facing a liquidity problem. Reassuringly, Greek interest rates fell sharply, from 8.9% at the start of May to 7.8% in the middle of the month, consistent with the official programs eliminating the bad equilibrium.

Perceptions of insolvency, however, stayed high. One month later, Moody's credit agency labelled Greek bonds "junk" given their high likelihood of default. In October, in the town of Deauville, the French and German prime ministers announced that their countries would not fully pay for Greek debts, but always require private creditors to

[13] More technically, the picture uses data on 5-year Greek bonds CDS spreads, and calculates the implied probability of default over the duration of the contract assuming that default arrives as a Poisson event, and that the recovery rate is 35.4%, the value it turned out to be according to Cruces and Trebesch (2013).

Figure 8: The perceived insolvency probability of Greek sovereign bonds



lose some of their credits. The perception of default rose, crossing 50%, and reaching 70% by June of 2011. At this time, the French and German governments further insisted on "private sector involvement", starting the process to negotiate what would be the residual value of Greek bonds that creditors could claim in case of a default. Perceived default spiked again, and another credit agency (Standard & Poors) followed by assessing the risk of insolvency as very high.

By then, the official creditors had changed their mind relative to one year before. The EU postponed a second rescue package for Greece, and the IMF admitted in its July review that the debt was not sustainable "with high probability". Insolvency was by then admitted by all, and by October of 2011 the EU was proposing that creditors accept to lose 50% of the amounts lent. After a new prime minister taking over and another tentative offer in January, by February of 2012, Greece indeed defaulted on its bonds. Creditors exchanged €177 bn of old Greek bonds for new bonds with a present value that was 64.6% lower.

Looking back, perhaps it should have been clearer that Greece was insolvent right at the start of 2010. Between then and the actual default two years later, there was a dramatic reversal of private capital flows, that in the previous decade had flown into Greece, and now ran for the exit. During this time, total capital inflows also fell, but much less dramatically, as public capital flew in to replace the private capital. As the official credit gets slowly paid over the years, the future will tell how much value the EU countries transferred to Greece.

At the same time, similar capital flows and spikes in interest rates happened in Italy, Portugal, and Spain. None of them defaulted on their debt and, after only a few years of public capital inflows, they were able to return to relatively lower interest rates. This suggests that they were perhaps illiquid, and that the problems in Greece may have triggered the shift in beliefs to the bad equilibrium for a short time, which the EU/IMF programs helped to eliminate. Yet, at the start of 2010, in comparison to Greece, Portugal had twice as high net external debt, Italy's GDP per capita had grown 45% less in the previous ten years, and Spain's banks were in worse shape. The more general lesson is that in real time, distinguishing insolvency and illiquidity is an almost-impossible task.

6 The nexus between the private and public sectors

After describing how the funding structure of modern banks amplified shocks and gave rise to multiplicity, we discussed how sovereign debt was particularly prone to liquidity crises. In modern economies, banks and public debt are intrinsically linked. From one direction, banking crises typically come with large fiscal costs associated with directly bailing out the banks and collecting fewer taxes and spending more on social payments during the recession that typically ensues. This makes public debt more risky and lowers its value. As banks outside of the United States typically hold a significant amount of national debt, banks' balance sheets suffer even further.

There are several reasons why banks' hold so much national debt. First, financial regulation forces banks to hold a fraction of their assets in safe securities, and the rules of financial regulation treat the debt held by a government of its sovereign as riskless. In other words, banks are not required to set any equity cushion aside for holding government debt. When default risk is high, the public debt pays a high interest rate, and this becomes an attractive investment relative to alternatives that require holding equity capital. Second, the normal conduct of monetary policy by central banks consists of buying government bonds, or accepting them as collateral, in exchange for giving banks reserve deposits at the central bank. By holding government bonds as assets, banks make sure they will have access to central bank liquidity if necessary. They especially do so during fiscal crises, exchanging the risky government bonds for safe deposits at the central bank. Third, public debt markets in many countries are organized so that banks first buy government bonds from the government during the public issuance and then resell them over time to other private investors. Banks are primary dealers of government bonds, an activity which gives them profits, but which requires them to often warehouse government bonds for some period of time, until they find a buyer for the bonds. Fourth, because the regulator of banks is the government who must find buyers for its risky debt, it often uses "moral suasion" to pressure banks to buy its bonds beyond what their risk-return would recommend. This may well be optimal: because a banking crisis often has deep costs on the overall economy, by making banks hold many government bonds, the government is able to commit not to default. This eliminates high interest illiquidity equilibria.

At the same time, banks often count on both explicit and implicit guarantees from the government. Explicitly because, as we discussed in section 3, governments insure some bank deposits in order to reduce the incentives to run on banks. Implicitly because, if a bank is large enough, its failure spills over to many sectors that rely on banks to handle

payments and obtain short-term credit as part of their normal operations. To avoid these large economic costs, governments often choose to bail out banks in trouble, even if no official guarantee existed beforehand.[14]

6.1 The diabolic/doom loop

The effect of this concentration of national bonds held by national banks and of government guarantees to banks is a diabolic loop.[15] Imagine that, because of a liquidity crisis, investors raise their perceived default risk on government bonds. An increase in the interest rate of new bonds implies that older bonds held by banks are now worth less. This loss is significant and gets amplified through the spirals that we discussed earlier, thus leading to cuts in lending. Less lending lowers economic activity, which lowers tax revenues and raises spending through the automatic stabilizers. The government's finances therefore deteriorate. At the same time, with the drop in the bank's equity, the likelihood that the government guarantees will be triggered rises. This extra spending also worsens the fiscal balance. Both combined, the public finances become worse, which puts additional strains on the sustainability of government debt. Their prices fall further triggering a new turn in the loop. Figure 9 illustrates the diabolic loop.

