Liquidity and Discipline. Bank Due Diligence over the Business Cycle

Abstract

The quality of bank lending is increasingly viewed as a force driving the buildup and unfolding of crises. In a dynamic general equilibrium model, we show that banks' access to liquidity and the values of loan portfolios govern banks' incentives and effectiveness in producing information on loans. Consistent with granular loan-level evidence from U.S. banks, the calibrated model predicts that loan due diligence deteriorates during expansions and intensifies during contractions. This countercyclicality attenuates investment and output effects of liquidity shocks but can moderately amplify loan quality shocks. Credit policies may dilute stabilizing effects of due diligence.

JEL classification: E32, E44

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1 Introduction

Banks perform fundamental functions in the economy. Among their activities, they intermediate liquidity between savers and borrowers and they perform due diligence and information production on loans (Allen and Gale, 2000). Banks' access to liquidity is a primary determinant of their intermediation activity and, hence, of their role in the aggregate economy. During the Great Recession and the European sovereign debt crisis, tight liquidity constraints in the markets for bank wholesale funding (e.g., interbank deposits and repos) acted as a transmission mechanism of the crises (Acharya and Mora, 2015). In the years preceding the Great Recession, easy access to funding liquidity promoted a major growth of bank lending (Bernanke, 2009).

While the role of banks' access to liquidity in aggregate economic activity is well established, less is known about the way this interacts with banks' activity of information production and due diligence on loans. Yet this activity is critical for banks'

access to funding liquidity. Banks produce a wealth of information (e.g., credit scores and ratings, risk models, analyses of borrowers and collateral assets) that preserves the viability of loan portfolios and certifies banks' financial status and regulatory compliance to bank supervisors and financiers (Barth et al., 2004; Berger and Udell, 2006; Lisowsky et al., 2017). BIS (2015) describes how banks' due diligence affects supervisors' assessment of regulatory compliance. And there is broad evidence that loan due diligence influences banks' access to wholesale liquidity and its cost (e.g., banks' CDS spreads; King, 2008; King and Lewis, 2020; Furfine, 2001). Like banks' access to liquidity, banks' due diligence appears to fluctuate over the business cycle. In the liquidity frenzy preceding the Great Recession, many observers pointed to banks' inadequate due diligence on their expanding loan portfolios. Empirical studies find that booming liquidity may dilute banks' incentives to undertake ongoing due diligence on loans, while banks appear to step up due diligence during contractions (Lisowsky et al., 2017; Ruckes, 2004; Becker et al., 2020).

These considerations elicit fundamental questions on the nexus between the banking sector and the aggregate economy: what role does banks' due diligence play in business cycle transmission? How does banks' due diligence interact with banks' access to funding liquidity over the business cycle? And how do credit policies in support of bank liquidity shape this interaction and, through it, business cycle transmission? To address these questions, we first present evidence on banks' due diligence activities by hand-matching granular data from the U.S. syndicated loan market with bank-level data. Using proxies for banks' due diligence effort often considered in the empirical literature (e.g., the fraction of loans retained by banks in the syndicated market), we document significant time variation of due diligence efforts in the U.S. banking sector over the 1996-2015 period.[1] We then find that banks perform more due diligence during contractions, especially if they have poor access to wholesale liquidity.

Motivated by this evidence, we build a dynamic general equilibrium model in which banks intermediate liquidity between households and firms. Following prior macroeconomic models with a banking sector (e.g., Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Bernanke and Gertler, 1987), banks face constraints when gathering retail and wholesale liquidity. These constraints limit the value of banks' retail deposits and interbank borrowing not to exceed the pledgeable value of their assets (loans and government bond holdings). As in previous studies (e.g., Gertler and Kiy-

[1] See, e.g., Sufi (2007) and Section 3 for more on the proxies for banks' due diligence.

otaki, 2010; Gertler and Karadi, 2011), collateral constraints stem from the risk that banks default strategically on their obligations to financiers. The key departure from previous studies is that, building on the banking literature (e.g., Diamond and Rajan, 2001, 2005), we stress the information sensitivity of loans and let banks perform ongoing due diligence on loan portfolios. This costly due diligence affects the loan recovery value expected by bank supervisors and financiers in the event of bank default and thus the haircuts on loan portfolios, impacting on the value of loans pledgeable by banks in liquidity markets. We show that two main mechanisms drive banks' due diligence effort over the business cycle: the tightness of wholesale and retail liquidity constraints ("liquidity channel"); and the marginal effect of banks' due diligence on loan pledgeability, governed by the value of assessed loan portfolios ("pledgeability channel"). Tighter liquidity disciplines banks, pushing them to perform more due diligence to enhance the pledgeable recovery value of loans and restore the access to liquidity; larger values of loan portfolios increase the marginal productivity of loan analysis in affecting loan pledgeability and, hence, due diligence incentives. These channels also govern the impact of banks' due diligence on the aggregate economy.

We calibrate the model to data on the U.S. economy and to the U.S. banking data used in the empirical analysis. We then simulate the response to shocks and investigate how banks' due diligence affects business cycle transmission and how credit policies shape this influence. The model predicts that due diligence deteriorates when lending and output expand, progressively eroding the pledgeable recovery value of loans. By contrast, due diligence strengthens during contractions, sustaining loan recovery and pledgeable values. The model thus matches our empirical findings and the view that in liquidity booms banks become less diligent in producing information on loans, while they step up due diligence during contractions (e.g., Dell'Ariccia and Marquez, 2006; Lisowsky et al., 2017; Ruckes, 2004). Turning to the aggregate implications, the model predicts that this countercyclical due diligence attenuates investment and output effects of funding liquidity shocks while it can moderately amplify loan quality shocks. The model can then offer insights to the debate on banks' role in business cycles. It is often argued that in bad times a tightening of bank lending standards can exacerbate lending contractions, possibly aggravating downturns. In our setting, where we account for the role of due diligence in facilitating banks' access to liquidity markets, fluctuations in bank due diligence can moderately amplify loan quality shocks, but attenuate the effects of liquidity shocks.

Specifically, the first two aggregate shocks we consider influence banks' access to

funding liquidity: a negative shock to the value of collateralizable government bonds and a restrictive regulatory shock to collateral pledgeability in the wholesale liquidity market. By tightening banks' liquidity constraints, these shocks significantly boost banks' "hunger" for liquidity (liquidity channel), while mildly shrinking the value of assessed loans (pledgeability channel). The net effect is an increase in banks' due diligence incentives. In turn, despite the reduced information productivity due to the diminished value of loans, the countercyclical due diligence attenuates the contraction of credit, investment and output. A negative loan (capital) quality shock, in contrast, significantly erodes loan values and, hence, the productivity of banks' information collection. This can make the countercyclical due diligence an amplifier of this shock: costly due diligence on deteriorated loans can drain resources from banks more than facilitate their access to liquidity.

We next revisit the effects of the shocks when credit policies are implemented. We consider three types of policies implemented in recent downturns (see, e.g., Gertler and Kiyotaki, 2010): liquidity provisions to banks in the wholesale liquidity market, equity injections into banks, and direct lending to firms. Following contractionary shocks, credit policies directly loosen banks' collateral constraints. In doing so, however, they also dilute banks' incentives to step up due diligence, especially when they take the form of equity injections into banks. Nonetheless, the dilution of due diligence is short-lived and credit policies retain a stabilizing role in the medium-long run.

The mitigation of loan haircuts implied by the countercyclical due diligence can be compared with what predicted by the data. The responses in the model are in the ballpark of our estimates on the impact of shocks on due diligence, in conjunction with estimates on the impact of due diligence on loan haircuts (Mora, 2015; Ivashina, 2009). The effects are quantitatively relevant. Calibrating the magnitude of the contractionary shocks to match the effect of recent aggregate shocks on key banking indicators, over a one-year horizon the average increase in due diligence relative to the steady state ranges from 5% to 17%, depending on shocks. Following the negative bond value shock, the model predicts that, over a four-year horizon, an increase of due diligence 15% larger in each period is associated with investment and output drops 3.5% smaller on average. The attenuating effect of due diligence following the regulatory shock is similar, while its amplifying effect following the (loan) capital quality shock is significantly milder. Further, the countercyclical due diligence reduces the output variance by 11% following liquidity (bond value and regulatory) shocks, while increasing it by 1.3% following loan quality shocks. These effects on macroeconomic

volatility are larger than those of a 5% change in the bank capital adequacy ratio.

In the model, we endogenize the effect of banks' due diligence on loan recovery values building on Diamond and Rajan (2005, 2006). We posit that, unlike the primary markets for liquidity, the liquidation market for the project loans of defaulting banks is affected by trading frictions. Due to the bank heterogeneity that characterizes our economy, banks that default strategically need to identify suitable buyers of project loans in the liquidation market.[2] Loan due diligence enhances this ability, raising the recovery value of loans and, hence, the loan value pledgeable in markets for liquidity.

The last part of the paper considers alternative specifications of banks' due diligence. In a first extension, due diligence helps build a stock of knowledge and experience on loans (Degryse et al., 2009). In a second extension, due diligence affects not only the pledgeability of loans in markets for liquidity but also loan returns. Finally, in a third extension banks are insulated from wage fluctuations and face a constant marginal cost of due diligence. These specifications may influence the strength of the mechanisms but do not alter the aggregate consequences of banks' due diligence.

The paper unfolds as follows. In Section 2, we discuss empirical and theoretical underpinnings of our analysis and relate it to prior studies. Section 3 presents empirical evidence that motivates the model. Section 4 lays out the model and solves for agents' decisions. In Sections 5 and 6, we analyze and quantify the effects of shocks and the impact of credit policies. Section 7 considers extensions. Section 8 concludes. Details on the data and additional results are relegated to the online Appendices.

2 Prior literature

2.1 Empirical and theoretical underpinnings

A first component of our mechanisms is the cyclical behavior of banks' due diligence. The hypothesis that due diligence fluctuates over the business cycle is explored in banking studies (Becker et al., 2020; Lisowsky et al., 2017). A tenet of theoretical banking studies is that liquidity booms can be associated with a decline in due diligence effort, while liquidity shortages can incentivize such effort (Ruckes, 2004; Dell'Ariccia and Marquez, 2006). The liquidity channel in our model mirrors this view. Some banking studies stress that due diligence incentives are also driven by the

[2] As in Gertler and Kiyotaki (2010), banks receive idiosyncratic investment opportunities shocks, which motivates the existence of a wholesale (interbank) liquidity market. We posit that liquidated project loans can only be purchased by banks with the same investment opportunities.

value of loans extended and by the returns to loan analysis (Holmstrom and Tirole, 1997). Due diligence incentives could then weaken during contractions, when loan portfolio values shrink. The pledgeability channel in our economy mirrors this view. On the empirical side, a growing body of studies document a countercyclical behavior of bank due diligence. We discuss these studies in our empirical section.

A second component of our mechanisms is the influence of banks' due diligence on banks' access to liquidity markets. There is extensive evidence of this influence. King (2008), King and Lewis (2020) and Furfine (2001) find that banks' due diligence influences costs and availability of liquidity for banks (e.g., banks' CDS spreads). Afonso et al. (2011) document that during the Great Recession U.S. banks that exerted lower due diligence received less funding and faced higher rates (see also Filipović and Trolle, 2013, for international banks; Acharya and Mora, 2015, for U.S. banks; Dent et al., 2021, for UK banks; and Bräuning and Fecht, 2017, for German banks). Using data for the euro area, Tolo et al. (2017) and Angelini et al. (2011) find that after 2007 banks that engaged in weaker due diligence and had lower credit-worthiness faced higher costs of liquidity.[3] The relevance of the link between banks' liquidity access and their due diligence effort is also made clear by the stance of regulators: the discipline provided by liquidity markets is at the core of the third pillar of Basel bank regulation, for example (BIS, 2001). And, recently, some empirical studies have pointed to possible unintended effects of credit policies, due to the dilution of the discipline provided by liquidity markets (see, e.g., Allen et al., 2020). Examining euro area data, Brunetti et al. (2011) document that, at least in the short run, public injections of liquidity in the interbank market may not improve significantly banks' liquidity access but result in higher spreads.

2.2 Related studies

The paper relates to a growing literature on the role of banks in aggregate economic activity. In this literature, a broad strand of studies investigate the role of banks' access to liquidity in business cycle transmission (see, e.g., Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Gennaioli et al., 2014; Bocola, 2016; Bofondi et al., 2018; Lakdawala et al., 2018). In some papers, shocks to the values and pledgeability

[3] There is a growing literature on the effects of banks' health on lending decisions. Chodorow-Reich and Falato (2021) find that banks in worse financial status are more likely to contract lending in response to firms' violations of credit covenants. Relevant studies on the effects of loan covenant violations on credit extended also include Drechsel (2020), Lian and Ma (2021) and Greenwald (2019).

of banks' collateralizable assets lead to a tightening of banks' collateral (e.g., capital) constraints, impairing banks' intermediation capacity (Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Bocola, 2016). These papers do not examine the role of banks' due diligence and information production.

A second strand of literature examines the role of banks' information production in macroeconomic stability. A number of studies in banking investigate the effect of bank screening and lending standards on borrowers' creditworthiness, the "weeding out" of bad loans, and the returns to loan portfolios (see, e.g., Manove et al., 2001; Broecker, 1990; Ogura, 2006). Some banking studies explore aggregate implications of these theories of lending standards. Dell'Ariccia and Marquez (2006) show that during booms the rising number of new borrowers can lead banks to loosen lending standards, while in De Marco and Petriconi (2016) the loosening of lending standards is induced by increasing bank competition. Closer to our approach, Goodfriend and McCallum (2007) study a dynamic general equilibrium economy where bank loan officers are employed in the production of loans and this affects the returns to lending activities. We study an alternative channel of influence of banks' information production. In our economy, by performing due diligence and information acquisition on loan portfolios, loan officers raise their recovery value and, hence, their pledgeability in markets for liquidity. This enables us to study the disciplining effect that banks' access to wholesale and retail liquidity has on due diligence (King, 2008; King and Lewis, 2020; Furfine, 2001). Investigating how due diligence interacts with banks' access to liquidity also yields normative insights. Our analysis reveals that credit policies in support of bank liquidity can temporarily disincentivize due diligence.

More broadly, the paper relates to the theoretical literature on information cycles in credit markets and their aggregate consequences. Recent theoretical studies show that expansions can exhibit limited information acquisition by lenders and borrowers. This can stem from a growing productivity of projects which dilutes information acquisition incentives (Gorton and Ordoñez, 2020) or from the evolution of beliefs on collateral quality (Gorton and Ordoñez, 2014). It can alternatively stem from a rise in collateral prices (Asriyan et al., 2021). An information regime shift can then precipitate a crisis, either because the step up of information acquisition tightens project selection (Gorton and Ordoñez, 2014) or because it entails a costly transition from collateral-based to screening-based lending (Asriyan et al., 2021). In our applied setting, it is banks' liquidity access that mainly drives due diligence, rather than the price of firms' collateral or the productivity of firms' projects. We show that,

while due diligence fluctuations can sometimes magnify shocks, they can also act as an important stabilizer. Credit policies may unintentionally dilute this stabilizing effect.[4]

3 Empirical evidence

In this section, we first discuss extant evidence on the cyclical behavior of banks' due diligence. Hand-matching granular loan-level data from the U.S. syndicated loan market with bank-level data, we then investigate the response of due diligence to aggregate shocks and whether this response depends on banks' access to liquidity.

3.1 The cyclical behavior of due diligence

As noted, there is growing evidence of a countercyclical behavior of bank due diligence. Using data from the Risk Management Association and a difference-in-difference approach, Lisowsky et al. (2017) find that, during the lending boom of 2002-2007, U.S. banks reduced their collection of audited financial statements from firms (a proxy for ongoing loan due diligence), especially in regions with significant lending growth. This pattern reversed in the crisis of 2008–2011. Becker et al. (2020) find that Swedish banks were more diligent in assigning credit scores to borrowers during two recent downturns than during the booms. Matching data from 2004 to 2012 on the accounts of one of the largest Swedish banks with data from the Swedish leading credit bureau, they uncover that the information content of the bank's loan analysis was higher in downturns. Ambrocio and Hasan (2019) document that banks' discretion (unexplained variations in loan terms) is partly attributable to banks' due diligence and information acquisition. They then show that the information component to banks' discretion rises during recessions.