6.2 European banks and their sovereigns

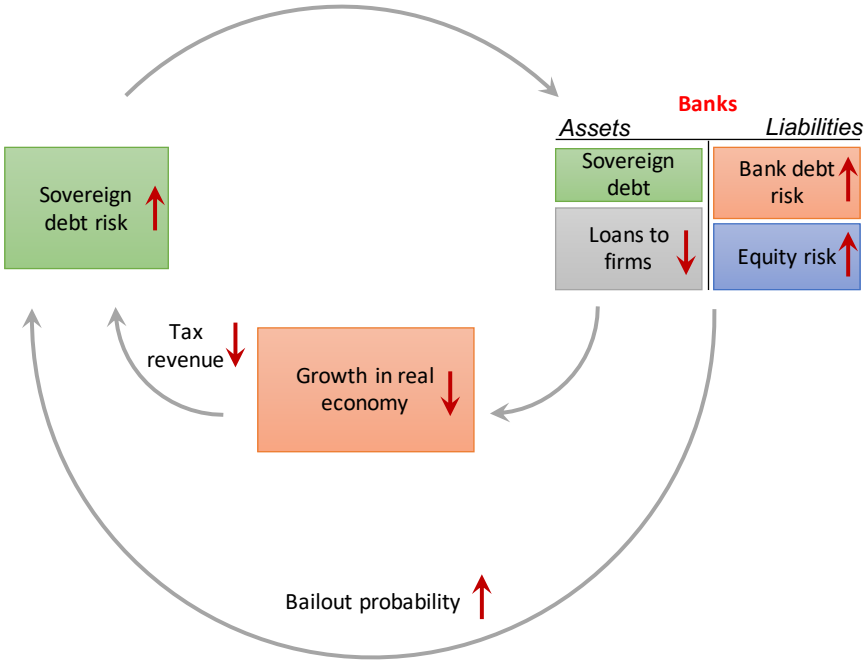
European banks were especially prone to hold national sovereign bonds. Each country's sovereign bonds were treated as fully safe by regulators throughout the crisis even in cases where the country's fiscal situation was near insolvency. The ECB's policies, in the absence of a euro-wide safe bond, was to accept sovereign bonds of every country in exchange for reserves. The public debt markets of each individual sovereign are often not very liquid, especially for smaller countries, increasing the reliance on banks as primary dealers. Finally, given the history of frequent defaults, some of the countries in the periphery put a great value in the commitment provided by banks holding public debt.

At the same time, the guarantees given by the government to banks were both extensive but also more fragile. As noted in section 3, a few banks in almost every European

[14] On the diabolic loop, see Brunnermeier et al. (2016) and Farhi and Tirole (2018), and on evidence for it in Europe see Acharya, Drechsler and Schnabl (2014).

[15] Brunnermeier et al. (2011) first coined this phenomenon the diabolic loop, Obstfeld (2013) preferred calling it the doom loop, Farhi and Tirole (2018) instead dubbed it the deadly embrace, and policy speeches in Europe often refer to it as the adverse feedback loop. We use the original term, but they are all equivalent.

Figure 9: Diabolic loop between sovereign risk and financial risk



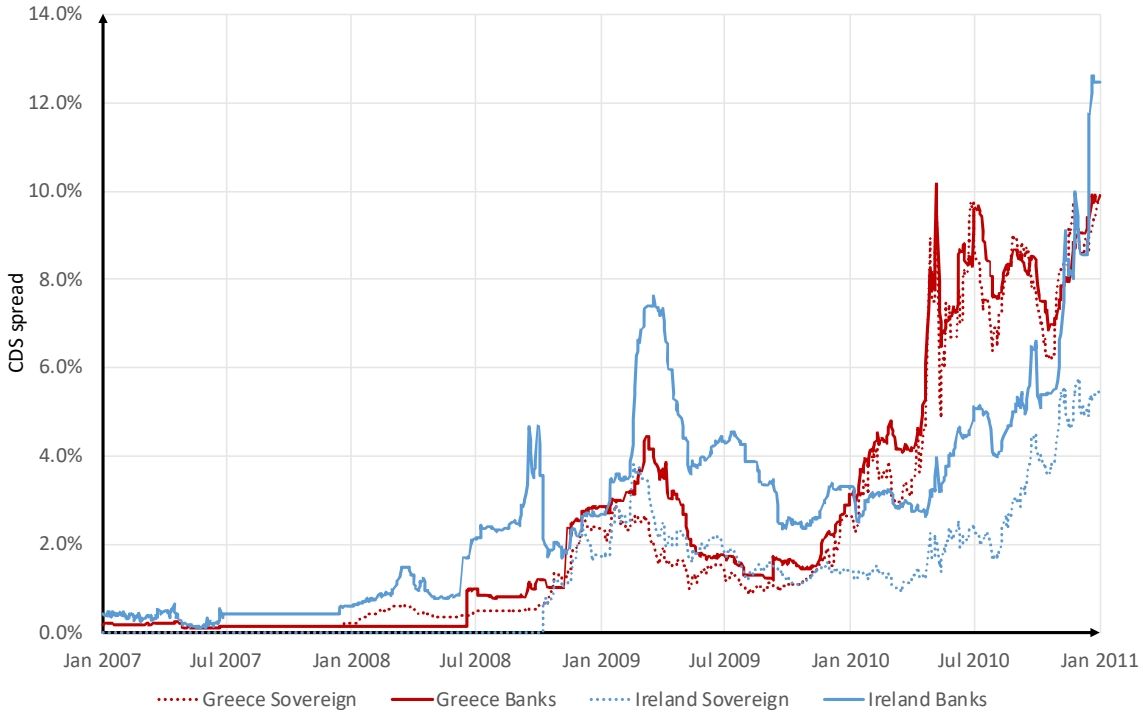
country are very large, with assets crossing borders. As a result, the commitment of their sovereign to bail them out is not credible. It would take a large amount of public spending to bail out even a single bank, and there is little room in the public budget for it.

Therefore, the diabolic loop was particularly acute in the European crisis, as illustrated by figure 10. The top panel plots measures of the default probability of banks and the sovereign for Ireland in blue between the start of 2007 and the end of 2010.[16] The large Irish banks suffered losses in 2007 and 2008, partly as a result of losses in the American sub-prime market that were amplified through the funding spirals we discussed. On September of 2008, the Irish minister of finance issued a broad State guarantee to the banks, thus enhancing the diabolic loop. As the figure shows, the risk of banks and sovereigns became tightly linked, even more so when the banks failed and the government had to bail them out. The figure also shows the evolution of bank and sovereign risk for Greece during the same period. As Greece had trouble borrowing from abroad early in the crisis, Greek banks started holding a very large amount of Greek bonds in their balance sheets. The diabolic loop was very strong, so when sovereign risk rose, bank risk rose and vice versa.