3.2 Data and empirical framework

To conduct our empirical analysis, we hand-matched data from three sources: the Thomson Reuters LPCs DealScan database, which collects detailed data on syndi-

[4]Looking at the modelling of information, in Gorton and Ordoñez (2014) lenders or borrowers collect information on firms' collateral. In Asriyan et al. (2021), lenders screen project quality, in alternative to granting credit collateralized by firms' pledgeable assets. In our setting, in which lenders themselves are liquidity constrained, lenders' due diligence raises the pledgeability of loans in markets for liquidity. Thus, pledgeable loans and due diligence are complements.

cated bank loans; the Call Reports compiled by the Federal Reserve Board, which provide information on banks' balance sheets and on banks' access to interbank market liquidity; and data in Rauch (1999) on product information complexity. The data set covers 17,894 loans extended by 199 banks to 5,408 firms over the 1996-2015 period. The Appendix provides details on data sources and sample design.

The syndicated loan market is an ideal empirical laboratory. Syndicated lending constitutes a large fraction of bank lending and is often used to track banks' due diligence (Sufi, 2007). In a syndicated loan the borrower signs an agreement with the lead arranger which specifies the loan characteristics (collateral, loan amount, covenants and a range for the interest rate).[5] The lead arranger then invites other banks to participate in co-financing the loan. Building on theories of banks as delegated monitors (e.g., Diamond, 1984; Holmstrom and Tirole, 1997), the literature treats the structure of the lending syndicate (especially the share of the loan retained by the lead arranger) as a proxy for the due diligence incentive of the lead arranger. Through the relationship established with the borrower, the lead arranger is in fact in a privileged position to perform due diligence on behalf of loan participants. However, its due diligence effort is costly and unobservable by participants and, since participants share the cost of bad loans, the lead arranger does not fully internalize the consequences of shirking on its effort. A way to curb this moral hazard is that the lead arranger retains a material share of the loan ("skin in the game") so that it suffers severe consequences if it shirks on due diligence (Gorton and Pennacchi, 1995; Holmstrom and Tirole, 1997; Leland and Pyle, 1977). Based on this argument, several empirical studies use the lead share (or the syndicate concentration) as a proxy for banks' due diligence effort. Sufi (2007) shows that at loan origination lead arrangers keep a larger share in loans that require more due diligence. Ivashina (2009) finds that a larger lead share at origination reduces the spread demanded by investors. Dennis and Mullineaux (2000) and Jones et al. (2005) document that lead arrangers retain a larger share, and the syndicate is more concentrated, when borrowers are informationally opaque (see also, e.g., Lee and Mullineaux, 2004; Focarelli et al., 2008; Amiram et al., 2016; and Berndt and Gupta, 2009).

[5] Lead arrangers receive a fee from the borrower for managing the loan. If there are two or more lead arrangers, then they are co-leads.

3.3 Empirical model

Figure 1 plots the evolution over time of the average share retained by lead arrangers in syndicated loans (our main proxy for banks' due diligence effort). The figure highlights key macroeconomic events occurred during the sample period: the NBER recessions (vertical bars) and the aggregate liquidity shock triggered by the introduction of a new FDIC (Federal Deposit Insurance Corporation) regulatory assessment base in 2011 (see Section 3.4 for a description of this shock). We observe, for example, that in the expansionary period preceding the Great Recession (our proxy for) banks' due diligence remained low; during the Great Recession due diligence intensified. It is useful to compare the behavior of our proxy with that of another measure sometimes used to track banks' due diligence, the share of subprime mortgage loans among all mortgage loans.[6] Figure 1 reveals a clear negative correlation between our proxy and this inverse measure of due diligence.

To investigate the cyclical behavior of banks' due diligence and its interaction with banks' funding liquidity, we estimate the following main empirical model:

$$\begin{aligned} Lead\ share_{b,l,t} = \alpha + \beta_1 shock_t + \beta_2 interbank_{b,t} + \beta_3 (shock_t \times interbank_{b,t}) + \\ + \beta_4^{\intercal} X_{b,t} + \beta_5^{\intercal} X_{l,t} + \eta_b + \eta_{year} + \epsilon_{b,l,t}. \end{aligned} \quad (1)$$

The dependent variable, *Lead share*, is the loan share of lead bank b in loan l extended at time (quarter) t, which proxies for the bank's due diligence effort. To test how due diligence responds to aggregate shocks, we insert two indicators for the occurrence of a *shock*, which respectively capture recessionary shocks and major regulatory shocks to wholesale liquidity access. We define *NBER recessions* as a dummy equal to one if quarter t is recessionary, zero otherwise. We also code a dummy, *exempted*, which aims at capturing the aggregate liquidity shock that was prompted by the 2011 FDIC assessment base regulatory change. This shock effectively raised the cost of wholesale liquidity except for reserve *exempted* institutions. We further describe this shock and the *exempted* variable below. A key independent variable of interest is the *interbank* exposure of the bank, which we use to proxy for the bank's participation in, and access to, the wholesale liquidity market. Following Furfine (2003), we define the interbank exposure in quarter t as the natural logarithm of the sum of the following items: cash and balances due from a depository institution, credit exposure of all off-balance sheet derivative contracts, loans and federal funds sold to a depository institution.

[6] The data on subprime mortgages (available up to 2012) are from Ferreira and Gyourko (2015).

In equation (1) we also insert a variety of controls for bank, loan and borrowing firm characteristics (captured by the vectors $X_{b,t}$ and $X_{l,t}$). We insert *information complexity*, a dummy equal to one if the industry in which the borrowing firm operates features heterogeneous products and assets and, hence, the borrower is informationally complex (see Rauch, 1999). Further, we insert *lending experience* as the number of loans that the lead arranger extended to the borrower in the five years prior to the current loan. To control for borrowing firms' specialization and riskiness and for the loan type we insert the firm's *sectorial specialization* and its S&P credit *rating* as well as a dummy equal to one if the loan type is *term A*. Concerning time-varying bank-level control variables, we insert the *reserves* balances at the central bank relative to total assets, the ratio of *deposits* to assets, the *return on assets*, the ratio of $TIER1$ capital over total assets, the *loan loss provisions* ratio, and the *bank size*. The vector η_b denotes bank fixed effects, while η_{year} is a vector of year dummies. Finally, ϵ is a loan-level shock, which captures stochastic disturbances.

The main coefficients of interest are β_1, β_2 and β_3. The β_1 coefficient captures the effect of aggregate shocks on the lead lender share (our proxy for bank due diligence). The β_2 coefficient captures the impact of the lead lender's access to wholesale liquidity. The β_3 coefficient reflects how the impact of aggregate shocks depends on the lead lender's access to wholesale liquidity. In Appendix Table 1, we provide definitions for the variables used in the estimations. Appendix Table 2 presents summary statistics.

3.4 Estimates

Our focus is on the effect of aggregate shocks and of the access to interbank liquidity on the loan share retained by the lead arranger. Table 1 reports the main coefficients of interest (see Appendix Table 3 for the full estimates). In column I, we estimate a baseline model without interaction terms (standard errors clustered at the bank-year level). The estimated coefficient of the $NBER$ *recessions* dummy is positive and statistically significant, suggesting that, after controlling for bank, loan and borrower characteristics, banks undertake more due diligence during recessions than in normal times. The coefficient suggests that during recessions the lead share rises by 3.2 percentage points (9.4% of the sample mean). The coefficient of *interbank* exposure is negative, that is, banks tend to retain higher due diligence incentives when they have lower access to wholesale liquidity. The coefficient implies that a 1-percentage point decrease in the interbank liquidity access increases the lead share by 4 percentage points. We also find that banks with more lending experience perform somewhat less

due diligence. Next, in column II we augment the baseline regression with the control for product information complexity. The results carry through and information complexity enters with the expected positive sign, suggesting that banks perform more due diligence when borrowers have informationally complex products and assets.

In column III, we examine the marginal effect of interbank liquidity access on the lender's loan share during recessions. The coefficient of the interaction term is negative and statistically significant, suggesting that lower access to interbank liquidity further boosts the due diligence effort of the lead arranger during recessions.

In column IV, we consider the effect of an aggregate negative liquidity shock of regulatory origin. The Dodd-Frank financial reform required a change in the FDIC fee for banks to fund the deposit insurance. In 2011, the assessment base for banks' fee was changed from domestic deposits to assets minus tangible equity, effectively raising the costs for accessing wholesale liquidity. However, foreign branches and agencies and custodial banks were exempted from the new assessment base, retaining easier access to wholesale liquidity. The estimated coefficient on the interaction between access to interbank liquidity and *exempted* banks in column IV is positive. This means that, among the banks hit by the restrictive regulatory shock, those with more difficult access to wholesale liquidity had higher incentive to perform due diligence.

Finally, in column V we augment the regression of column I with the interaction between $NBER$ *recessions* and *lending experience*. The estimates suggest that lending experience dilutes banks' incentive to step up due diligence during recessions.

To summarize, the estimates point to these patterns: i) banks perform more due diligence following aggregate recessionary shocks; ii) banks perform more due diligence when they have difficult access to wholesale liquidity, especially during recessions; iii) when restrictive regulatory shocks hit the wholesale funding market, banks with difficult access to wholesale liquidity perform more due diligence than banks with easy access; iv) banks perform less due diligence when they have stronger lending experience with firms. As we will see, the predictions of the theoretical model are consistent with these patterns, as well as key quantitative responses.

3.5 Alternative specifications

In Appendix Table 4 we perform robustness tests. In column I, we saturate the supply side time-varying unobserved using bank-year fixed effects. These allow to control for unobservable time-varying bank fundamentals to isolate credit supply. Essentially, we compare the same bank lending to a different firm in a given year, while using

only the within variation of each bank-firm combination for estimation. In column II, we add loan purpose fixed effects. Columns III and IV control for the firm's riskiness and the loan type, respectively. The results carry through in these tests. In untabulated tests, we also experimented with replacing the dependent variable with the shares of participant banks. The coefficients on *interbank* and *shock* tend to lose significance, suggesting that our main findings can be attributed to the lead arranger's due diligence incentives and not to other banks' tendency to participate in the loan.[7]

4 The model

Motivated by the empirical findings, we develop a dynamic general equilibrium model where banks intermediate liquidity between households and firms and perform information production (due diligence) on loans. The economy comprises four sectors: households; firms, divided between final goods producers and capital producers; banks; and a government. Households consume and supply labor to firms and to banks. Banks borrow liquidity from households in a retail deposit market and borrow liquidity one from another in an interbank market, consistent with our empirical framework. Due to the risk of banks' strategic default, banks' access to liquidity is subject to collateral constraints: the value of their retail and interbank borrowing cannot exceed the pledgeable value of their assets. Banks perform ongoing due diligence on loans, raising their recovery value in the event of default and thus their pledgeable value in markets for liquidity. Loan due diligence is costly, however, as it entails the hiring of loan officers.[8] Banks can also pledge government bonds as collateral when borrowing liquidity.[9] The model incorporates different shocks to banks' constraints and loan values. This enables us to investigate how banks' due diligence responds to liquidity and loan quality shocks, affecting their transmission to the real sector.

[7] For example, re-estimating the specification in column I of Table 1, the estimated coefficient on *interbank* equals 0.08 (not significant at conventional levels).

[8] Loan officers study financial statements, produce analyses of borrowers and their capital assets, and interact with bank supervisors and rating agencies (Ruckes, 2004).

[9] Government bond holdings constitute a relevant share of banks' assets in many countries, including the United States and eurozone countries, and are often used as collateral in wholesale liquidity markets (Gennaioli et al., 2014). For example, around 75 percent of repo transactions in the euro area use government bonds as collateral (Hördahl and King, 2008).

4.1 Households

To keep the model tractable, we follow the standard assumption of a representative household. Households comprise workers, who earn wages, and bankers, who earn profits by managing banks. Workers can be employed in the production of final goods or as loan officers in banks. There is perfect consumption insurance within the household. We follow the setup in Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) where bankers exit in each period with an i.i.d. probability $(1-\sigma)$ and transfer all their retained earnings to the household when exiting.[10] This ensures that bankers cannot accumulate enough assets such that their collateral constraints never bind. To keep the relative number of workers and bankers constant, $(1-\sigma)f$ workers randomly convert into bankers (where f denotes the fraction of bankers). Each new banker receives a startup transfer from the household, as a small and exogenous fraction θ of the total assets of exiting bankers.

Households earn the wage rate W_t^H on labor supplied in the goods sector (H_t) and the wage rate W_t^L on labor supplied in the banking sector (L_t). They also earn a gross rate of return R_{t-1}^D on deposits as well as profits Π_t from owning banks and firms. They use their funds for consumption C_t, to hold deposits D_t, and to pay lump-sum taxes T_t. They choose consumption, deposit holdings and labor supply to maximize their expected lifetime utility according to

$$\max_{\{C_t, D_t, H_t, L_t\}_{t\geq 0}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln\left(C_t - h_C C_{t-1}\right) - k_H \frac{H_t^{1+\varphi}}{1+\varphi} - k_L \frac{L_t^{1+\tau}}{1+\tau} \right] \tag{2}$$

$$\text{s.t.} \quad C_t + D_t + T_t = R_{t-1}^D D_{t-1} + W_t^H H_t + W_t^L L_t + \Pi_t.$$

In (2), h_C denotes habits on consumption, while φ and τ are the inverse of Frisch elasticity for labor supplied to the production of goods and to banking activities, respectively. The parameters k_H and k_L govern the labor disutility in the two sectors.

Equation (3) is the labor supply condition for the two labor types:

$$-\frac{U_{H_t}}{U_{C_t}} = W_t^H; \quad -\frac{U_{L_t}}{U_{C_t}} = W_t^L. \tag{3}$$

[10] As capital constraints bind for bankers around the steady state, bankers will always retain earnings while in business and pay dividends upon exiting.

Letting $\Lambda_{t,t+1} \equiv \beta \frac{U_{C_{t+1}}}{U_{C_t}}$, the Euler condition for consumption reads

$$1 = E_t \Lambda_{t,t+1} R_t^D. \tag{4}$$

4.2 Firms

Final goods producers There is a continuum of final goods producers of unit mass located on a continuum of islands. Final goods producers use capital and labor to produce final goods through a constant returns to scale technology. Capital is not mobile while labor is perfectly mobile across firms and islands, so we can express aggregate output as a function of aggregate capital and labor:

$$Y_t = A_t K_t^{\alpha} H_t^{1-\alpha}, \tag{5}$$

where Y_t is output, α denotes the capital share, K_t is the capital stock and A_t is the total factor productivity.

Denoting by Z_t the return to capital, the factor demand curves are

$$W_t^H = (1-\alpha)\frac{Y_t}{H_t}; \quad Z_t = \alpha \frac{Y_t}{K_t}. \tag{6}$$

Following Gertler and Kiyotaki (2010), in every period t a fraction π^i of islands receive the opportunity to invest, whereas in a fraction $\pi^n = 1 - \pi^i$ of islands there are no investment opportunities. Firms on investing (non-investing) islands issue state-contingent securities X_t^i (X_t^n), at a market price $Q_t^{X,i}$ ($Q_t^{X,n}$), to banks. Each firm security constitutes a claim to the future returns of a unit of present capital.

Let δ denote the capital depreciation rate. Then, in islands with investment opportunities capital accumulated is $I_t + \pi^i(1-\delta)K_t$, while in islands without investment opportunities it is $\pi^n(1-\delta)K_t$. Aggregating and denoting by ψ_t an AR(1) shock to the quality of physical capital that occurs after production in t, the law of motion for aggregate capital is

$$K_{t+1} = \psi_t \left[I_t + (1-\delta)K_t \right] = \psi_t \left[I_t + \pi^i(1-\delta)K_t + \pi^n(1-\delta)K_t \right]. \tag{7}$$

The capital quality shock can capture disruptions in the goods producing sector (Gertler and Karadi, 2011). This provides a convenient way of capturing exogenous variation in the quality of the portfolios of firm shares held by banks.

Capital producers Capital producers choose their investment, I_t, to maximize the expected present value of profits given by the value of new capital sold to firms in investing islands minus the cost of investment. Their optimization problem reads

$$\max_{\{I_t\}_{t\geq 0}} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left\{ Q_t^{X,i} I_t - \left[1 + F\left(\frac{I_t}{I_{t-1}} \right) \right] I_t \right\}, \tag{8}$$

where $F\left(I_t/I_{t-1}\right) I_t$ represents physical adjustment costs, with $F(1) = F'(1) = 0$, and $F''\left(1\right) > 0$. In equilibrium the price of capital has to be equal to the marginal cost of producing capital:

$$Q_t^{X,i} = 1 + F\left(\frac{I_t}{I_{t-1}} \right) + \frac{I_t}{I_{t-1}} F'\left(\frac{I_t}{I_{t-1}} \right) - E_t \Lambda_{t,t+1} \left(\frac{I_{t+1}}{I_t} \right)^2 F'\left(\frac{I_{t+1}}{I_t} \right). \tag{9}$$

4.3 Banks

The banking sector is the core of our model. Banks intermediate liquidity and perform ongoing due diligence on their claims on borrowing firms. Because of the risk of banks' strategic default, their access to retail and wholesale markets for liquidity is subject to constraints. In particular, banks have to satisfy a collateral (capital) constraint, such that a weighted sum of the values of their liabilities (retail deposits and interbank borrowing) cannot exceed the pledgeable value of their assets (loans and government bonds). They have also to satisfy an interbank collateral constraint, such that their interbank borrowing cannot exceed the value of collateral assets (government bonds) they can pledge in the interbank market.

In our economy banks choose the amount of information they produce on their claims on borrowing firms (government bonds are a plain-vanilla, informationally transparent asset). Banks routinely produce information (e.g., credit scores and ratings, risk models, analyses of borrowers and collateralized assets) that preserves the viability of loan portfolios and certifies banks' financial status and regulatory compliance to supervisors and financiers, shaping their access to liquidity. Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) justify banks' collateral constraints with the argument that bankers can default strategically on their liabilities. Bank financiers, in turn, can force defaulting bankers into liquidation and recover a portion of the liquidation value of banks' assets. Unlike in Gertler and Karadi (2011), we allow the recovery value of loans (firm shares) in the event of bank default, and hence their pledgeable value, to be an increasing function of banks' due diligence on loans,

as captured by the endeavor of loan officers (l_t^h). Below in this section, we endogenize banks' due diligence function along the lines of Diamond and Rajan (2001, 2005): the liquidation market for banks' claims on firms is characterized by trading frictions and banks' due diligence mitigates these frictions.

In period t, after aggregate shocks are realized, a bank chooses deposits (d_t) and government bond holdings (b_t). After that, shocks to investment opportunities occur. Thereafter, a bank in island h chooses its interbank position (m_t^h), holdings of firm shares (x_t^h) and the amount of labor to employ in due diligence (l_t^h), where the $h \in \{i, n\}$ superscript represents whether an investment opportunity is available or not in the island. Since deposits and bond holdings are chosen before uncertainty over types is resolved, banks in islands without investment opportunities find themselves with a liquidity surplus, while banks in islands with investment opportunities face a shortage. The former will then lend to the latter in the interbank market.

A bank maximizes the expected discounted sum of dividends it transfers to the household. The bank's optimization problem in recursive form reads

$$V_{t-1}(\cdot) = E_{t-1}\Lambda_{t-1,t}\left[\sum_h \pi^h(1-\sigma)n_t^h + \max_{d_t,b_t,m_t^h,x_t^h,l_t^h}\sum_h \pi^h\sigma V_t(d_t,b_t,m_t^h,x_t^h,l_t^h)\right]$$

$$\text{s.t.} \quad Q_t^{X,h}x_t^h + Q_t^B b_t = n_t^h + d_t + m_t^h - W_t^L l_t^h, \qquad [\sigma\pi^h\lambda_t^h] \qquad (10)$$

$$R_t^D d_t + \xi R_t^M m_t^h \leq Q_t^B b_t + \mathcal{P}(Q_t^{X,h}x_t^h, l_t^h)Q_t^{X,h}x_t^h, \qquad [\sigma\pi^h\mu_t^h] \qquad (11)$$

$$R_t^M m_t^h \leq \chi_t Q_t^B b_t, \qquad [\sigma\pi^h\gamma_t^h] \qquad (12)$$

where n_t^h is the bank's net worth, Q_t^B is the price of the one-period government bond, and R_t^M denotes the gross interest rate on interbank loans. $\mathcal{P}(\cdot)Q_t^{X,h}x_t^h$ is the recovery value of firm shares in the event of default and, hence, their pledgeable value; equivalently, $[1-\mathcal{P}(\cdot)]Q_t^{X,h}x_t^h$ can be thought as the haircut, or provision, applied to the market value of the portfolio of firm shares. Banks' net worth at time t is the gross payoff from assets funded at $t-1$, net of borrowing costs:

$$n_t^h = [Z_t + (1-\delta)Q_t^{X,h}]\psi_t x_{t-1} + \psi_t^{B_g} b_{t-1} - R_{t-1}^D d_{t-1} - R_{t-1}^M m_{t-1}. \qquad (13)$$

The gross payoff from assets depends on the location specific asset price $Q_t^{X,h}$. The term $\psi_t^{B_g}$ is an exogenous AR(1) shock to the value of government bonds.

Equation (10) is the resource constraint. Net worth, deposits and interbank net borrowing are used to invest in firm shares and in government bonds and to pay

wages to loan officers. Equation (11) is a collateral (capital) constraint which requires that the weighted sum of the values of bank liabilities (retail deposits and interbank borrowing) cannot exceed the pledgeable value of bank assets. The parameter ξ is a weight governed by capital requirements. In the baseline analysis, we specify the recoverable portion of the portfolio of firm shares ("due diligence function") as:[11]

$$\mathcal{P}(Q_t^{X,h}x_t^h, l_t^h) = \zeta \left(\frac{l_t^h}{Q_t^{X,h}x_t^h} \right)^{1-\phi}. \tag{14}$$

This is an increasing and concave function of the labor of loan officers in due diligence, per unit of firm shares. $\zeta > 0$ is a parameter capturing the effectiveness of due diligence. Below in this section we show that the due diligence function in (14) can be derived endogenously from the recovery process of the assets of defaulting banks. Using (14), we obtain the recovery value of firm shares:

$$\mathcal{P}(Q_t^{X,h}x_t^h, l_t^h)Q_t^{X,h}x_t^h = \zeta(Q_t^{X,h}x_t^h)^{\phi}(l_t^h)^{1-\phi}. \tag{15}$$

The constant-returns-to-scale function for the pledgeable recovery value of firm shares permits the tractability of the representative agent approach: it ensures that banks' policy functions are linear, which allows us to aggregate across banks without keeping track of the distribution of their net worth.

Equation (12) imposes the constraint that interbank borrowing cannot exceed the value of government bonds pledged as collateral in the interbank market. The term χ_t represents an exogenous regulatory shock to the loan-to-value (LTV) ratio in the interbank market. When simulating the effects of changes in χ_t, we consider both a persistent AR(1) process and a permanent (deterministic) shock.

[11] In Section 7 we will consider alternative specifications of banks' due diligence.

The bank's first order conditions are

$$[\partial x_t^h]: \quad -Q_t^{X,h}\lambda_t^h + \underbrace{\zeta\phi\mu_t^h(Q_t^{X,h})^{\phi}(x_t^h)^{\phi-1}(l_t^h)^{1-\phi}}_{Due\ Diligence\ Effect} +$$
$$+E_t\Lambda_{t,t+1}\sum_{h'}\pi^{h'}[Z_{t+1}+(1-\delta)Q_{t+1}^{X,h'}]\psi_{t+1}(1-\sigma+\sigma\lambda_{t+1}^{h'})=0, \tag{16}$$

$$[\partial m_t^h]: \quad \lambda_t^h - \xi R_t^M\mu_t^h - R_t^M\gamma_t^h - R_t^M E_t\Lambda_{t,t+1}\sum_{h'}\pi^{h'}(1-\sigma+\sigma\lambda_{t+1}^{h'})=0, \tag{17}$$

$$[\partial d_t]: \quad \sum_h \pi^h\lambda_t^h - R_t^D\sum_h\pi^h\mu_t^h - R_t^D E_t\Lambda_{t,t+1}\sum_{h'}\pi^{h'}(1-\sigma+\sigma\lambda_{t+1}^{h'})=0, \tag{18}$$

$$[\partial l_t^h]: \quad l_t^h = \underbrace{\left[\frac{\zeta(1-\phi)}{W_t^L}\right]^{\frac{1}{\phi}}}_{\substack{Resource\ drain\\ channel}} \underbrace{\left[\frac{\mu_t^h}{\lambda_t^h}\right]^{\frac{1}{\phi}}}_{\substack{Liquidity\\ channel}} \underbrace{\left[Q_t^{X,h}x_t^h\right]}_{\substack{Pledgeability\\ channel}}, \tag{19}$$

$$[\partial b_t] \quad : \quad Q_t^B\left[-\sum_h\pi^h\lambda_t^h + \sum_h\pi^h\mu_t^h + \chi_t\sum_h\pi^h\gamma_t^h\right] +$$
$$+E_t\Lambda_{t,t+1}\psi_{t+1}^{B_g}\sum_{h'}\pi^{h'}(1-\sigma+\sigma\lambda_{t+1}^{h'})=0. \tag{20}$$

Consider (16): purchasing more firm shares tightens the current resource constraint (whose shadow value is λ_t^h) but relaxes the next period resource constraint ($\lambda_{t+1}^{h'}$).[12] It also tends to relax the capital constraint (μ_t^h), especially when due diligence is intense (l_t^h is high). Looking at (17), an increased interbank market position relaxes the current resource constraint but tightens the capital constraint and the interbank constraint (γ_t^h). From (19), hiring more loan officers in due diligence activities drains resources (through wage payments), tightening the resource constraint, but relaxes the capital constraint by raising the pledgeable recovery value of firm shares. The extent of the latter effect hinges on the tightness of the capital constraint (μ_t^h) and on the state-contingent value of firm shares $Q_t^{X,h}x_t^h$. These effects will give rise to two key channels ("liquidity" and "pledgeability") through which due diligence responds to shocks and affects their transmission. From (20), government bonds accumulation loosens both capital and interbank constraints while tightening the resource constraint.

[12] We index the next-period price of shares ($Q_{t+1}^{X,h'}$) and the expected shadow value of the resource constraint ($\lambda_{t+1}^{h'}$) by h' as they depend on which island type a bank enters in the subsequent period.

4.4 Government

We use capital letters for aggregate quantities. Output is divided among consumption, investment and government expenditure, which is exogenously fixed at the level G. Government expenditure is financed by lump sum taxes (T_t) and bonds

$$G = T_t + Q_t^B B_t - \psi_t^{B_g} B_{t-1}. \tag{21}$$

Let η denote the elasticity of taxes to public debt, T be the long-run level of taxation and B be the long-run level of public debt. The tax rule is

$$T_t = T + \eta \left(B_t - B \right). \tag{22}$$

Credit policies In addition to fiscal policy, the government can carry out credit policies. We consider three policies implemented in recent crises: provision of liquidity to banks in the interbank market; bank equity injections; and direct lending to firms. We momentarily abstract from these policies and introduce them in Section 6.

4.5 Equilibrium

In equilibrium, total claims issued in investing and non-investing islands equal aggregate capital acquired by each type:

$$X_t^i = I_t + (1-\delta)\pi^i K_t; \quad X_t^n = (1-\delta)\pi^n K_t. \tag{23}$$

The labor market clearing condition for loan officers reads

$$L_t = L_t^i + L_t^n = \sum_h \left[\frac{\zeta(1-\phi)\mu_t^h}{W_t^L \lambda_t^h} \right]^{\frac{1}{\phi}} Q_t^{X,h} X_t^h. \tag{24}$$

The market clearing condition for interbank loans requires

$$M_t^i + M_t^n = 0, \tag{25}$$

and the social resource constraint reads

$$Y_t = C_t + \left[1 + F\left(\frac{I_t}{I_{t-1}} \right) \right] I_t + G_t. \tag{26}$$

The economy can be hit by aggregate shocks to bond values ($\psi_t^{B_g}$), interbank market regulation (χ_t), and loan (capital) quality (ψ_t).

In the Appendix we also derive the law of motion of banks' net worth.

4.6 Endogenizing banks' due diligence function

We endogenize the due diligence function in (14). Without loss of continuity, this section may be read after the results of Sections 5 and 6.

In Diamond and Rajan (2001, 2005, 2006), due diligence and information production on loans allow banks to identify suitable buyers of project loans in the event of default, raising the pledgeable recovery value of loans. We formalize a mechanism along these lines exploiting the heterogeneity of the banking sector between investing and non-investing islands. We posit that the specificity of bank claims on firms requires that, if a bank defaults strategically and its assets are liquidated, only banks in the same island type can reuse the liquidated firm shares (e.g., because they have dealt with the same capital investment opportunities). However, in the liquidation market for firm shares trading frictions prevent from identifying buyers from the same island type and banks in default are randomly matched with potential buyers. Perri and Quadrini (2018), Ramey and Shapiro (2001), Eisfeldt and Rampini (2006), and Gavazza (2011) model trading frictions in liquidation markets for banks' or firms' assets. Irani et al. (2020) document that banks engage in more due diligence when they participate more intensely in the secondary market for syndicated loans. Gorton and Pennacchi (1995) and Altman et al. (2010) find that banks' due diligence raises the marketability of loans and banks' returns from loan sales in the secondary market.

For instance, in the Appendix we show that the expected recovery value of the firm shares of a defaulting bank from an investing island is

$$\mathcal{P}(\mathcal{S}_t^i, \mathcal{M}^i, \mathcal{M}^n) Q_t^{X,i} x_t^i = \frac{\mathcal{S}_t^i \mathcal{M}^i}{\mathcal{M}^i + \mathcal{M}^n} Q_t^{X,i} x_t^i, \tag{27}$$

where $\mathcal{P}(\cdot)$ is the probability of being matched with a bank (buyer) from an investing island, $\mathcal{M}^i$ and $\mathcal{M}^n$ denote the measures of banks in investing and non-investing islands, respectively, and $\mathcal{S}_t^i$ is the search intensity of the bank in the liquidation market. The value $[1 - \mathcal{P}(\cdot)] Q_t^{X,i} x_t^i$ can be interpreted as the loan loss in the event of default and liquidation and thus represents the haircut applied to the market value of loans. Note also that $\mathcal{M}^i / (\mathcal{M}^i + \mathcal{M}^n) = \pi^i$.

Following previous studies (Cavalcanti and Wallace, 1999; Araujo and Minetti,

2007; Habib and Johnsen, 1999), banks' search intensity in the liquidation market, $\mathcal{S}_t^i$, is an increasing and concave function of the labor of loan officers in due diligence, per unit of firm shares:

$$\mathcal{S}_t^i = \zeta^i \left(\frac{l_t^i}{Q_t^{X,i} x_t^i} \right)^{1-\phi}, \tag{28}$$

where the parameter ζ^i captures the search effectiveness of loan officers. Replacing (28) into (27), and letting $\zeta^i = \zeta/\pi^i$, we obtain the function (15).

5 Model analysis

We study the response of the economy to shocks. The first two shocks –"liquidity shocks"– capture disruptions in banks' access to liquidity. As noted, we consider a bond value shock that reduces the value of pledgeable government bonds; and a regulatory shock that increases the collateral requirements in the wholesale liquidity market. The former can mimic the effects of sovereign debt problems. The latter can reflect changes in the stance of regulators, such as the U.S. FDIC regulatory shock studied in Section 3. The third shock –"loan (capital) quality shock"– is a hybrid between a reduction in the returns of firms' productive capital and a drop in the value of banks' claims on firms. All the shocks are intended to produce a downturn.

We ask the model two main questions: what is the response of banks' due diligence following shocks? Does the response of due diligence, and its interaction with banks' access to liquidity, propagate or attenuate business cycle fluctuations? In Section 6, we will revisit these questions when the government conducts credit policies.

5.1 Calibration

The model is calibrated to quarterly frequency and solved numerically by locally approximating around the non-stochastic steady state. We use fairly standard parameters for preferences, technologies and the government sector (see Table 2). Parameters affecting the utility function are calibrated according to empirical estimates of medium scale DSGE models (see, e.g., Lubik and Schorfheide, 2006; Smets and Wouters, 2007; Justiniano et al., 2013). Habits in consumption are calibrated to 0.5, whereas the Frisch elasticity of labor supply is set to 4 in both the final goods and the banking sectors, in line with the suggestion by Chetty et al. (2011) for macro models. The labor disutility parameters, k_H and k_L, are calibrated in order to match

a steady state for the hours worked equal to 0.33. The discount factor β is calibrated to 0.99, implying a yearly steady state deposit rate ($R^D - 1$) of around 4%. In the final goods sector, the effective share and depreciation rate of capital are set to the standard values of $\alpha = 0.33$ and $\delta = 0.025$, respectively. These imply a labor share of 66% and an annual depreciation rate of 10%. The investment adjustment cost is calibrated to 2.5. The steady state proportion of government expenditures (G/Y) is calibrated to 0.2 in line with Gertler and Karadi (2011).