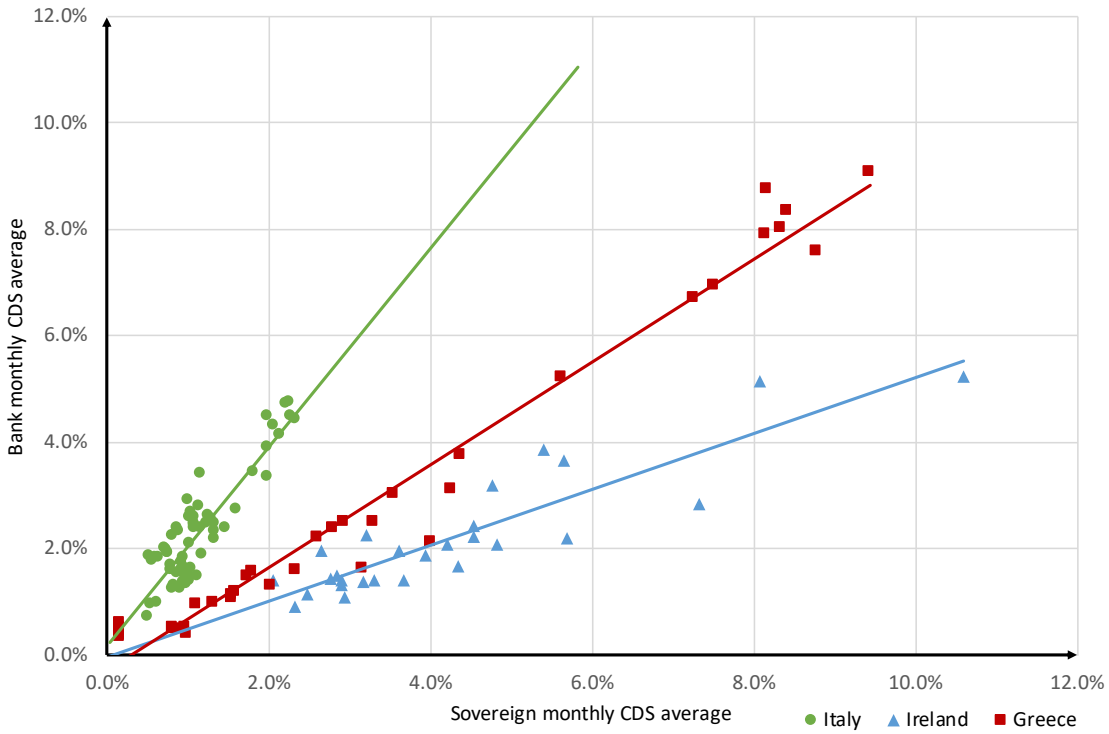
[16]These measures, the credit default swap spread, are a measure of the insurance premia charged in markets to guard against default. For banks, it averages the CDS for the three largest banks in the country.

Figure 10: The European sovereign-bank nexus

(a) Sovereign and banks CDS spreads in Greece, Ireland, 2007-2010



(b) Correlation of sovereign and bank risk for Italy (14-17) and Greece, Ireland (07-10)



The bottom panel of figure 10 presents this association more systematically by plotting the monthly averages of these proxies for default of banks against those of sovereigns. Also included is data for Italy in the more recent 2014-2017 period, when risk of default was not as high. The correlation continues to be large. The diabolic loop is an unsolved problem of the euro area. The positive association is clear, and it is even higher for Italy in the recent period than it was for Greece and Ireland in the past.

There have been different attempts to break the diabolic loop. For instance, in the spring of 2013, the head of the Ecofin group of finance ministers defended in an interview that from then on banks that failed should default on their senior bonds rather than being bailed out by governments, as had just happened in Cyprus. Within a few hours, banks stocks across Europe dropped but the sovereign government bond yields stabilized, as the diabolic loop was reduced. Later on, political pressure led to recalling these statements.

7 The flight to safety

The previous two sections described why and how, in a crisis, the perceived risk of government bonds, private bonds, and bank debt all rise together, and so do their associated interest rates. A further feature of modern financial crises is that, even as interest rates across sectors and regions all spike up, the interest rates in some asset classes and regions become unusually low. These price movements reflect a flight of capital to safety. As investors shift their portfolios away from assets they deem to be risky and towards those that they deem to be safe, the price of the latter rise. In many financial crises, this shift naturally occurs from equities to government bonds as the former are perceived as riskier in their payoffs than the latter.

In the euro area, there is no euro-wide government bond to serve as safe haven. The perceptions of risk applied to regions as opposed to asset classes, so the the flight-to-safety capital flows became cross-country capital flows. During the euro crisis, the yield on German government bonds was historically low.

The crisis raises the question of why German bonds were perceived to be safe while Greek bonds were not, or more generally, on what determines a safe asset. A safe asset has (at least) three properties. First, it has limited risk in the sense of giving its holder the same payoff across a wide variety of possible future scenarios. The holder does not need to investigate what is more or less likely to happen in the future, nor does she need to consider whether the asset will give payoffs that are high when money is more valuable

to her or the other way around, and thus making it easy to sell this asset across people with different beliefs about the future or tastes about risk. Second, having low risk and high liquidity are especially true when the economy is in a crisis at which time being insulated from risk is particularly valuable. Investors do not know for sure when the next crisis will come, but they know that the safe asset will be easy to sell and give a sure payoff. In other words, a safe asset is valuable at a random point in time, when a crisis occurs, while a risk-free asset with a certain maturity is risk-free at this particular ex-ante specified point in time. Third, the safety status of an asset is to a large degree self-fulfilling: an asset is safe if it is perceived by all to be safe. This makes trading it always very liquid and implies that its price will not fall and often even rises during a crisis because all want to hold it. This last property is at heart a tautology. It implies that an asset can stop being safe because it is no longer perceived as such. What can drive such shifts?[17]

7.1 Shifts in safe asset status in an asymmetric currency union

Consider a world with two regions, A and B, each of which issued debt in the past. Unlike the debt in Section 5, this debt does not need to be refinanced by the government this period, but only comes due for a payment of 1 in the future, say in one period's time. Today, it trades in markets at prices P_A and P_B, respectively. Investors have a fixed amount of funds to invest, which we set to 2, so that it must be that $P_A + P_B = 2$. When both regions are perceived to be safe, we assume that the quantity of debt they have is the same so that $P_A = P_B = 1$.

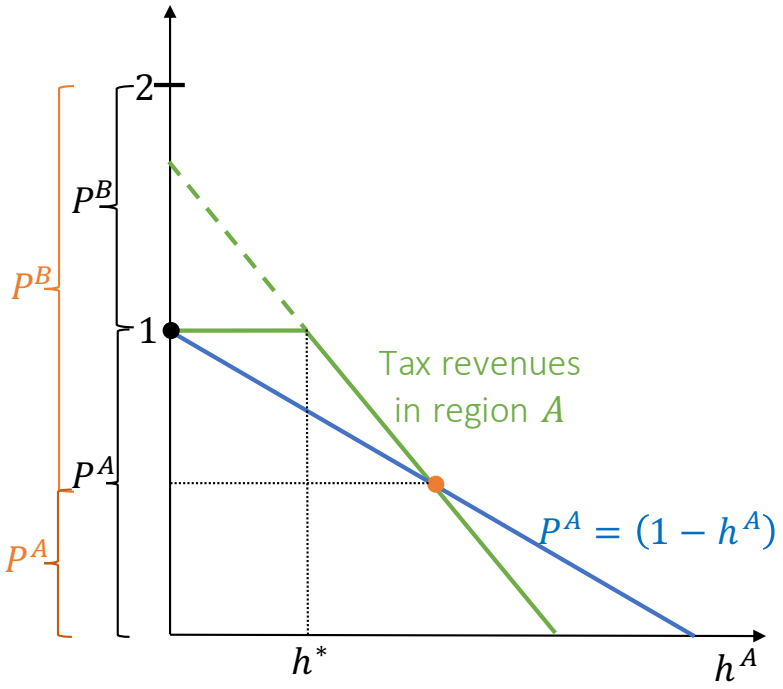
Imagine now that region A is not able to pay off its government debt in full in any circumstance. Investors will perceive the debt to not be safe, since it pays less than its face value of 1 in some states of the world next period. They will then apply a haircut of h_A to the expected payoff of the bond, so the price of the bond becomes $P_A = 1 - h_A$.[18] Region B is always regarded as safe. Therefore, when h_A rises, capital flows from region A to region B, as P_A falls and P_B rises.

Figure 11 displays this capital flow and the flight to safety. In the horizontal axis is the haircut on region A, so the price of the debt in the vertical axis is given by the downward-

[17]For more on the model of safety below see Brunnermeier and Huang (2019), on flights to safety see Calvo (1998), and on the capital flows in the euro area see Lane (2012).

[18]This assumes that investors are risk neutral and their preference discount rate is zero. The $1 - h_A$ is also called the recovery rate on the bond.

Figure 11: Flight to safety



sloping blue line. In the vertical axis, the price of region B's debt is given by the difference between 2 and P_A.

The figure also shows a downward-sloping green line referring to the tax revenues of region A. These are linked to the safe-asset status of the bonds.[19] Firms in region A produce output using machines, labor, and other inputs, as well as by holding safe bonds as working capital with which to guarantee payments to suppliers and workers. If the haircut on the bond in region A is zero, then that bond is safe, and it is held by its firms. The government collects tax revenues by taxing the output of the firms, and uses them to pay for the government debt, which are held by these same firms. Imagine now that the haircut becomes positive. Then, the firms have to substitute bonds from region A for bonds from region B. As the haircut increases, P_B is higher, so the cost of these bonds rises. This makes production more costly leading to less production and therefore less output. Because the government funds itself by taxing this output, tax revenues fall, so the green line slopes down.

At first, for small haircuts below h^*, this is pictured by the dashed green line. Tax

[19] In Section 5, we already discussed how the the funds available to pay for the government bond are affected by the financial soundness of banks.

revenues fall with a higher haircut, but they are still above the value of 1 that is due for payment on the debt. Therefore, the government still pays all the debt in full. There is no reason for there to be a haircut in the first place, so having a haircut is not an equilibrium, nor it is rational for firms to expect haircuts below h^*.

When the downward-sloping green line falls below the value of 1, then the line is no longer dashed. For these high haircuts output, and therefore tax revenues, fall so much that the government of region A has to default on the debt and pay less than the promised face value. As the figure shows, there are two equilibria identified by dots. In one equilibrium (the black dot) the debt from region A is perceived to be safe, the haircut is zero, and firms in region A hold the debt for their production purposes. This generates enough tax revenue to pay the debt when it comes due. The debt is safe because it is perceived to be safe. In the other equilibrium (the orange dot), region A's bond loses its safe-asset status. Haircuts are high, capital flows to region B, production becomes costly, and so tax revenues are low in region A, justifying the lack of safety of the debt. At the same time, as the price of region A's bonds fall and their yield rises, the yield in the government bonds in the safe region decline.