In the banking sector, following Gertler and Kiyotaki (2010), we set the survival rate of bankers $\sigma = 0.97$, implying that bankers survive for eight years on average. We use data from the banking sector, including the database used in the empirical analysis of Section 3, to jointly calibrate six parameters, π^i, ξ, θ, ϕ, ζ, B/Y. We match six targets: i) investing banks' leverage; ii) investing banks' bond-to-asset ratio; iii) investing banks' annual salary to asset ratio; iv) the loan-deposit interest rate spread; v) the bond-deposit interest rate spread; vi) the interbank-deposit interest rate spread. In the U.S. Call Reports data, between 1996 and 2015 (the time frame of the our empirical analysis) the average bank leverage was 9.5. For the same period, the average holdings of Treasury securities and agency- and Government-sponsored enterprise (GSE)-backed securities amounted to 15% of bank assets. The annual expenses on salaries and employee benefits amounted to 1.46% of bank assets. Banks' leverage ratio and the share of sovereign bonds holdings among bank assets are similar for the euro area. From the OECD Survey of the euro area we calculated an average banks' leverage ratio of 9 for the year 2014, while, for the same year, intersecting data from the Supervisory Banking Statistics of the European Central Bank with data in Altavilla et al. (2017), we computed an average holding of government bonds amounting to 13% of bank assets. We target an annual loan-deposit spread, bond-deposit spread, and interbank-deposit spread of 3%, 0%, and 0.5%, respectively.

5.2 Liquidity shocks

Bond value shock We first study the effects of a shock that lowers government bond values (a fall in $\psi_t^{B_g}$). The standard error of the shock is set to obtain a drop of bank capital equal to 3% of the GDP, in the ballpark of the impact of a sovereign debt restructuring like that occurred during the euro area sovereign debt distress (see Guerrieri et al., 2013). The persistence of the shock is calibrated to 0.85.

In Figure 2, the continuous lines are the impulse response functions (IRFs) gen-

erated by our model.[13] All variables are expressed as quarterly percentage deviations from the steady state except for the external finance premium (EFP, the ratio between the return on firm shares and that on deposits), for which we consider the annualized deviation from the steady state.[14] Following the negative bond value shock, due diligence shoots up by 13% on impact. Over a two-year horizon, it is, on average, 6% higher than in steady state. Two channels primarily drive the response of banks' due diligence to the shock (see equation 19): the tightness of liquidity constraints (liquidity channel), which disciplines banks; and the marginal effect of due diligence associated with the value of assessed claims on firms (pledgeability channel).[15]

The shock implies that government bonds are less desirable and, hence, lowers their market price. Bonds serve as collateral in the interbank market and the fall in the value of bond holdings limits banks' ability to borrow liquidity in the interbank market (the Lagrange multiplier on the interbank constraint, γ_t^i, rises). The tightening of the interbank constraint boosts banks' hunger for liquidity, as it can also be inferred from the rise of the Lagrange multiplier on the capital constraint (μ_t^i).[16] This raises banks' incentive to perform due diligence to increase the pledgeable recovery value of their claims on firms and gain easier access to liquidity.

Looking at the pledgeability channel, the tightening of the interbank and capital constraints reduces banks' demand for firm shares, lowering their price. The fall in the value of firm shares held by banks tends to depress the marginal productivity of due diligence. Nonetheless, this reduced due diligence incentive is outweighed by the increased incentive driven by the tighter liquidity. Using equation (19), the left panel of Figure 3 confirms that the liquidity channel is quantitatively stronger than the pledgeability channel and the resource drain channel (driven by a mild increase in loan officers' wages).[17] This is in line with the evidence in Section 3, where we found that banks increase due diligence when they have lower access to liquidity, especially

[13] In all figures, the responses refer to investing islands except for output, investment and values of bond holdings which are aggregate.

[14] The return on firm shares of type h is $R_{t+1}^{K,hh'} = \psi_{t+1}\left[Z_{t+1} + (1-\delta)Q_{t+1}^{X,h'}\right]/Q_t^{X,h}$ where the stochastic rate $R_{t+1}^{K,hh'}$ depends on the state of the next period h'.

[15] Recall that a third channel, the resource drain channel, is also at work.

[16] A tightening of the capital constraint of this kind would also occur if banks were subject to a negative net worth shock. In the Appendix, we consider the responses to such a shock.

[17] Following a negative bond value shock, banks' incentive to step up due diligence exerts an upward pressure on loan officers' wage rate, while the increase in households' labor supply induced by the income effect exerts a downward pressure. Figure 3 shows that, as a result of these two contrasting forces, the resource drain channel tends to weigh less than the liquidity and pledgeability channels. In Section 7.3, we will come back to the role of the resource drain channel.

during recessions. It is also in line with Lisowsky et al. (2017) and Becker et al. (2020), who show that during a lending contraction banks step up loan due diligence. In our model, there is a strong negative correlation (-0.9 under the bond value shock) between the value of bank financing to firms and due diligence effort.

To assess the aggregate implications of the countercyclical due diligence, we compare our model with an alternative model in which the response of due diligence is weaker by construction. In particular, we consider a comparison economy in which banks pay a proportional tax on labor hiring and get rebated the tax revenues lump sum. Due to the tax, banks face a higher marginal cost when hiring loan officers and, hence, any increase in due diligence following a shock is attenuated relative to the baseline economy. To ease interpretation, we set the tax so that the increase in the hiring of loan officers relative to the steady state is on average one percentage point smaller than in our baseline economy along the simulation period. As an average difference of one percentage point in due diligence responses is arguably a conservative comparison, we will later experiment with more pronounced differences (see Section 5.4).

In Figure 2, the dashed lines are the IRFs of the comparison economy. The increase in banks' due diligence supports the pledgeable recovery value of firm shares, relaxes banks' capital constraint and facilitates credit extension to firms. At the same time, it drains resources from banks, due to the larger wage bill. In spite of the fall in information productivity, the former effect prevails, so that investment and output decrease less in our economy than in the comparison. To summarize, following a negative bond value shock, banks' enhanced due diligence attenuates the impact of the shock on the real sector. By employing more resources in loan analysis, banks partially relax their own collateral constraints, easing liquidity provision to firms.

Appendix Figure 1 studies how the weight ϕ on due diligence in function (15) influences the IRFs. In one scenario ("high ϕ"), $\phi = 0.8$; in the other, ("low ϕ") $\phi = 0.60$. When ϕ is high due diligence responds more on impact (top panel) and the drop in banks' holdings of firm shares, investment and output is more attenuated.

Regulatory shock Figure 4 shows the effects of a reduction in the interbank LTV χ_t (as, e.g., following the FDIC assessment shock examined in Section 3). The standard deviation of the shock is set to obtain a decrease of the interbank rate of 2%, like that observed after the 2011 change in the FDIC regulation (Kreicher et al., 2013). The persistence of the shock is calibrated to 0.85.

Following the shock, due diligence rises by 11% on impact but, after a number of periods, it drops below its baseline value. Over a two-year horizon due diligence is, on average, 1.5% higher than in steady state; over a four-year horizon it exhibits a 0.2% average reduction. Again, we can read the effects primarily through the lenses of the liquidity and pledgeability channels. The lower LTV tightens the interbank collateral constraint, even if the usefulness of bonds as collateral and, hence, their values are pushed up. This raises the demand for retail liquidity, tightening the capital constraint. On the other hand, the increase in the value of bond holdings relaxes the capital constraint. The multiplier on the capital constraint slightly rises, while after some periods the relaxing effect gains strength and the multiplier converges to its steady state value. The middle panel of Figure 3 indeed shows that for some periods the liquidity channel contributes to the rise of due diligence. This is consistent with the estimates in Section 3, which suggested that, following the FDIC regulatory shock, banks with difficult access to liquidity stepped up due diligence. In the long run, driven by the attenuation of the liquidity channel, due diligence eventually falls below the steady state. Nonetheless, despite its less countercyclical response, due diligence is still a powerful shock attenuator: holdings of firm shares, investment and output drop less than in the comparison economy, as Figure 4 shows.[18]

We also simulated the effect of a permanent regulatory shock to χ_t. The results (available from the authors) are similar to those obtained for the temporary regulatory shock, although banks' due diligence rises more following a permanent shock.

5.3 Loan quality shocks

We now turn to study an exogenous decline in loan (capital) quality (ψ_t), which induces a drop in the value of capital assets and, hence, in the value of firm shares held by banks. In line with Gertler and Kiyotaki (2010), the standard deviation of this shock is 5%. The IRFs are in Figure 5. In spite of a large drop in information productivity, the effect of the shock is still an increase in banks' due diligence (consistent with our empirical findings): due diligence increases by 18% on impact and, on average, by 16% over a two-year horizon. The right panel of Figure 3 makes clear that the liquidity channel dominates the pledgeability and resource drain channels in equation (19). However, relative to the liquidity shocks, the more substantial drop in information productivity makes the countercyclical due diligence a moderate ampli-

[18] Appendix Figure 1 (middle panel) reveals that, similar to what found for the bond value shock, banks' due diligence is more responsive and acts as a better stabilizer for a higher value of ϕ.

fier, rather than an attenuator, of this shock. Output and investment, in fact, go down somewhat more than in the comparison model (where, by construction, due diligence increases on average one percentage point less). Intuitively, there is a sharper drop in firm shares values and, hence, in information productivity. The resource drain caused by the rising wage bill for bank workers is thus large relative to the benefit of due diligence in preserving the pledgeable value of firm shares of deteriorated quality.[19]

Appendix Figure 1 (bottom panel) considers different values of ϕ and confirms that banks' due diligence behaves as a moderate amplifier: more intense due diligence (when ϕ is high) leads to a larger drop of shares values, investment and output.

5.4 Quantitative assessment

We assess the quantitative relevance of the effects uncovered in the previous section.

The response of due diligence There is no obvious mapping between the model's due diligence and the proxy for due diligence (the lead share) used in the empirical analysis of Section 3. A more promising exercise consists of comparing the response of the loan haircut $1 - \mathcal{P}(\cdot)$ driven by due diligence with what predicted by the data. Consider the 5% decline in loan (capital) quality. This is in line with the magnitude of the shock that Gertler and Kiyotaki (2010) implement to mimic the U.S. recession started in 2008, although somewhat smaller than that shock (recall that in the empirical analysis the *NBER recessions* dummy also encompasses the milder 2001 recession).[20] Following this shock, in our model the loan haircut reduction implied by the countercyclical due diligence is 4.39% over a one-year horizon.

We then estimate the empirical response of $1 - \mathcal{P}(\cdot)$ in two steps. First, our empirical estimates show that, in the 1996-2015 period, during an NBER recession an average bank increases its lead share by 3.2 percentage points (column I, Table 1). Next, we consider studies on the impact of banks' lead share on loan haircuts. Using data on U.S. syndicated loans for a period largely overlapping with ours, Mora (2015) estimates that a 1-percentage point increase in the lead share reduces the probability

[19] The fact that banks' due diligence response can accentuate the contraction of investment and output is not surprising. In choosing due diligence, banks maximize dividend distribution, not the aggregate investment or output. Further, banks impose externalities one on the other, as they do not internalize the effects of their labor hiring on the wages paid by other banks. Since our analysis is positive rather than normative, a reader should not be tempted to interpret a response of due diligence that magnifies the contraction as being suboptimally high.

[20] However, the 2001 recession was shorter than the recession started in 2008 and thus weighs less in the sample.

of loan haircut by $1.5\%-2.3\%$, depending on specifications. For a comparable sample, Ivashina (2009) estimates that a 1-percentage point increase in the lead share reduces the loan default premium by 0.73%. Combined with our estimates, these findings suggest that in an NBER recession the countercyclical due diligence reduces loan haircuts by $4.8\% - 7.4\%$, using the estimates in Mora (2015), and by 2.4%, using the estimates in Ivashina (2009). As summarized in (29), this is in the ballpark of the percentage change of the loan haircut $1 - \mathcal{P}(\cdot)$ predicted by the model (-4.39%):

$$\underbrace{\Delta\% \ [1-\mathcal{P}(\cdot)]}_{\text{-4.39\%}} \approx \underbrace{\frac{\Delta\% \ Lead \ share}{\Delta \ Dummy \ NBER}}_{3.2 \ p.p.} \times \underbrace{\frac{\Delta \ Loan \ haircut}{\Delta \ Lead \ share} \times \frac{1}{Initial \ haircut}}_{\text{-[1.5\%-2.3\%] or -0.73\%}}. \quad (29)$$

Figure 6 assesses the contribution of due diligence to attenuating the drop in the pledgeable recovery value $\mathcal{P}(\cdot)Q_t^{X,i}X_t^i$ of firm shares in the baseline economy relative to the comparison economy with reduced due diligence. In the figure, we plot IRFs computed as differences between the baseline economy and the comparison economy. The bold line is the differenced-IRF of pledgeable recovery values ($\mathcal{P}(\cdot)Q_t^{X,i}X_t^i$); the shaded area shows the contribution of banks' due diligence (L_t^i) to this difference; the light area is the contribution of the market value of firm shares ($Q_t^{X,i}X_t^i$). As Figure 6 shows, following the liquidity shocks the contribution of banks' due diligence to mitigating the fall of pledgeable recovery values is relatively large.[21]

The response of macroeconomic variables A first way to evaluate the contribution of the countercyclical due diligence to the transmission of shocks is to compare the responses of macroeconomic variables in our model with those in the comparison model. Recall that in the impulse response analysis of Sections 5.2-5.3 we considered a comparison economy in which, along the simulation horizon, the average increase in due diligence relative to the steady state is one percentage point smaller than in the baseline economy. We here consider also a less conservative comparison such that the average increase in due diligence relative to the steady state is three percentage points smaller than in the baseline economy along the simulation horizon. For convenience, Figure 7 summarizes the responses of investment and output in the baseline economy (continuous line) and in the two comparison economies (dashed and dotted lines).

Consider the responses to a negative bond value shock. In the more conservative

[21] We focus on liquidity shocks, for which the baseline economy exhibits a lower contraction of macroeconomic variables than the comparison economy.

comparison, a one percentage point larger increase of due diligence in our economy than in the comparison economy (19% of the average response in the comparison economy) is associated, over a four-year horizon, with average percentage drops of investment and output 3.2% and 3.6% smaller, respectively. In the less conservative comparison, a three percentage points larger increase of due diligence in our economy than in the comparison economy is associated, over the same horizon, with average percentage drops of investment and output 9.6% and 10.5% smaller, respectively. The attenuating effect of the countercyclical due diligence is similar, though somewhat lower, following the restrictive regulatory shock. Over a four-year horizon, a one percentage point larger increase of due diligence in our economy than in the comparison (50% of the response of the comparison economy) is associated with average percentage drops of investment and output 5.8% and 6.3% smaller, respectively. In the less conservative comparison, a three percentage points larger increase of due diligence is associated with average percentage drops of investment and output 7.5% and 8.1% smaller. Finally, following the negative capital quality shock, a one percentage point increase of due diligence larger in our economy than in the comparison (5% of the response of the comparison economy) is associated with average percentage drops of investment and output 5% and 0.1% larger, respectively. These figures point to a relevant stabilizing effect of banks' countercyclical due diligence following liquidity shocks and to a mild amplifying effect following loan quality shocks.

In Table 3, Panel A, we compare the contribution of each shock to the variances of investment and output between the baseline economy and the comparison economies. In the baseline model the combined contribution of the liquidity shocks is smaller than in the comparison models (by 11% for output, using the more conservative comparison), while the contribution of the capital quality shock is larger (by 1.3% for output, considering the more conservative comparison). An alternative way to quantify the contribution of due diligence to macroeconomic volatility is to look at the size of the variance of output and investment induced by each shock (Table 3, Panel B). Liquidity shocks entail a smaller variance in the baseline economy than in the comparison economies, while the capital quality shock induces a larger variance. To have a better sense of the magnitudes, we also present the variances in an economy with tighter capital regulation. In particular, we alter the parameter ζ in (15) in a way such that the investing banks' leverage is 5% lower than the baseline. The impact of due diligence on macroeconomic volatility appears to be sizeable compared with the impact of this significant alteration of capital requirements.

6 Credit policies

Credit policies have represented an important component of the policy response to recent crises. We now revisit the results when the government conducts liquidity and equity injections into banks and direct lending to firms. The government finances these credit policies by issuing bonds to households, $D_{G,t}$, that are a perfect substitute of retail deposits and pay a riskless rate R_t^D. Implementing the policies involves an efficiency cost: the government has to sustain a deadweight loss of ϱ_L for each unit supplied, for example reflecting administrative costs for implementing the policies.[22]

6.1 The impact of credit policies on due diligence

The first credit policy consists of the provision of uncollateralized liquidity to banks that borrow in the interbank market. We assume that the liquidity provision $m_{G,t}^i$ is a fraction Φ_t of the total interbank borrowing $m_t^i = m_{P,t}^i + m_{G,t}^i$, where $m_{P,t}^i$ is the borrowing from private banks. The second policy takes the form of equity injections into banks conducted through purchases of bank assets. The government acquires shares from banks at a price, $Q_{G,t}^X$, higher than the market one, $Q_t^{X,i}$, thus making a transfer to banks. At time t, the quantity of shares $x_{G,t}^i$ owned by the government is a fraction Φ_t of the total intermediated shares $x_t^i = x_{P,t}^i + x_{G,t}^i$, where $x_{P,t}^i$ is the quantity of privately owned shares. Under equity injections, banks' capital constraint becomes

$$R_t^D d_t + \xi R_t^M m_t^h \leq Q_t^B b_t + \zeta \left[Q_t^{X,h} (x_t^h - x_{G,t}) \right]^{\phi} l_t^{1-\phi} + \zeta Q_{G,t}^X x_{G,t}. \tag{30}$$

The last credit policy consists of direct lending to firms on investing islands. The quantity of direct lending $x_{G,t}^i$ is a fraction Φ_t of total intermediated shares $x_t^i = x_{P,t}^i + x_{G,t}^i$, where $x_{P,t}^i$ is the quantity of shares privately intermediated.

For each policy, as in Gertler and Kiyotaki (2010), the government intervenes when the premium between the return on firm shares and that on deposits exceeds its steady state

$$\Phi_t = \upsilon \left[(E_t R_{t+1}^{K,ii'} - R_t^D) - (R^{K,ii'} - R^D) \right], \tag{31}$$

where $R_{t+1}^{K,ii'} - R^D$ is the steady state premium and υ is a feedback parameter.

The responses to shocks of selected variables under each credit policy are in Figure

[22] The government budget constraint is amended accordingly (see, e.g., Gertler and Kiyotaki, 2010).

8, together with the responses in the baseline economy without credit policies (the responses of other variables are in Appendix Figures 3-5). The parameter υ is calibrated to 10 and ϱ_L is equal to 0.001 (see Gertler and Karadi, 2011). On impact, relative to the baseline economy, liquidity provisions to banks moderate the tightening of banks' collateral constraints following contractionary shocks (see the first column of Figure 8 and Appendix Figure 3). This dilutes banks' incentive to step up due diligence to relax the constraints. Thus, while having a direct stabilizing effect, this policy dilutes the stabilizing function of due diligence in the wake of liquidity shocks.[23] However, over the medium-long run this diluting effect on due diligence vanishes. In fact, the tightness of the capital constraint progressively converges to that of the baseline economy (liquidity channel). Moreover, the higher market value of firm shares induced by liquidity provisions promotes due diligence incentives (pledgeability channel).

Consider next equity injections (second column of Figure 8 and Appendix Figure 4). When the government directly injects equity into banks, their capital constraint is significantly relaxed. This, in turn, tends to considerably reduce banks' incentive to step up due diligence (liquidity channel). Moreover, as the shares value drops, the lower pledgeability provides further incentive to curtail due diligence (pledgeability channel). Thus, banks reduce due diligence and, following liquidity shocks, the attenuating effect of due diligence fades.

Finally, the third column of Figure 8 and Appendix Figure 5 show the impulse responses under a policy of direct lending to firms. Direct lending loosens the interbank and capital constraints, diluting due diligence incentives, at least in the short run. In the medium-long run the liquidity effect vanishes and the higher value of firms' shares raises due diligence incentives via the pledgeability channel.

To summarize, credit policies may have unintended consequences in terms of weaker incentives of banks to step up due diligence. The impulse responses reveal that equity injections into banks are associated with the most pronounced dilution in due diligence effort. Yet, the dilution of due diligence is short-lived and credit policies retain a stabilizing role in the medium-long run, as we further elaborate below.

6.2 Quantitative effects of credit policies

Tables 4 and 5 display the quantitative implications of credit policies for different simulation horizons. In the absence of credit policies, following the negative bond

[23] Following bond value and regulatory shocks, under liquidity injections the response of due diligence remains lower than that in the baseline economy without credit policies for about one year.

value shock, the average increase in due diligence in each period over a four-year horizon is around 5%, a value higher than that observed when the government pursues a credit policy. In fact, under liquidity provisions to banks, the average due diligence increase over a four-year horizon is 4.7%; under direct lending to firms, the average increase is 4.6%. Under equity injections into banks, instead, due diligence drops on average by 2.5%. Qualitatively similar results are found for the other shocks (Table 4). Thus, equity injections entail the most pronounced dilution of due diligence.

To quantify how the diluting effects of credit policies on bank due diligence influence the real sector, we compare the output drop under each policy with that observed in the absence of credit policies (Table 5). The mix of lower due diligence and government credit policy always attenuates the effects of a shock. Following a bond value shock, in our baseline economy the average output loss over a four-year horizon is 0.32%. The credit policy that achieves the largest output stabilization is direct lending (output goes down on average by 0.14%), whereas the policy that attains the smallest stabilization is equity injections (output goes down on average by 0.3%).[24] This is consistent with the observation that equity injections entail the most pronounced dilution of due diligence. The conclusions carry through to the regulatory shock. Following this shock, the average output loss over a four-year horizon is 0.42% in the absence of credit policies and shrinks to 0.18% under direct lending. Equity injections, on the other hand, achieve a significantly weaker stabilization: output declines by 0.4% on average. The stabilizing effect of liquidity provisions lies between the other two policies (output declines by 0.33% on average). Overall, equity injections into banks turn out to be the least successful policy in stabilizing the economy while direct lending to firms turns out to be the most successful policy.[25]

7 Extensions: Specification of due diligence

This section considers alternative specifications of banks' due diligence. First, we posit that due diligence helps build a durable stock of knowledge and experience on loan portfolios (Section 7.1). Next, we allow due diligence to affect not only the pledgeability of loans in markets for liquidity but also the return on loans (7.2). Finally, we consider alternative specifications of the cost of due diligence (7.3).

[24] Under liquidity provisions, the average output reduction is 0.25%.

[25] For the capital quality shock, over a four-year horizon, output decreases on average by 1% in each period in the absence of credit policies. The output drop shrinks to 0.79% under direct lending, while the stabilization achieved by liquidity provisions and equity injections is smaller.

7.1 Due diligence and knowledge accumulation

Since loans typically span multiple years, banks' due diligence decisions may have a long-lasting impact. This cannot be mapped directly into our model, in which loans last for one period. A reduced-form way of capturing a long-lasting impact of due diligence is to allow it to affect not only the recovery value of current loans but also that of future loans. To this end, we now posit that due diligence helps accumulate a stock of experience and knowledge on loan portfolios. To capture a notion of banks' knowledge stock on loans, which affects their recovery value, we introduce habits in the function (15) for the recovery value of firm shares:[26]

$$\mathcal{P}(Q_t^{X,h}x_t^h, l_t^h, s_{t-1})Q_t^{X,h}x_t^h = \zeta[Q_t^{X,h}(x_t^h + h_x s_{t-1})]^{\phi}(l_t^h)^{1-\phi}, \tag{32}$$

where

$$s_{t-1} = \rho_s s_{t-2} + (1-\rho_s)x_{t-1}. \tag{33}$$

In equation (32) the parameter h_x captures the contribution of banks' prior knowledge stock, s_{t-1}, to the pledgeable recovery value of firm shares. Equation (33) is the law of motion of the knowledge stock, where ρ_s denotes the persistence in the stock of habits. In the calibration, h_x is set to 0.7, in line with the estimates for lending relationships in Aliaga-Díaz and Olivero (2010). The persistence parameter ρ_s is calibrated to 0.5.

Figure 9 studies how banks' sluggish accumulation of knowledge influences the role of due diligence. We plot the differences in the IRFs between the model where banks perform due diligence and the comparison economy with reduced due diligence. The dashed lines represent these differenced-IRFs for the extended setup with knowledge accumulation while the solid lines correspond to the setup without knowledge accumulation. A positive (negative) differenced-IRF for output signals that due diligence attenuates (magnifies) the negative effects of a shock. In response to liquidity shocks, the case with sluggish knowledge accumulation features a smaller positive difference than the case without knowledge accumulation. This reveals that the due diligence is somewhat less effective in attenuating the impact of liquidity shocks when banks accumulate knowledge progressively. Following a loan quality shock, there is a stronger attenuation in the immediate aftermath of the shock and a smaller amplification in

[26] A broad literature captures the role of experience through habits (see, e.g., Abel, 1990, Ravn et al., 2006, and, for an application to the credit market, Aliaga-Díaz and Olivero, 2010). Habib and Johnsen (1999) and Höwer (2016), among others, document the role of banks' prior knowledge in the recovery and liquidation of project loans and assets in the event of default.

subsequent periods. The results thus suggest that, when banks' knowledge takes time to build, the insights of the baseline analysis carry through, although due diligence has a somewhat less sharp influence.[27]

To further explore the consequences of banks' sluggish knowledge accumulation, in Appendix Figure 7 we perform a comparison of the IRFs of investment and output across different values of the parameters governing the knowledge accumulation speed (ρ_s) and the contribution of the knowledge stock to loan recovery values (h_x). In line with the insights of Figure 9, Appendix Figure 7 suggests that a higher persistence ρ_s (that is, a stronger time-to-build component) somewhat weakens the stabilizing role of due diligence after liquidity shocks.

This extended setting can offer elements to the debate on the stabilizing or destabilizing role of relationship lending technologies (Ongena and Smith, 2001; Sette and Gobbi, 2015). Our dynamic economy with endogenous banks' due diligence shows that one needs to account also for the flexibility with which due diligence responds to shocks and affects the real sector. A large stock of banks' relational knowledge could introduce a time-to-build component, reducing this flexibility.

7.2 Due diligence and loan returns

In our setting, the influence of banks' due diligence on the transmission of shocks hinges on its impact on the pledgeability of loan portfolios in liquidity markets. As noted, a complementary role of due diligence consists of its influence on loan portfolio returns. To incorporate this role, we now posit that each bank of type h invests e_t^h units of funds (in units of final good) and hires l_t^h loan officers to produce loans, in the spirit of Goodfriend and McCallum (2007). Loans are used to purchase x_t^h units of capital goods at the price $Q_t^{X,h}$:

$$Q_t^{X,h} x_t^h = (e_t^h)^{\phi_1} (\omega l_t^h)^{1-\phi_1}. \tag{34}$$

[27] The Appendix provides more details on the responses in the economy with knowledge accumulation. Appendix Figure 6, for example, shows that due diligence effort rises less sharply in the economy with knowledge accumulation. This is in line with the negative effect of lending experience on banks' due diligence effort estimated in the empirical analysis (see, e.g., Table 1, column 5).

A bank's optimization problem in recursive form then becomes:

$$V_{t-1}(\cdot) = E_{t-1}\Lambda_{t-1,t}\left[\sum_h \pi^h(1-\sigma)n_t^h + \max_{d_t,b_t,m_t^h,e_t^h,l_t^h}\sum_h \pi^h\sigma V_t(d_t,b_t,m_t^h,e_t^h,l_t^h)\right]$$

$$\text{s.t.} \qquad e_t^h + Q_t^B b_t = n_t^h + d_t + m_t^h - W_t^L l_t^h, \qquad [\sigma\pi^h\lambda_t^h] \qquad (35)$$

$$R_t^D d_t + \xi R_t^M m_t^h \leq Q_t^B b_t + \zeta(e_t^h)^{\phi_2}(l_t^h)^{1-\phi_2}, \qquad [\sigma\pi^h\mu_t^h] \qquad (36)$$

$$R_t^M m_t^h \leq \chi_t Q_t^B b_t. \qquad [\sigma\pi^h\gamma_t^h] \qquad (37)$$

We let $\phi_1 > \phi_2$. It is immediate that when $\phi_1 = 1$, $Q_t^{X,h}x_t^h = e_t^h$ and the model boils down to the baseline setting. Using also (34), banks' net worth at time t now reads:

$$n_t^h = [Z_t + (1-\delta)Q_t^{X,h}]\psi_t\frac{(e_{t-1})^{\phi_1}(l_{t-1})^{1-\phi_1}}{Q_{t-1}^X} + \psi_t^{B_g}b_{t-1} - R_{t-1}^D d_{t-1} - R_{t-1}^M m_{t-1}. \quad (38)$$

Thus, a difference from the baseline setting is that now due diligence directly affects the evolution of banks' net worth, besides their access to liquidity.

In the Appendix, we present details on the solution and calibration of this extended model as well as impulse responses to liquidity and loan quality shocks.[28] As in the baseline analysis, we compare the responses of this extended economy with those of a comparison economy with reduced due diligence (one percentage point smaller increase of due diligence along the simulation horizon, see Appendix Figure 8). We also compare the impulse responses in this extended economy with those in the baseline economy (see Appendix Figure 9). The impulse responses yield the following insights. First, due diligence continues to exhibit a countercyclical behavior in this extended setting, rising in response to all the negative shocks, and in a manner similar to that observed in the baseline analysis. In particular, the increase in banks' due diligence is only slightly less pronounced following negative bond value shocks and mildly sharper following regulatory and loan quality shocks. Second, due diligence retains a stabilizing role following liquidity shocks and a mildly amplifying role following capital quality shocks. A further interesting observation emerges by looking at the recovery path from liquidity shocks. In this extended setting, the stabilizing effect of due diligence following liquidity shocks appears to be sharp in the short and

[28] In this extended setting, the parameters ϕ_1 and ω in (34) govern the contribution of due diligence to loan portfolio production and returns, relative to its contribution to loan recovery value and pledgeability in markets for liquidity. We calibrate ϕ_1 and ω in a way such that in steady state the former effect weighs for approximately one third and the latter effect for approximately two thirds in banks' demand for loan officers.

medium run but also to fade somewhat in the longer run: investment and output eventually recover somewhat faster in the economy with reduced due diligence. A possible interpretation of this finding is that in this extended setting banks' incentive to invest in firms' shares is directly influenced by the intensity of their due diligence, because due diligence directly affects the returns from loan portfolios. Along the recovery from the shocks, as due diligence starts weakening, that is, reverting back to its steady state level after its initial rise, banks' incentive to invest in firm shares fades as well, more quickly than in the baseline setting. This, in turn, slows down the recovery of investment and output. The results thus appear to confirm that the role of due diligence studied in our main analysis is critical in making banks a better macroeconomic stabilizer, and that a stronger emphasis of banks (and bank regulators) on this role of due diligence might make banks' stabilizing influence more persistent. We leave a more comprehensive exploration of this point to future research.

7.3 The cost of due diligence

In the model, besides the liquidity and pledgeability channels, the third force that drives the cyclical behavior of banks' due diligence is the resource drain channel (recall equation (19) and Figure 3). A determinant of the resource drain is the dynamics of loan officers' wage rate in the banking sector. Following negative shocks, the increase in households' labor supply induced by the income effect exerts a downward pressure on the wage rate in the banking sector. On the other hand, banks' incentive to step up due diligence following negative shocks exerts an upward pressure. The dynamics of loans' officers wage rate, and the contribution of the resource drain channel to the response of due diligence, depends on the interplay of these two mechanisms.[29]

In this extension, we verify to what extent the wage dynamics in the banking sector affects the role of due diligence in the transmission of shocks. To this end, we consider GHH preferences and let households face a linear disutility in supplying labor to the banking sector. Under this alternative specification of households' utility, the supply of labor to the banking sector is infinitely elastic and, hence, loan officers' wage rate remains constant following shocks.

Appendix Figure 10 displays the responses to shocks. The insights of the baseline model are confirmed when the impact of loan officers' wage fluctuations is muted. Following liquidity (bond value and regulatory) shocks, for example, due diligence

[29] The dotted line in Figure 3 reflects the pattern of loan officers' wage rate and illustrates the contribution of the resource drain channel.

retains a stabilizing role. Moreover, comparing the responses in the fixed wage economy with those in the baseline economy (Appendix Figure 11), we observe that in the fixed wage economy the output drop is somewhat smaller than in the baseline following bond value shocks, while it is slightly larger following regulatory shocks. This can be explained with the observation that in the baseline model the resource drain channel slightly dampens the countercyclicality (and hence the stabilizing role) of due diligence following bond value shocks while it mildly contributes to its countercyclicality (and hence to its stabilizing role) after regulatory shocks (see Figure 3).[30]

8 Conclusion

This paper has studied the behavior of banks' due diligence over the business cycle and its impact on business cycle transmission. An analysis on U.S. data uncovered a tendency of banks to step up loan due diligence during recessions, especially when banks' access to liquidity is limited. Motivated by this evidence, we constructed a model in which banks face constraints in liquidity markets tied to the pledgeable value of their assets and perform due diligence to enhance the pledgeable recovery value of their loan portfolios. Two major channels govern due diligence: a liquidity channel, whereby tighter liquidity disciplines banks, incentivizing them to perform loan due diligence; and a pledgeability channel, whereby changes in loan values influence the impact of due diligence on loan recovery values.