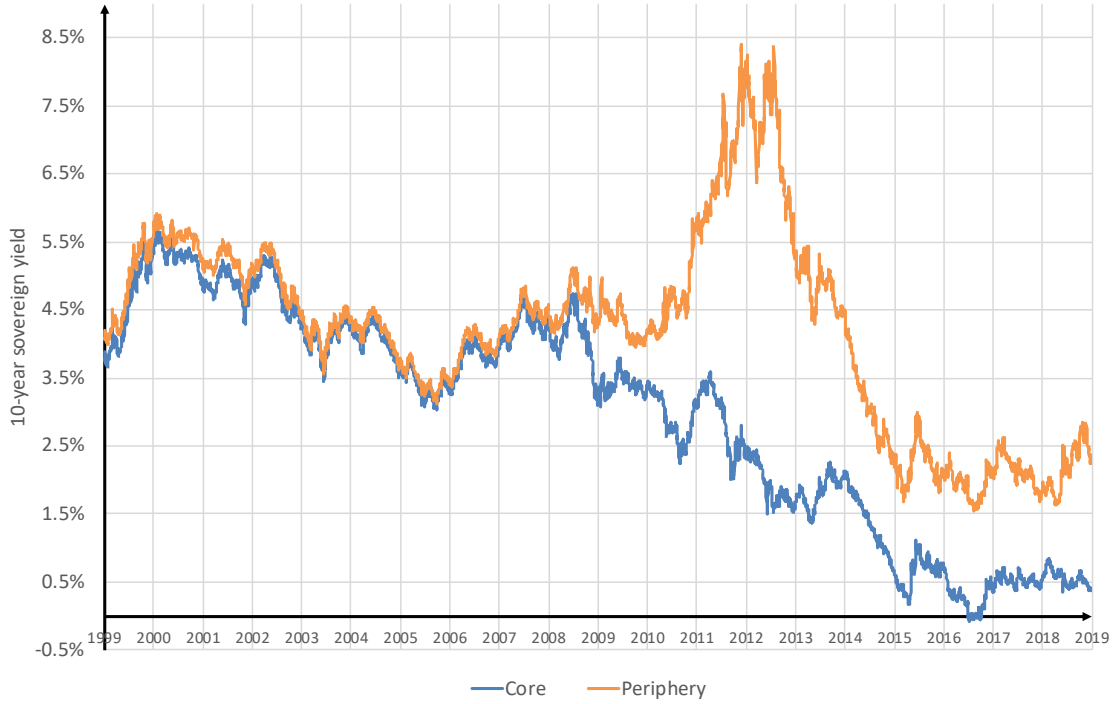
So far, we have assumed that region B's bonds are always safe. But the two regions are identical in the model. Therefore, flipping the analysis, there is a third equilibrium where it is region B's bonds that lose their safe status, and it is region A that benefits from the flight to safety. This highlights that the key source of the problem is the asymmetry in the supply of the safe asset across the two regions.

7.2 Borrowing costs for euro area periphery and core countries

Figure 12 plots the sovereign yields between the start of 1999 and the end of 2018 for the euro area core countries (Germany and France) and its periphery countries (Greece, Ireland, Italy, Portugal and Spain).[20] Before the crisis, the yield on sovereign bonds of all these countries was approximately the same suggesting that all could be safe assets. Between the start of 2010 and the end of 2012, the two series diverged sharply. Even seemingly innocuous statements from policymakers during this time would throw markets into a frenzy with sharp run-ups and rapid falls in national interest rates in the periphery. At the same time, yields in the core steadily fell. These sharp increases in the spread

[20] We calculate these aggregate variables by a weighted average of the country variables, with weights given by the GDP of each country, averaged over the period. The yeils refers to the 10-year government bond yields.

Figure 12: 10-year sovereign yields in periphery and core of Europe



between the two rates came with large capital flows from the periphery to the core and deep recessions in the periphery.

The gap in the yields between the two regions can arise in response to two sources of risk, as investors require a higher compensation ex ante to bear this risk. The first is that the exchange rate of the periphery currency can depreciate relative to the core, so that when converted to the same units, the return is lower than the stated interest rate. The introduction of the euro in 1999 had eliminated the perception of exchange rate risk between the two regions since they now shared a single currency. However, in 2010, it re-emerged in the form of "re-denomination risk". The risk was that debt in euros would be re-denominated into new national currencies worth less than the euro. As an example, financial contracts went from putting the probability that Greece leaves the euro at below 1% in 2007 to above 50% in 2010. In July 2012, as the spread peaked, the president of the ECB Mario Draghi affirmed that "...the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough." Perceptions of this risk fell sharply and so did interest rates.

The second source of risk that the periphery may be more likely to default than the core is the focus of this section. The Maastricht Treaty imposed a bail-out clause that

made it formally illegal for other European institutions to bail out countries with debt problems. The reasoning behind this constraint was that by making default risk explicit, it would eliminate inflation risk arising due to fiscal problems as the ECB would not be forced ex post to debase the real value of the debt by inflation. Moreover, making default risk explicit was a way to activate market discipline, and have countries that fail to follow disciplinary budget rules face a higher interest rate. However, this also implied that the periphery bonds lose their safe asset status, since they neither kept constant payoff across various circumstances, nor did they keep their high market liquidity during a crisis.

How were the core countries able to keep their safe asset status throughout this period? Germany and France's fiscal situation may well have been one where the green line was sufficiently high that it never intersected the blue line and there was only the good equilibrium where its debt was safe. If so, then a fiscal-sharing mechanism, whereby fiscal funds were transferred from the core to the periphery, could lower and raise their green lines, respectively, in a way that could reduce the flows and ameliorate the crisis in the periphery. Alternatively, perhaps core bonds could also have moved to the bad equilibrium, but it was enough that their fiscal situation was relatively more solid than that in the periphery. As the model made clear, a crisis in the periphery can serve as a coordinating device for expectations pushing several or even all of the periphery countries into the crisis equilibrium where their bonds lose their safety status. But there is an asymmetry in that there is always at least one country in the core that benefits from capital inflows and lower yields. As funds fled the periphery and searched for a safe harbor, the yield on core bonds fell further raising the interest rate gap.

An alternative solution is to attack the root of the problem: the asymmetry between the bonds and their underlying fiscal situations across different regions. A common bond solves the problem from the start because it imposes a single equilibrium with no cross-region flights to safety. Importantly, such a bond can be designed without one country having to guarantee for the other country's debt.[21]

[21] How to design such a bond is crucial so that it does not create more problems than the ones it solves. A bond where all regions are jointly liable for the payments, like a Eurobond, so that if one does not pay the others must cover the shortfall, creates great moral hazard. An alternative that removes the joint and several liability, and so does not create these distortions, is the issuance of sovereign bond-backed securities (SBBS or ESBies).