The model reveals that banks' due diligence intensifies following contractionary shocks, while it slackens during expansions. The countercyclical due diligence, in turn, attenuates the aggregate effects of liquidity shocks, but may moderately amplify the effects of shocks to the quality of loan portfolios. The analysis also reveals that credit policies traditionally viewed as stabilizing may have the unintended consequence of diluting banks' due diligence incentives during recessions. For example, interventions aimed at sustaining banks' access to wholesale liquidity may temporarily reduce banks' due diligence, though they retain a stabilizing effect in the long run.

The paper leaves open relevant questions. A natural research question is how conventional monetary policy could influence the cyclical behavior of banks' due diligence. This might also yield insights into the impact of wholesale liquidity market regulations on the effectiveness of the monetary stance. We leave this and other

[30] Following capital quality shocks, the output drop is somewhat smaller in the fixed wage economy.

questions to future research.

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Table 1: Banks' due diligence (loan shares), aggregate shocks, and liquidity access

	I	II	III	IV	V
Interbank exposure	-0.040**	-0.041	-0.037**	-0.013	-0.040**
	(0.015)	(0.029)	(0.015)	(0.009)	(0.015)
NBER recessions	0.032**	0.034	0.288**		0.055***
	(0.013)	(0.038)	(0.115)		(0.016)
Lending experience (# of loans)	-0.010***	-0.009***	-0.010***	0.002**	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Information complexity		0.055***			
		(0.010)			
Interbank exposure*NBER recessions			-0.014**		
			(0.006)		
Interbank exposure*Exempted banks				0.026**	
				(0.010)	
Lending experience*NBER recessions					-0.008***
					(0.002)
+ bank, loan, and firm controls	Y	Y	Y	Y	Y
Observations	17,756	2,393	17,756	12,387	17,756
R-squared	0.107	0.178	0.108	0.0738	0.108
Year FE	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y
Clustered standard errors	Bank*Year	Bank*Year	Bank*Year	Bank*Year	Bank*Year

The table reports coefficient estimates and standard errors (in parentheses). In all columns the dependent variable is the lead lender share in the syndicated loan. Coefficient estimates for the additional controls are reported in Appendix Table 3. All variables are defined in Appendix Table 1. All specifications are estimated with a linear probability model (HDFE) and include fixed effects (as noted in the lower part of the table) to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at the bank-year level. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

Table 2 - Baseline calibration

Parameter	Value	Description
Households		
β	0.99	Discount factor
φ	0.25	Inverse of Frisch elasticity (goods sector)
τ	0.25	Inverse of Frisch elasticity (banking sector)
k_H	4.45	Disutility of labor in goods production
k_L	0.202	Disutility of labor in due diligence activities
Firms		
α	0.33	Capital share
δ	0.025	Capital depreciation rate
$I(F''/F')$	2.5	Inverse elasticity of investment to the price of capital
Banks		
θ	0.003	Transfer to new bankers
π^i	0.106	Probability of new investment opportunities
ξ	0.934	Weight on interbank loans
ϕ	0.796	Exponent in due diligence function
Government		
η	1.05	Elasticity of taxes to public debt
G/Y	0.20	Steady state proportion of government expenditures

Table 3 - Due diligence and macroeconomic volatility

Panel A - Variance decomposition (% difference)

		Capital quality	Bond value	Regulatory
Baseline minus Comparison (1 p.p.)	Y_t	1.3%	−2.8%	−8.1%
Baseline minus Comparison (3 p.p.)	Y_t	2.7%	−11.6%	−12.1%
Baseline minus Comparison (1 p.p.)	I_t	29.2%	4.6%	−2.8%
Baseline minus Comparison (3 p.p.)	I_t	21.6%	−3.1%	1.4%

Panel B - Variance driven by each shock (% difference)

		Capital quality	Bond value	Regulatory
Baseline minus Comparison (1 p.p.)	Y_t	1.1%	−2.8%	−8.3%
Baseline minus Comparison (3 p.p.)	Y_t	4.1%	−10.4%	−11.0%
Baseline minus Lower ζ	Y_t	0.2%	0%	0%
Baseline minus Comparison (1 p.p.)	I_t	15.1%	−7.3%	−13.9%
Baseline minus Comparison (3 p.p.)	I_t	−1.8%	−21.3%	−17.6%
Baseline minus Lower ζ	I_t	5.4%	−0.2%	0.1%

The lower ζ economy features a leverage of investing banks 5% lower than the baseline.

Table 4 - Average percentage change of due diligence for each credit policy at different horizons.

	Baseline $\Delta\%L_t^i$	Direct Lending $\Delta\%L_t^i$	Liquidity Provision $\Delta\%L_t^i$	Equity Injections $\Delta\%L_t^i$
1-year				
Bond value	8.5%	5.5%	6.9%	−11.7%
Regulatory	4.5%	0.03%	1.9%	−27.0%
Capital quality	17.5%	16.6%	17.2%	14.4%
2-years				
Bond value	6.4%	5.1%	5.7%	−6.2%
Regulatory	1.5%	−0.3%	0.5%	−17.7%
Capital quality	16.8%	15.9%	16.5%	13.8%
4-years				
Bond value	4.9%	4.6%	4.7%	−2.5%
Regulatory	−0.2%	−0.5%	−0.3%	−11.3%
Capital quality	15.6%	14.9%	15.4%	12.9%

Table 5 - Average percentage change of due diligence and output for each credit policy (four-year horizon).

	Baseline		Direct Lending		Liquidity Provision		Equity Injections	
	$\Delta\%L_t^i$	$\Delta\%Y_t$	$\Delta\%L_t^i$	$\Delta\%Y_t$	$\Delta\%L_t^i$	$\Delta\%Y_t$	$\Delta\%L_t^i$	$\Delta\%Y_t$
Bond value	4.9%	−0.32%	4.6%	−0.14%	4.7%	−0.25%	−2.5%	−0.30%
Regulatory	−0.2%	−0.42%	−0.5%	−0.18%	−0.3%	−0.33%	−11.3%	−0.40%
Capital quality	15.6%	−1.0%	14.9%	−0.79%	15.4%	−0.95%	12.9%	−0.98%

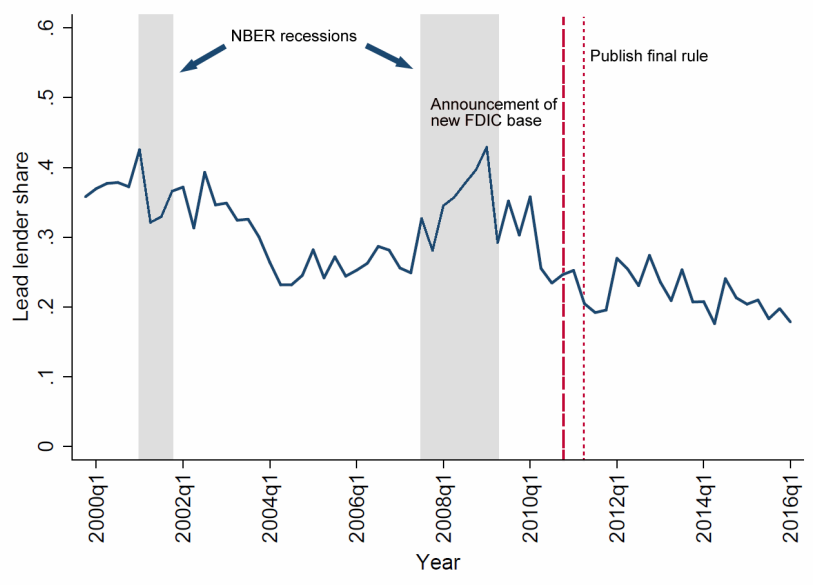


Figure 1 - Evolution of the average loan shares of lead banks in U.S. syndicates.

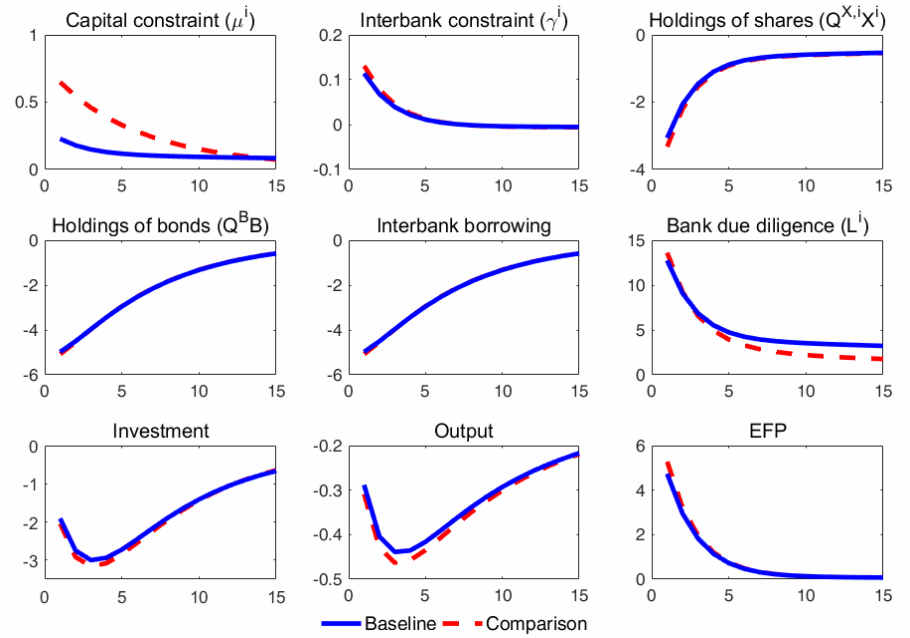


Figure 2 - Responses to negative bond value shock. All the IRFs refer to investing islands except for output, investment and bond value which are aggregate. All variables are expressed as quarterly percentage deviations from the steady state except for the external finance premium which is annualized.

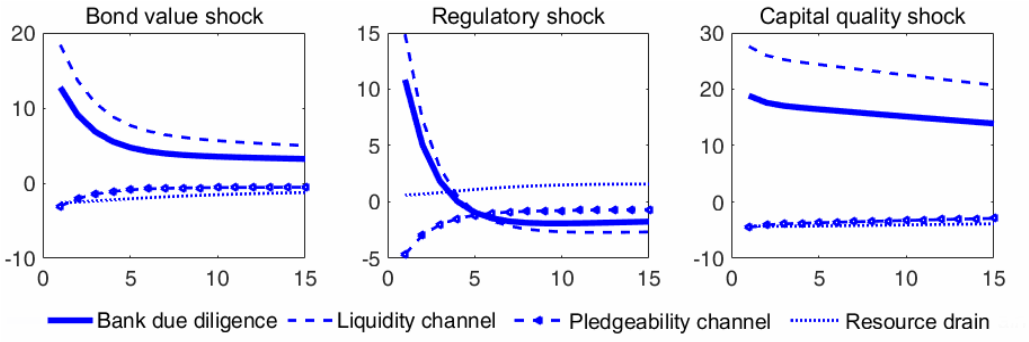


Figure 3 - Forces that contribute to bank due diligence response (see equation 19). All the IRFs refer to investing islands.

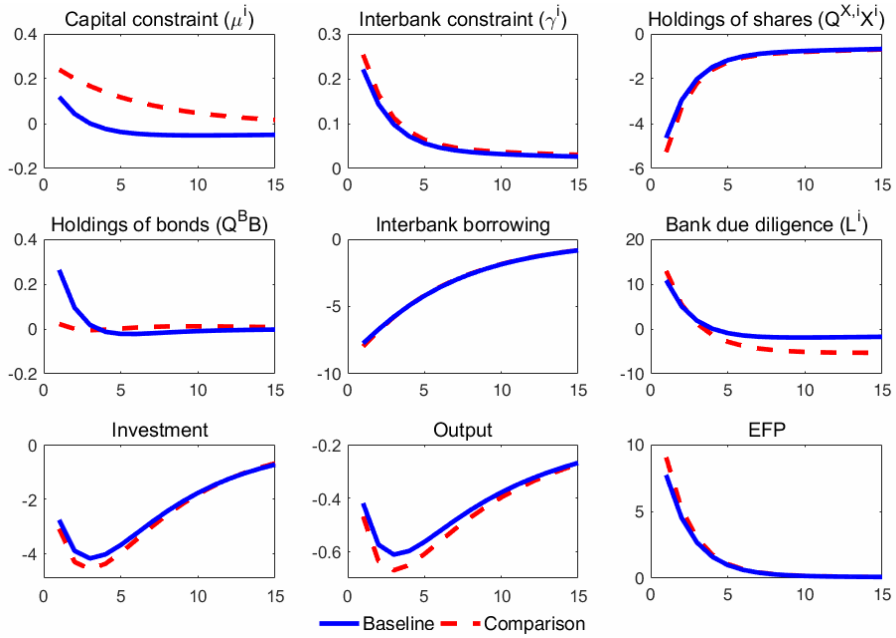


Figure 4 - Responses to negative regulatory shock. All the IRFs refer to investing islands except for output, investment and bond value which are aggregate.

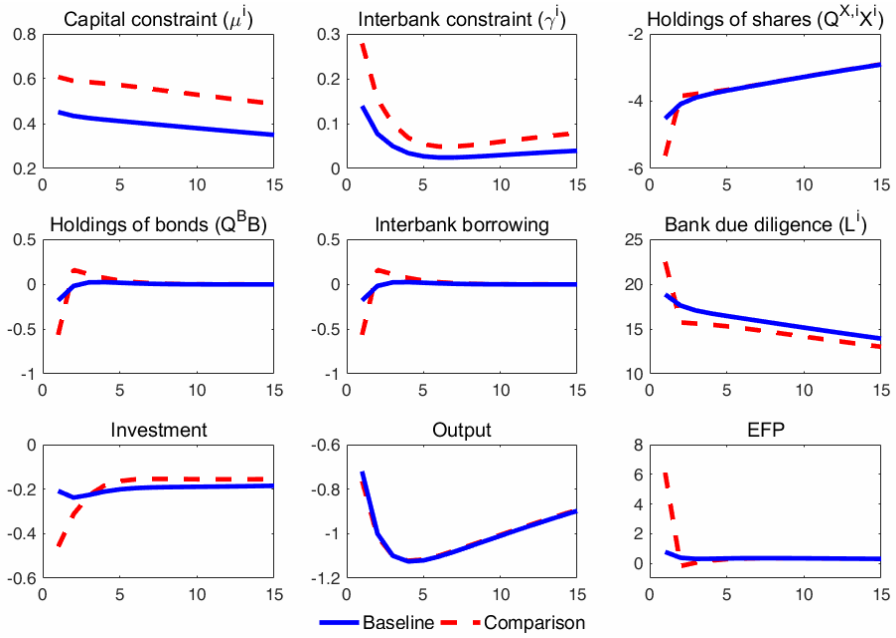


Figure 5 - Responses to negative capital quality shock. All the IRFs refer to investing islands except for output, investment and bond value which are aggregate.

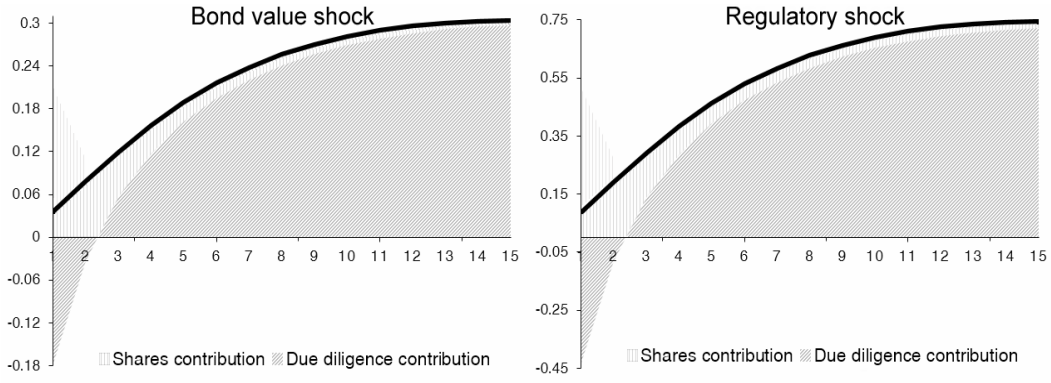


Figure 6 - Contribution of shares value and bank due diligence to changes in pledgeable values. The IRF (in difference) refers to investing islands.