8 Unconventional monetary policy

Many central banks have a dual mandate, aiming to keep inflation close to a target (usually 2%) while reducing the amplitude of the business cycle and unemployment. When an economy enters a garden-variety recession with no significant financial component, the standard response is to lower interest rates. Insofar as inflation expectations are sticky, this will lower real interest rates, providing incentives for firms to invest more as financing is cheaper, and households to spend more and save less because the return to doing so is lower. This increase in spending raises aggregate demand, which raises output if there are nominal rigidities in the economy such that prices do not fully rise in response. Thus, output is stabilized.

In the past, central banks traditionally lowered interest rates by either lowering its desired target for an interbank rate at which banks lend to each other overnight with little risk (in the case of the Fed, the Federal funds rate), or by lowering the rate at which the central bank lends a limited amount to these banks over a short period of time (in the case of the ECB, the MRO for one week). Both of these cuts in rates were achieved by increasing the amount of reserves: the deposits banks hold at the central bank. Reserves are nothing but entries in a spreadsheet at the central bank stating how much each bank has deposited, but because they are the unit of account in the economy, they are the way in which payments are settled between any two banks or between any two economic agents that use banks. Since interbank credit is an imperfect substitute for reserves, and reserves pay no interest, the interbank rate gives the opportunity cost of reserves. When there were more reserves, the interbank rate falls.

Financial crises come with deep recessions. From the perspective of the dual mandate, the response of monetary policy might appear to be the same, and from the perspective of interest rates, interbank rates also fall. But there are differences in the policy tools that can be used and in their effect during a financial crisis.[22]

8.1 New central banking: reserve satiation and quantitative easing

In a financial crisis, several sections already discussed how liquidity spirals and the possibility of a liquidity crisis create a role for policymakers. The central bank can help to attenuate the crisis by lending to banks to replace the missing funding from wholesale

[22]To understand unconventional monetary policy and reserve satiation see Reis (2016) and Reis (2019), and for an application to the policies of the ECB see Hartmann and Smets (2019).

interbank markets, by buying government bonds, or even just by providing strong signals of commitment to shift beliefs. All of these involve the central bank using its power to create reserves, and giving them to banks, either by buying government bonds or by accepting these bonds as collateral in central bank loans. This reduces the opportunity cost of reserves, that is the gap between the interbank rate i and the rate paid on reserves i^v.

While this could be done by keeping the rate on reserves at 0, the need to supply abundant funding to the banking sector would imply that $i = 0$. The central bank would then lose its power to affect the interest rate and steer inflation and real activity. A superior alternative is to instead pay non-zero interest on reserves. As long as $i^v = i$, then the opportunity cost of reserves is still driven to zero, but the central bank can now choose whatever level of i^v it wants. The effective policy tool is now the interest on reserves controlled by the central bank, not the interbank rate that it may target. With this policy, the demand for reserves by banks is satiated, which offsets the private funding crisis. The top panel of figure 13 illustrates the choice of the interest rate paid on reserves and the way in which this choice can lead to *reserve satiation*.

While this change in policy tool from the interbank rate to the interest on reserves, and in equilibrium from scarce to abundant reserves, arose during the crisis, economists have long argued that it is desirable at all times. More famously, Milton Friedman argued that reserve satiation is desirable because, since the central bank can just create reserves at no cost by changing the entries on its spreadsheet, the private opportunity cost of reserves should be zero. Therefore, reserve satiation is sometimes called the Friedman rule, and it is particularly desirable when the demand for reserves is very high during a financial crisis.

A second form of unconventional policy concerns the duration of the interest rates that the central bank focuses policy on. The interest on reserves is an overnight rate. During a deep financial crisis, bringing it down all the way may not be enough to provide the needed stimulus to inflation and real activity. Note that there is a limit how negative the central bank can set the overnight interest rate before people start hoarding cash and banks stop lending. Yet, for many investment and savings decisions, the relevant cost of financing or return on savings that affect inflation and real activity are likely not the overnight rate but those that apply to months or years. The central bank would like to lower these longer-maturity interest rates in order to maximize the amount of stimulus it provides.

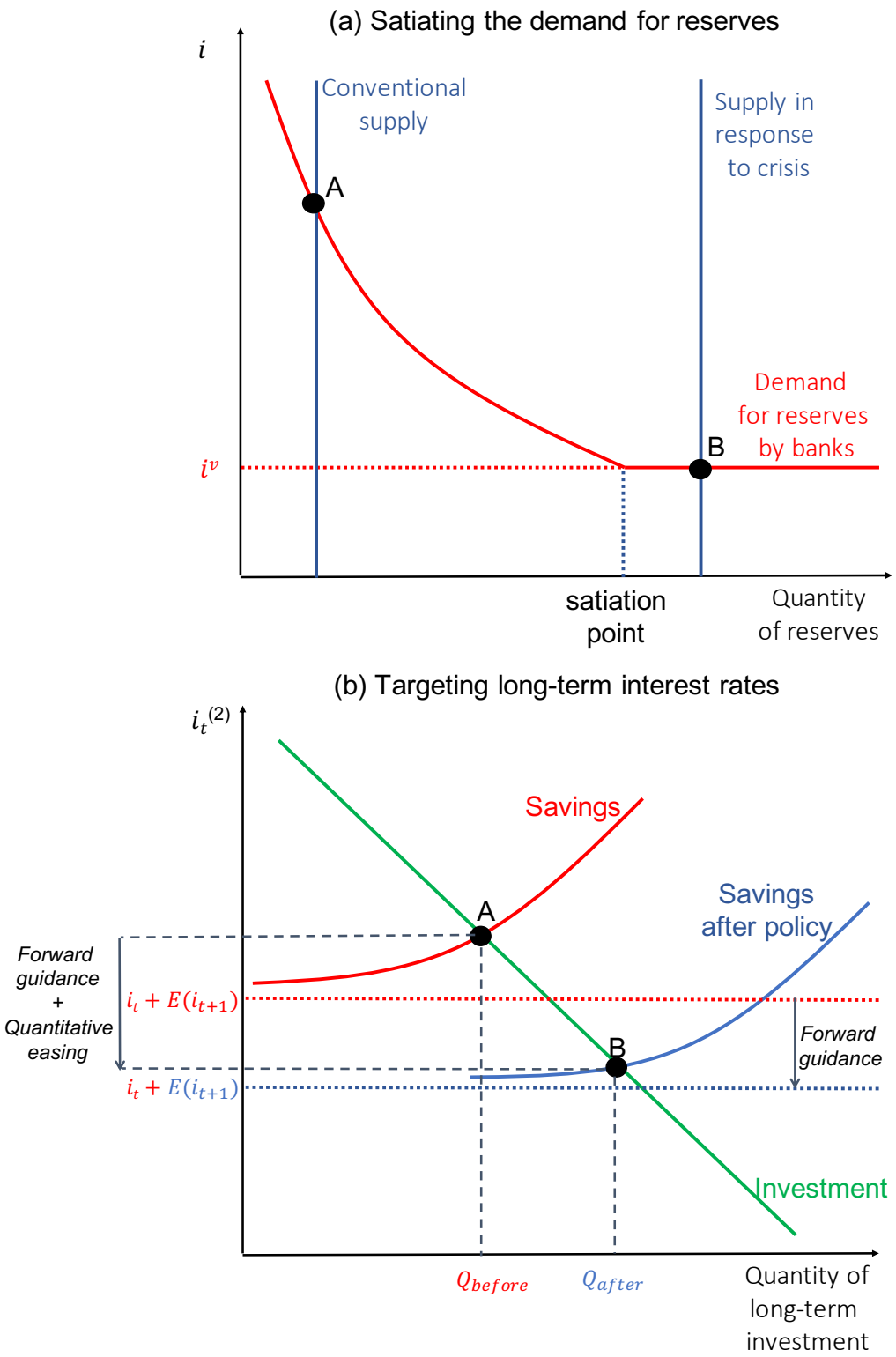
To understand how it can do so, consider a simple case where at date t, aside from the 1-period rate i_t, there is also a "long-term" interest rate at which firms and households can borrow or save for two periods: $i_t^{(2)}$. The smaller is $i_t^{(2)}$, the lower the opportunity funding cost of two-period investments, and so the larger the investment in two-period projects. The bottom panel of figure 13 represents this as a downward-sloping green line.

From the perspective of the saver, she can either invest for two periods, or roll over two successive one-period investments. However, next period's one-period interest rate is not known today, so the best the saver can do is form an expectation of it, call it $\mathbb{E}[i_{t+1}]$. Under efficient financial markets, where all the risk from this rollover strategy can be diversified away, the demand for two-period savings would be a horizontal line at $i_t + \mathbb{E}[i_{t+1}]$, as portrayed in figure 13 by the dotted line. However, with imperfect financial markets, investors may require an extra premium, call it tp_t for term premium, to compensate for the different risk and funding needs that the two strategies may have. In the figure, this is represented by the upward-sloping savings line, under the assumption that the term premium increases if the private investors have to hold larger amounts of these risky hard-to-sell bonds. At the equilibrium in point A: $i_t^{(2)} = i_t + \mathbb{E}[i_{t+1}] + tp_t$ holds.

A central bank that wants to lower $i_t^{(2)}$, and has already driven down the short-term interest rate i_t to the lowest possible level, can follow two unconventional strategies. The first one, called *forward guidance* consists of making announcements of what future policy interest rates will be, and taking on whatever commitments are available to these announcements. This lowers the $\mathbb{E}[i_{t+1}]$ perceived by investors. In the graph, it shifts the demand curve vertically down. The second strategy, called *quantitative easing* consists of using newly-issued reserves to buy government bonds of longer maturities. By increasing the demand for bonds at those maturities, this raises their price and lowers the compensation for liquidity or risk that investors demand on them, thus lowering tp_t. This shifts the demand curve horizontally to the right. Combined, these two strategies lead to a new equilibrium in point B, where $i_t^{(2)}$ is lower and investment is higher.

The combination of reserve satiation and quantitative easing implies that the balance sheet of a central bank looks different from what is conventionally taught. Reserve satiation requires it to grow, since reserves are liabilities of the central bank, while quantitative easing requires it to develop a maturity mismatch between the overnight reserves in the liabilities side and the long-term bonds in the asset side. One side effect of this is that changes in $i_t^{(2)} - i_t$ now affect the net income flow earned or lost by the central bank. Before, with a small balance sheet and no interest paid on reserves, the net income was

Figure 13: Unconventional monetary policy



steady and small. Now, the central bank generates or loses significant resources in the conduct of its monetary policy, so its interaction with the fiscal authorities, and the extent to which it is has their support in conducting these unconventional policies becomes more relevant, putting strains on the independence of the central bank.

8.2 The euro area yield curve during the crisis

A yield curve plots the sequence of interest rates $i_t^{(m)}$ for different maturities m scaled so that they are all in annual units. Figure 14 plots the euro yield curve at different stages in the life of the ECB.[23] The figure also plots using dots the gap between the rate at which the ECB lends to banks at 28 days, the main refinancing rate or MRO, and the interest it pays on overnight reserves, the deposit rate. This provides a rough measure the opportunity costs of reserves, or of how far the European banking system was from reserve satiation.