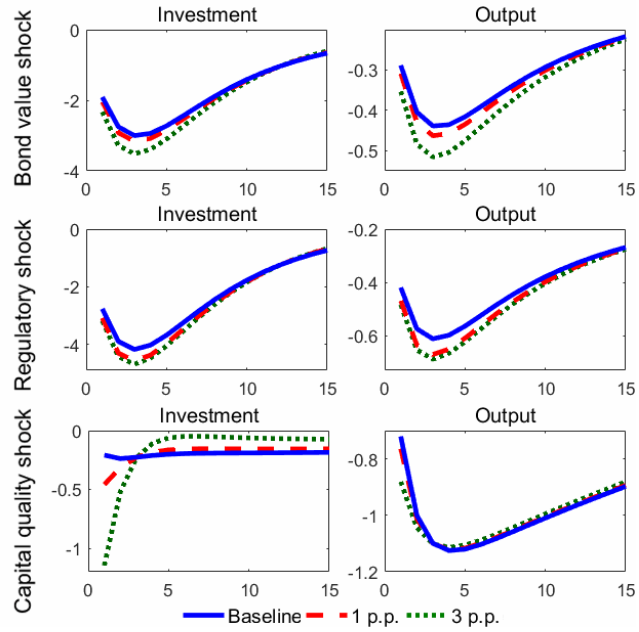


Figure 7 - Quantitative assessment of due diligence. Baseline economy and comparison economies.

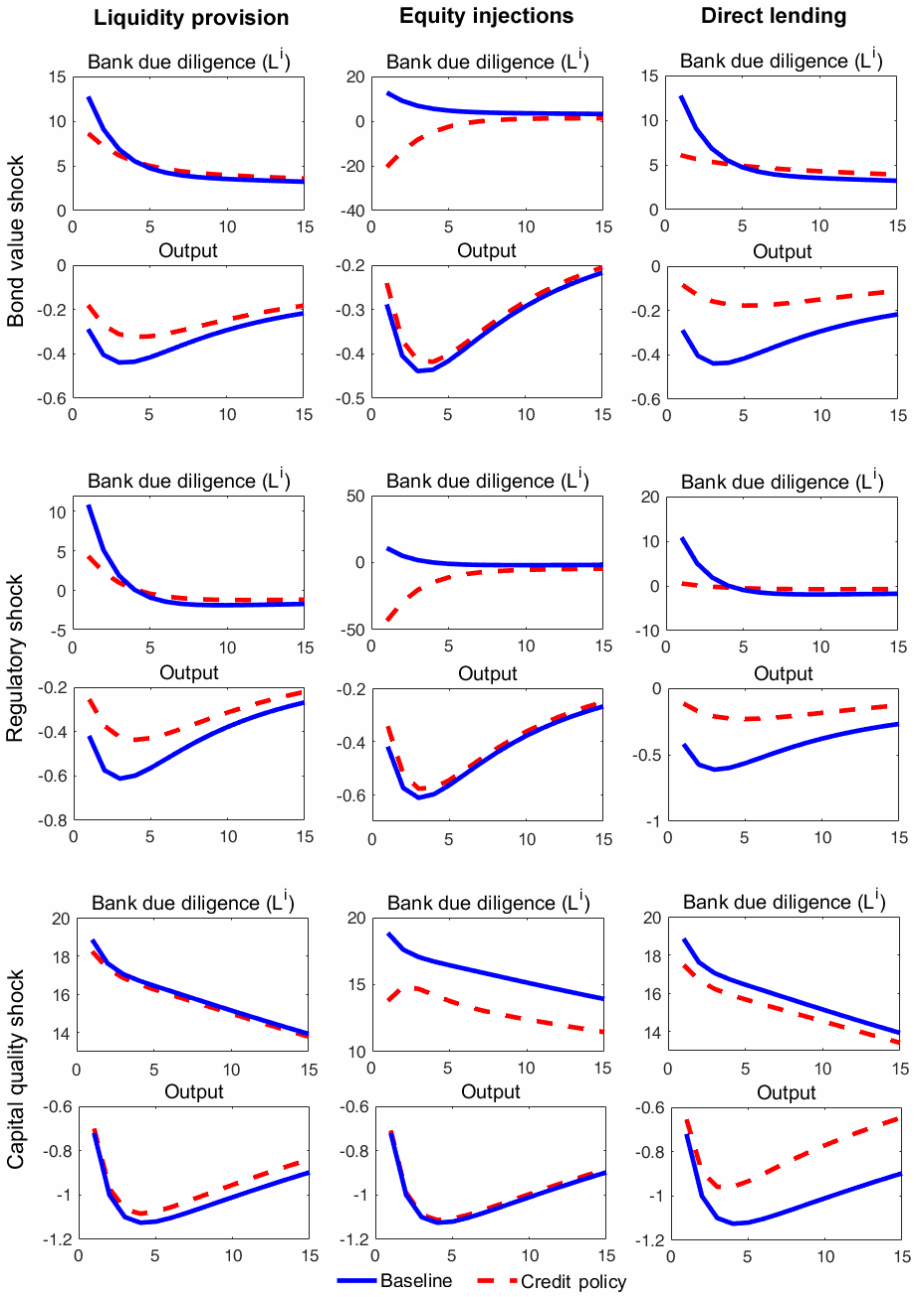


Figure 8 - Effects of credit policies. The IRF of bank due diligence refers to investing islands whereas output is aggregate.

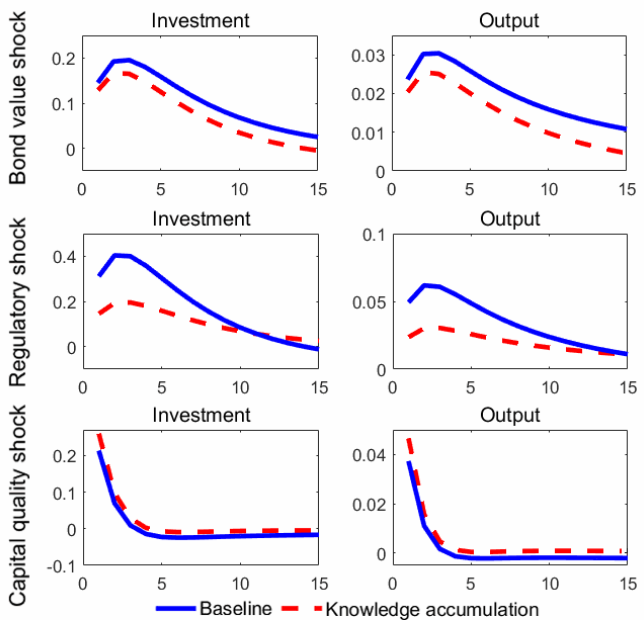


Figure 9 - Sluggish knowledge accumulation and interaction with due diligence. IRFs are in difference between the baseline and the reduced due diligence economy.

Online Appendices - Not for publication

The Appendices are organized as follows. Appendix A contains details on the data and supplementary empirical results. Appendix B presents further details and results for the main model: further derivation details (B1), the microfoundation for the due diligence technology (B2), additional quantitative results of the model (B3), a complete set of IRFs for each credit policy (B4). Appendix C presents further details on the extensions: more details on the extension with banks' sluggish knowledge accumulation (C1), more details on the extension with due diligence affecting loan returns (C2), and further details on the extension with an alternative specification of banks' due diligence cost (C3).

Appendix A – Data and further estimates (complements Section 3)

We obtain data on syndicated loans from DealScan. This database provides transaction-level information on the characteristics of the loan deal (amount, maturity, collateral, borrowing spread, performance pricing), as well as information on the syndicate members, the lead bank, the share of each bank in the syndicate, and the firm receiving the loan. We categorize loans as credit line, term A, B, C, D, and E and exclude term loans B because banks hold none of these loans after the syndication. Term loans B are structured specifically for institutional investors and almost entirely sold off in the secondary market. We apply three selection rules to avoid bias in our sample. This is an essential part of the sample selection process that is absent from most empirical studies using DealScan (for a similar strategy see Lim et al., 2014).

First, we disentangle banks from non-banks. We consider a loan facility to have a non-bank institutional investor if at least one institutional investor that is neither a commercial nor an investment bank is involved in the lending syndicate. Non-bank institutions include hedge funds, private equity funds, mutual funds, pension funds and endowments, insurance companies, and finance companies. To identify commercial bank lenders, we start from lenders whose type in DealScan is *US Bank*, *African Bank*, *Asian-Pacific Bank*, *Foreign Bank*, *Eastern Europe/Russian Bank*, *Middle Eastern Bank*, *Western European Bank*, or *Thrift/S&L*. We manually exclude the observations that are classified as a bank by DealScan but actually are not, such as the General Motors Acceptance Corporation (GMAC) Commercial Finance. Second, we exclude loans granted to utilities or to financial companies. Third, following Roberts (2015), we drop loans that are more likely to be amendments to existing loans, because these are misreported in DealScan as new loans, but they do not necessarily involve new money.

To obtain information for the financial statements of banks, we match these data with the U.S. Call Reports. We hand-match DealScan's lender name with the commercial bank ID (RSSD9001) from the Call Reports because there is no common identifier between these data sets. This process yields a unique identity for each lender. In turn, we link the lenders at their top holding company level (RSSD9348) to avoid losing observations. Because these reports are available on a quarterly basis, we match the origination date of the loan deal with the relevant quarter. For example, we match all syndicated loans that were originated from April 1st to June 30th with the second quarter of that year of the Call Reports.

Finally, to construct a measure for the degree of product information complexity, we exploit data from

Rauch (1999) on the categories of product differentiation. To harmonize the trade classification with industry classification, we use OECD information and Muendler (2009). Rauch (1999) sorts products into three categories: products traded on international exchanges, those with reference prices, and differentiated goods for which branding information precludes them from being traded on exchanges or reference priced.

Appendix Table 1: Variables definitions and sources

Name	Description	Source
Dependent variable:		
Lead lender share	The share of the loan held by the lead lender.	DealScan
Main explanatory variables:		
Interbank exposure	We follow Furfine (2003) to define the interbank exposures as the natural logarithm of the following sum: Cash and balances due from depository institutions (0010), credit exposure of all off-balance sheet derivative contracts (8764), loans to depository institutions and federal funds sold (b987).	Call Reports
Lending experience (# of loans)	The number of loans that the lead lender lent to the same borrower in the past five years prior to a current loan.	Own calculations
Exempted banks	A dummy equal to one if the bank is a reserve-exempted institution. The Dodd-Frank required that the FDIC fee is transitioned from a deposit-based assessment to an assessment based on assets minus tangible equity. However, bankers' banks and banks with a custodial business were given a specific exemption for reserves balances.	Own calculations
NBER recessions	Dummy variable equal to one for NBER recessions and zero otherwise	NBER
Information complexity	A dummy equal to one if an industry produces heterogeneous goods. We use Rauch (1999) data on the categories of product differentiation: those traded on international exchanges, those with reference prices, and differentiated goods for which branding information precludes them from being traded on exchanges or reference priced.	Rauch (1999)
Term	Dummy variable equal to one if the loan type is a term loan such as term loan A.	DealScan
Company rating	Firm S&P credit rating	DealScan
Reserves	Reserves balances at the central bank relative to total assets for each bank-quarter.	Call Reports
Sectoral specialization (SIC2)	$Sector_{b,t}^{Exper} = \frac{Loan_t^{b \longrightarrow s}}{Total\ Loan_t^{b \longrightarrow S}}$ the amount ($M) lent by bank b to a firm classified in a two-digit SIC sector s at time t over the total amount of lending ($M) lent by bank b to the total number of sectors (S). This index ranges from zero to one, with higher values reflecting higher exposure in the sector in which the firm operates.	Own calculations
Deposits	The fraction of total deposits over total assets	Call Reports
Return on assets	Return on assets	Call Reports
TIER 1	The fraction of TIER 1 capital over total assets	Call Reports
Loan loss provisions	Loan loss provisions ratio	Call Reports
Bank size	The natural logarithm of bank's total assets	Call Reports

Appendix Table 2: Sample summary statistics

	Level	N	Mean	Std	Min	Median	Max
Lead lender share	Loan	24,799	0.339	0.340	0.000	0.183	1.000
Interbank exposure	Bank	24,799	17.230	2.018	8.177	17.456	20.421
Lending experience (# of loans)	Loan	24,799	2.170	3.646	0.000	1.000	71.000
Exempted banks	Bank	2,730	0.927	0.259	0.000	1.000	1.000
NBER recessions	Bank	24,799	0.132	0.339	0.000	0.000	1.000
Information complexity	Bank	3,194	2.479	0.670	1.000	3.000	3.000
Term	Loan	24,799	0.165	0.372	0.000	0.000	1.000
Sectoral specialization (SIC2)	Loan	24,799	0.076	0.114	0.000	0.043	1.000
Company rating	Loan	24,087	16.157	7.029	1.000	15.000	23.000
Reserves	Bank	24,799	0.016	0.049	0.000	0.003	2.070
Deposits	Bank	24,799	0.655	0.105	0.000	0.657	0.932
Return on assets	Bank	24,799	0.010	0.005	-0.138	0.010	0.058
TIER 1	Bank	24,799	0.236	0.271	0.000	0.113	1.000
Loan loss provisions	Bank	24,799	0.019	0.008	0.000	0.017	0.085
Bank size	Bank	24,799	19.087	1.665	11.566	19.283	21.389

The table reports sample summary statistics. See Appendix Table 1 for definitions.

Appendix Table 3: Full coefficient estimates for Table 1

	I	II	III	IV	V
Interbank exposure	-0.040**	-0.041	-0.037**	-0.013	-0.040**
	(0.015)	(0.029)	(0.015)	(0.009)	(0.015)
NBER recessions	0.032**	0.034	0.288**		0.055***
	(0.013)	(0.038)	(0.115)		(0.016)
Lending experience (# of loans)	-0.010***	-0.009***	-0.010***	0.002**	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Information complexity		0.055***			
		(0.010)			
Interbank exposure*NBER recessions			-0.014**		
			(0.006)		
Interbank exposure*Exempted banks				0.026**	
				(0.010)	
Lending experience*NBER recessions					-0.008***
					(0.002)
Reserves	0.385**	0.633*	0.350**	0.007	0.367**
	(0.174)	(0.323)	(0.174)	(0.007)	(0.173)
Sectoral specialization (SIC2)	-0.202***	0.260	-0.202***	-0.013	-0.201***
	(0.053)	(0.225)	(0.053)	(0.020)	(0.053)
Deposits	0.109	-0.174	0.124	0.127**	0.115
	(0.085)	(0.161)	(0.086)	(0.051)	(0.085)
Return on assets	-0.720	-1.443	-0.674	0.066	-0.682
	(1.055)	(1.691)	(1.051)	(0.202)	(1.049)
TIER 1	0.031	-0.032	0.041	-0.007	0.037
	(0.046)	(0.077)	(0.046)	(0.017)	(0.046)
Loan-loss provisions	1.520	2.795	1.368	-0.524	1.376
	(1.211)	(2.176)	(1.202)	(0.416)	(1.207)
Bank size	-0.003	0.017	-0.005	-0.003	-0.003
	(0.020)	(0.035)	(0.022)	(0.024)	(0.018)
Observations	17,756	2,393	17,756	12,387	17,756
R-squared	0.107	0.178	0.108	0.0738	0.108
Year FE	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y
Clustered standard errors	Bank*Year	Bank*Year	Bank*Year	Bank*Year	Bank*Year

The table reports coefficient estimates and standard errors (in parentheses). In all columns the dependent variable is the lead lender share in the syndicated loan. All variables are defined in Appendix Table 1. All specifications are estimated with a linear probability model (HDFE) and include fixed effects (as noted in the lower part of the table) to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at the bank-year level. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

Appendix Table 4: Robustness tests

	I	II	III	IV
	Bank*Year FE	Purpose	Company rating	Term
Interbank exposure	-0.045***	-0.036**	-0.031**	-0.039**
	(0.016)	(0.015)	(0.014)	(0.016)
NBER recessions	0.033**	0.030**	0.044***	0.034**
	(0.014)	(0.013)	(0.015)	(0.013)
Lending experience (# of loans)	-0.010***	-0.009***	-0.006***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
Reserves	0.655***	0.307*	0.262*	0.407**
	(0.186)	(0.157)	(0.147)	(0.175)
Sectoral specialization (SIC2)	-0.191***	-0.141***	-0.002	-0.195***
	(0.053)	(0.050)	(0.040)	(0.053)
Deposits		0.089	0.020	0.095
		(0.075)	(0.075)	(0.085)
Return on assets		-0.517	-1.360	-0.701
		(0.940)	(0.918)	(1.049)
TIER 1		0.013	-0.010	0.025
		(0.042)	(0.041)	(0.047)
Loan loss provisions		1.031	1.372	1.534
		(1.129)	(1.103)	(1.203)
Bank size		-0.002	-0.004	-0.003
		(0.016)	(0.017)	(0.024)
Company rating			0.015***	
			(0.000)	
Term				0.047***
				(0.007)
Observations	17,724	17,754	17,265	17,756
R-squared	0.147	0.159	0.204	0.110
Year FE	N	Y	Y	Y
Bank FE	N	Y	Y	Y
Purpose FE	N	Y	N	N
Bank*Year FE	Y	N	N	N
Clustered standard errors	Bank*Year	Bank*Year	Bank*Year	Bank*Year

The table reports coefficients and standard errors (in parentheses) for lead lenders. All variables are defined in Appendix Table 1. In column I, we saturate the model with bank*year fixed effects. In column II, we insert loan purpose fixed effects. In columns III and IV, we control for the firm's riskiness and the type of loan, respectively. All specifications are estimated with a linear probability model (HDFE) and include fixed effects (as noted in the lower part of the table) to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at the bank-year level. The *, **, *** marks denote statistical significance at the 10, 5, and 1% level, respectively.