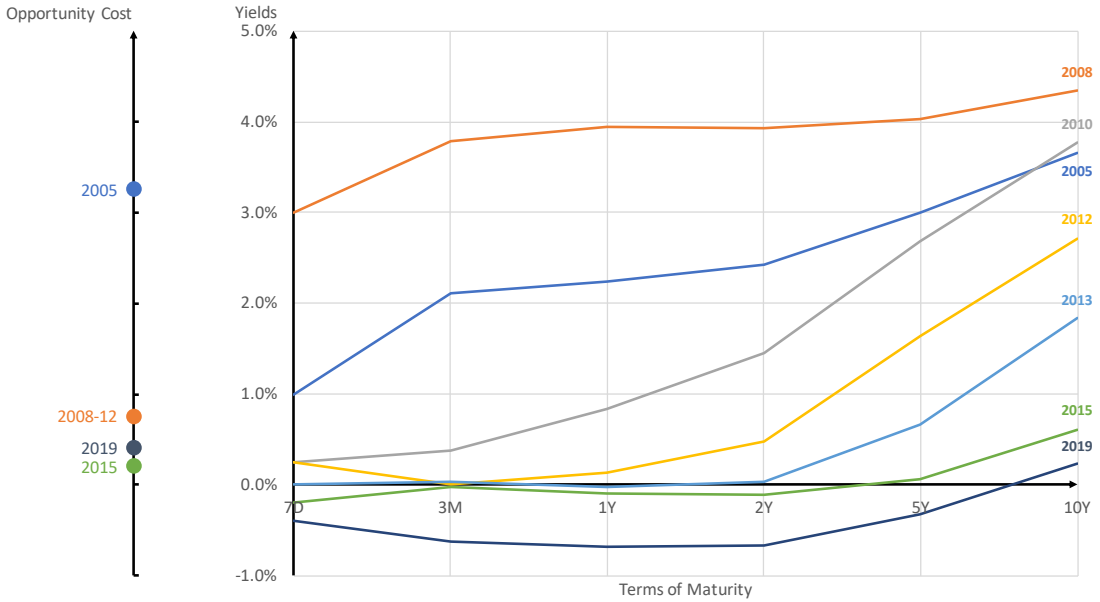
At the start of 2005, the yield curve had its "normal" upward-sloping shape as the European economy was expanding at a regular pace. The opportunity cost of reserves was high, reflecting the low interest paid on reserves and the small amount of reserves in the system.

At the start of 2008, the U.S. financial crisis had already generated funding problems for European banks. The ECB responded to the rightwards shift on the demand for reserves by expanding its balance sheet, and by lowering the opportunity cost of reserves through an increase in the deposit rate from 1% to 3%. At the same time, it did little to its normal interest rate policy, so the entire yield curve just shifted up with little change in slope. Between then and the start of 2010, the euro area entered a recession. The ECB's first reaction was to provide stimulus through conventional tools, by cutting short-term rates, so the yield curve steepened.

From the start of 2010 onwards, the euro crisis spilled over from the financial sector to the sovereign debt markets. The ECB not only went to the limits of conventional policy, cutting the MRO rate all the way down to 0.25%, but it also made clear that interest rates were likely to remain low into the future. While the interpretation of the legal mandate of the ECB at the time was that it could not acquire government bonds directly, it instead announced a lending program, LTRO (long-term refinancing operations), whereby banks

[23] Because there are no euro-wide safe bonds, as we discussed in the previous section, this yield curve is constructed by the ECB by averaging between the interest rates of of the sovereign bonds of different regions in the euro area, subject to the requisite that they are rated AAA and so are considered almost free of default risk.

Figure 14: The euro area yield curve and the opportunity cost of reserves



could buy the government bonds, and give them to the ECB for a long period of time in exchange for a loan of reserves. Thus, while neither forward guidance nor quantitative easing were officially adopted, they were implicitly being used. As a result, by the start of 2012 the yield curve had moved down almost in a parallel shift relative to 2010.

The ECB embraced unconventional policy in full force from then onwards. In 2012, the ECB announced, but never applied, its outright monetary transactions (OMT) program through which it could have acquired sovereign bonds from specific euro area countries in financial difficulties. The satiation of the demand for reserves went to the limit where by November of 2013 the MRO-deposit rate gap was only 0.25%. And forward guidance was explicitly pursued from July 2013 through official statements at policy meetings that the ECB would keep interest rates low for an extended period of time. From January 2015 onward, the ECB implemented a large scale asset purchase program, its quantitative easing, and bought assets from across the whole euro area. As a result between 2012 and 2015 the yield curve greatly flattened, and it has stayed flat until 2019.

The other side of the movements in the yield curve was the change in the ECB's balance sheet. Its size grew through the satiation of reserves from 1.2 trillion at the start of 2007 to 2.8 trillion by the end of 2015, and 4.5 trillion by the end of 2017. The share of securities held outright (instead of collateralized lending programs) went from 10% at the start of 2007 to 43% by the end of 2015 and 60% by the end of 2017. In turn, within its

lending programs, the share of longer-term operations went from 27% at the start of 2007 to 84% at the end of 2015 and 100% by the end of 2017. In undertaking these policies, the ECB took on a significant risk to its fiscal independence. Unlike other central banks that can count on commitments from the fiscal authorities to provide backing in case the central bank's equity becomes very negative, the ECB lacks clear fiscal support due to the fragmented nature of fiscal policy.

9 Conclusion

Economies sometimes go through macro-financial crises. These are neither solely crises in financial markets, with large changes in asset prices and trading volumes but limited impact on the macroeconomy, nor are they conventional macro crises for which the financial sector has a secondary role in transmitting shocks to fluctuations. Rather, macro-financial crises have their source or major amplification in the financial market, they have large macroeconomic effects, and the interaction between macroeconomic policy and financial institutions occurs through multiple reinforcing channels.

This article introduced readers to seven concepts in macro-finance that are central in a crisis. In the run-up to the crisis, large capital inflows intermediated by banks come with real misallocation between and within sectors. The banks that intermediate them see their balance sheet change as leverage increases and funding becomes collateralized by marked-to-market securities. After an initial shock, liquidity spirals and fire sales generate strategic complementarities that amplify the shock or create multiple equilibrium leading to systemic failure in the financial market, propagating to real activity. In the heart of the crisis, the previous use of debt makes it difficult to distinguish between solvency and liquidity, which produces wide fluctuations on interest rates paid. At this time, the holding of government bonds by banks links the financial sector to government fiscal policy in a way that brings both down together. As investors flee for safety, regional imbalances in the supply of safe assets can produce costly capital flows. Central banks can provide liquidity to banks and help markets distinguish between a solvency and a liquidity crisis but, to fight the recession, they resort to unconventional monetary policy, in the form of reserve satiation, forward guidance, and quantitative easing, all of which have an effect on different interest rates by changing the composition of the central bank balance sheet. Together, and related to each other, these seven concepts provide the tools to understand how macro-financial crises emerge, grow, and can be attenuated.

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