Appendix B – Further details and results for main model

B1 - Net worth evolution and aggregation (complements Section 4.5)

In this section we provide further details about the derivations for the banking sector. The aggregate bank balance sheet for each type $h \in \{i, n\}$ is given by

$$Q_t^{X,h} X_t^h + \pi^h Q_t^B B_t = N_t^h + \pi^h D_t + M_t^h - W_t^{L\frac{\phi-1}{\phi}} \left[\frac{(1-\phi)\zeta\mu_t^h}{\lambda_t^h}\right]^{\frac{1}{\phi}} Q_t^{X,h} X_t^h. \tag{B1}$$

The aggregate profit transferred to households reads

$$\begin{aligned}\Pi_t =& Q_t^i I_t - \left[1 + F\left(\frac{I_t}{I_{t-1}}\right)\right] I_t + (1-\sigma)\sum_h \pi^h \left\{[Z_t + (1-\delta)Q_t^{X,h}]\psi_t X_{t-1} + \psi_t^{B_g} B_{t-1} - R_{t-1}^D D_{t-1}\right\} + \\ &- \theta \sum_h \pi^h \left\{[Z_t + (1-\delta)Q_t^{X,h}]\psi_t X_{t-1} + \psi_t^{B_g} B_{t-1}\right\}.\end{aligned} \tag{B2}$$

where $X_t = X_t^i + X_t^n$. The total net worth for type h banks, N_t^h, equals the sum of the net worth of existing bankers $N_{o,t}^h$ (o for old) and of entering bankers $N_{y,t}^h$ (y for young):

$$N_t^h = N_{o,t}^h + N_{y,t}^h. \tag{B3}$$

Net worth of existing bankers equals earnings on assets net debt payments made in the previous period, multiplied by the fraction of bankers who survive until the current period, σ:

$$N_{o,t}^h = \sigma\pi^h \left\{[Z_t + (1-\delta)Q_t^{X,h}]\psi_t X_{t-1} + \psi_t^{B_g} B_{t-1} - R_{t-1}^D D_{t-1}\right\}. \tag{B4}$$

Because the arrival of the investment opportunity is independent across time, interbank loans are netted out in the aggregate. We posit that the household transfer to each new banker is a fraction $\theta/(1-\sigma)$ of the total value of the assets of exiting bankers, implying

$$N_{y,t}^h = \theta\pi^h \left\{[Z_t + (1-\delta)Q_t^{X,h}]\psi_t X_{t-1} + \psi_t^{B_g} B_{t-1}\right\}. \tag{B5}$$

Then, the aggregate bank net worth evolves as

$$N_t^h = \pi^h \left\{(\sigma+\theta)[Z_t + (1-\delta)Q_t^{X,h}]\psi_t X_{t-1} + (\sigma+\theta)\psi_t^{B_g} B_{t-1} - \sigma R_{t-1}^D D_{t-1}\right\}. \tag{B6}$$

B2 - Endogenizing banks' due diligence function (complements Section 4.6)

We endogenize the due diligence function in equation (14). As in Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), we posit that bankers can strategically default on their obligations to financiers (retail and interbank depositors). Bank financiers can force a defaulting banker into liquidation and recover the

liquidation value of the bank's assets. Following Diamond and Rajan (2001, 2005, 2006), the recovery value of firm shares is tied to the liquidation skills accumulated by the bank through due diligence. Diamond and Rajan (2001, 2005, 2006) show that, because of the features of deposit contracts, a banker can commit to exerting its liquidation skills. In particular, the first-come, first-served nature of deposit contracts induces a collective action problem that forces a transfer of the ownership of project loans if the bank tries to renegotiate the repayment below the pledgeable recovery value $\mathcal{P}(\cdot)Q_t^{X,h}x_t^h$ that the bank can obtain in the liquidation market. Unlike Diamond and Rajan (2001, 2005, 2006), bankers choose *ex ante* their effort in acquiring liquidation skills (due diligence intensity).

Diamond and Rajan (2001, 2005, 2006) argue that bankers' liquidation skills materialize in their ability to identify the best buyers of project loans in the liquidation market. Exploiting the characteristics of our economy we can formalize a mechanism along these lines through which bankers can raise the recovery values of firm shares. Suppose that the liquidation market for firm shares is an economy-wide market in which all bankers, from both investing and non-investing islands, participate. Further, shares purchased in investing islands can only be resold to, and reused by, bankers operating in investing islands; similarly, shares purchased in non-investing islands can be only resold to, and reused by, bankers operating in non-investing islands. This captures the specificity of bank claims: only banks in the same island type can effectively reuse liquidated shares. Finally, unlike in primary markets (the market for firm shares and the interbank market), in the liquidation market for firm shares a banker cannot identify the island of origin of other bankers. This captures the idea that the liquidation process of assets in secondary markets naturally entails trading frictions (see, e.g., Perri and Quadrini, 2018; Ramey and Shapiro, 2001; Eisfeldt and Rampini, 2006; Gavazza, 2011). Irani et al. (2020) document empirically that banks engage in more due diligence of loans when they participate more intensely in the secondary market for syndicated loans. Gorton and Pennacchi (1995) and Altman et al. (2010) find evidence that banks' due diligence raises the marketability of loans and banks' returns from loan sales in the secondary market.

Given this specification, the expected recovery value of the firm shares of a defaulting bank from an investing island is

$$\mathcal{P}(\mathcal{S}_t^i, \mathcal{M}^i, \mathcal{M}^n)Q_t^{X,i}x_t^i = \frac{\mathcal{S}_t^i \mathcal{M}^i}{\mathcal{M}^i + \mathcal{M}^n} Q_t^{X,i}x_t^i, \tag{B7}$$

where $\mathcal{P}(\cdot)$ is the probability of being matched with a bank (buyer) from an investing island, $\mathcal{M}^i$ and $\mathcal{M}^n$ denote the measures of banks in investing and non-investing islands, respectively, and $\mathcal{S}_t^i$ is the search intensity of the bank in the liquidation market. The value $[1-\mathcal{P}(\cdot)]Q_t^{X,i}x_t^i$ can be interpreted as the loan loss in the event of default and liquidation. Note also that $\mathcal{M}^i/(\mathcal{M}^i+\mathcal{M}^n) = \pi^i$. Following previous studies that incorporate trading frictions (Cavalcanti and Wallace, 1999; Araujo and Minetti, 2007; Habib and Johnsen, 1999), and in line with Diamond and Rajan (2001, 2005, 2006), we posit that the acquisition of information and due diligence of the bank allows it to more easily identify suitable buyers from its same type of island and, hence, to increase the probability of a suitable match. In particular, the search intensity of the bank satisfies

$$\mathcal{S}_t^i = \zeta^i \left(\frac{l_t^i}{Q_t^{X,i}x_t^i} \right)^{1-\phi}, \tag{B8}$$

that is, $\mathcal{S}_t^i$ is a standard increasing and concave function of the labor of loan officers in due diligence, per unit of firm shares. The parameter ζ^i captures the search effectiveness of loan officers. Replacing (B8) into (B7), and denoting $\zeta^i \equiv \zeta/\pi^i$, we obtain

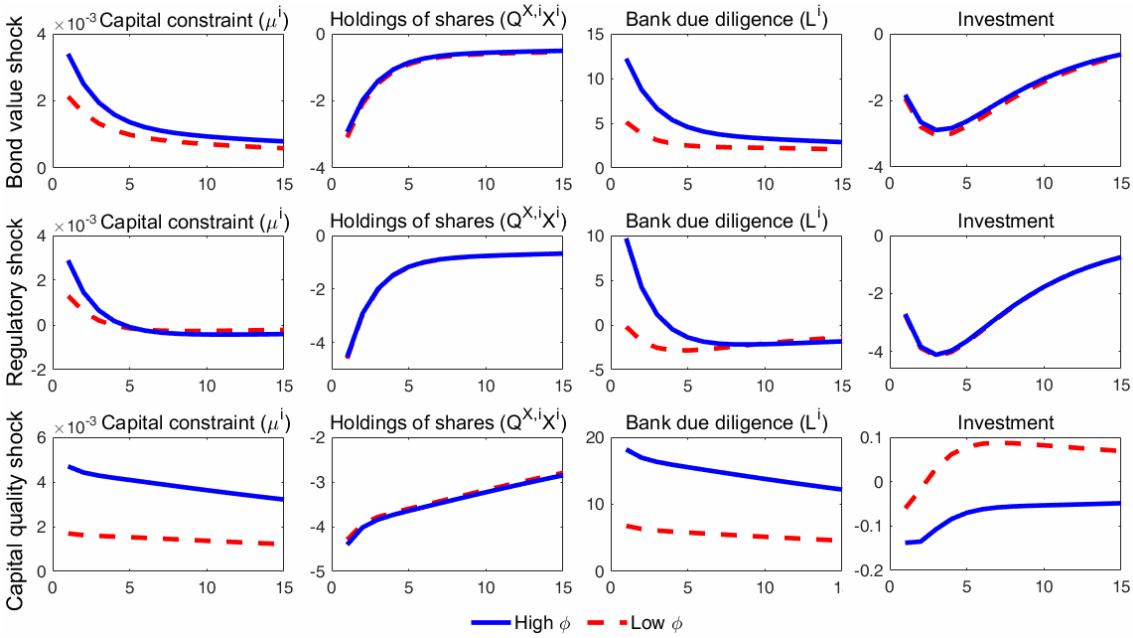
$$\mathcal{P}(\cdot)Q_t^{X,i}x_t^i = \zeta(Q_t^{X,i}x_t^i)^{\phi}(l_t^i)^{1-\phi}. \tag{B9}$$

This specification, which implies that the marginal product of loan officers' due diligence is increasing in the value of assessed firm shares, allows to reproduce the pledgeable recovery value of firm shares in the model (see equation (15) in the main text).

B3 - Additional IRFs for Sections 5.2 and 5.3

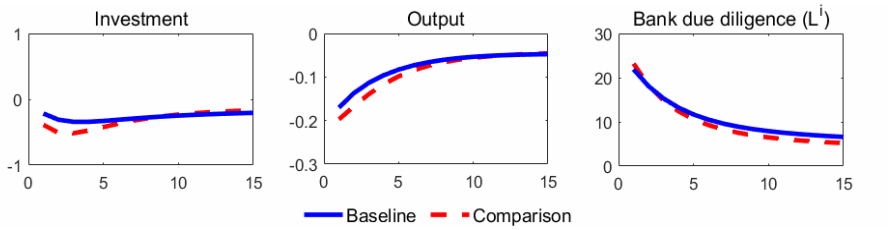
We present here additional impulse responses for Sections 5.2 and 5.3 (sensitivity of the IRFs to the parameter ϕ; IRFs to a net worth shock to the banking sector).

Sensitivity of IRFs to ϕ In Appendix Figure 1 we study how the weight ϕ on banks' due diligence in function (15) influences the IRFs. For all the shocks, due diligence is more intense in the "high ϕ" scenario ($\phi = 0.8$) than in the "low ϕ" scenario ($\phi = 0.60$). See Sections 5.2 and 5.3 for comments on the figure.



Appendix Figure 1 - Responses for different values of ϕ. All the IRFs refer to investing islands except for investment which is aggregate.

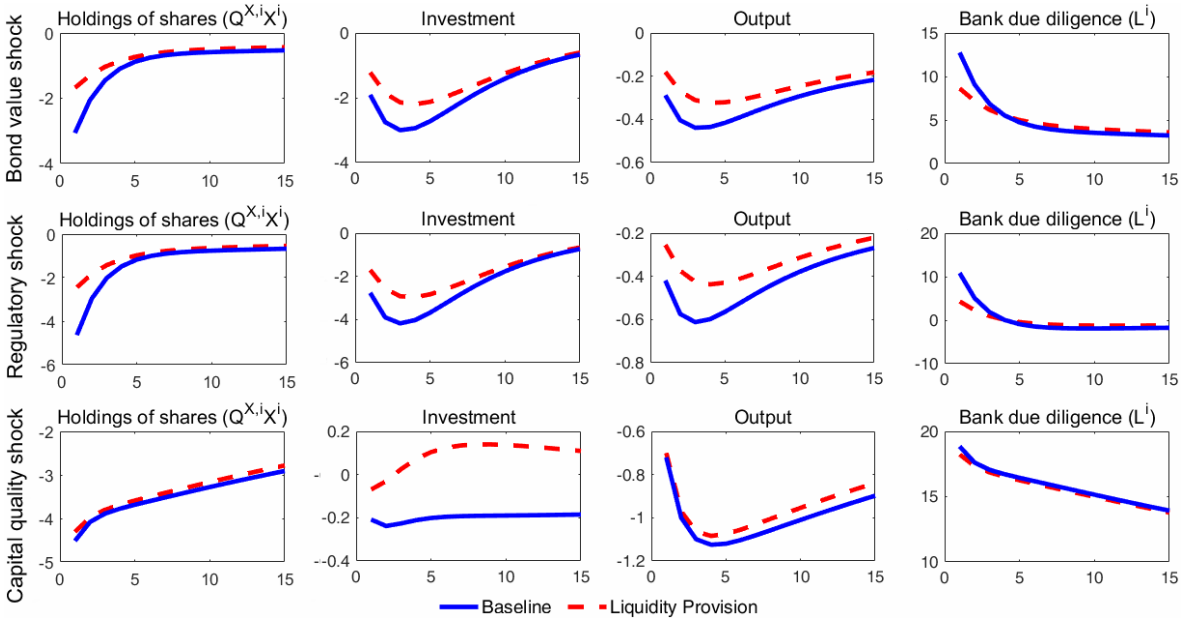
Responses to a net worth shock In Appendix Figure 2, we display the impulse responses to a net worth shock to the banking sector, consisting of an exogenous reduction in banks' net worth.



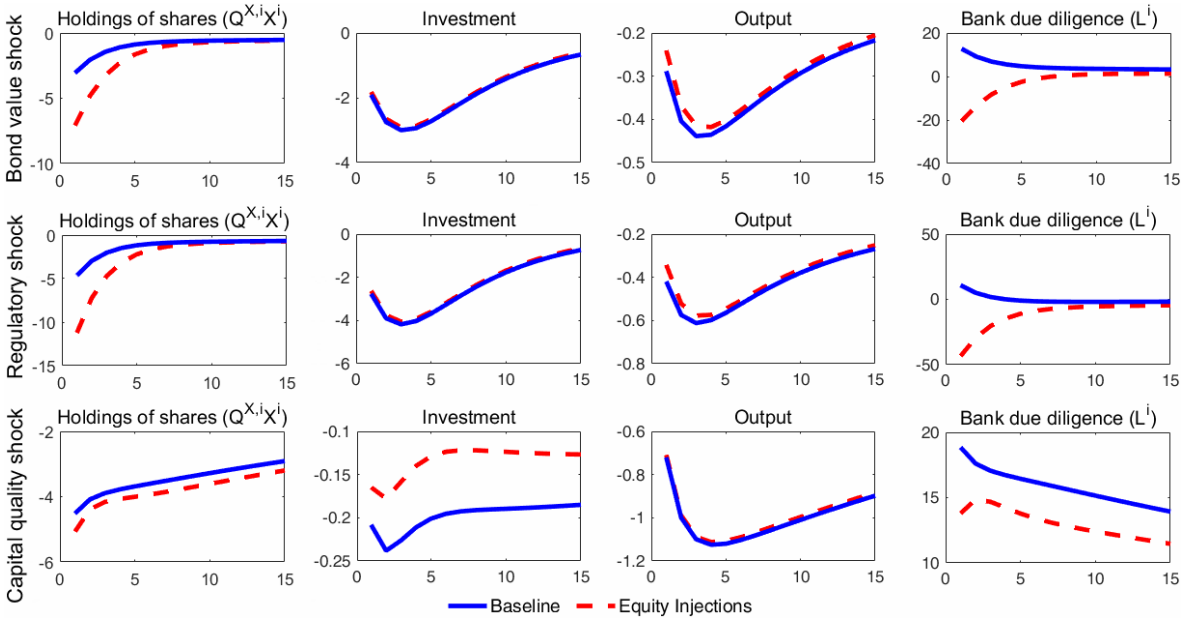
Appendix Figure 2 - Responses to negative net worth shock.

B4 - Additional IRFs for credit policies (complements Section 6)

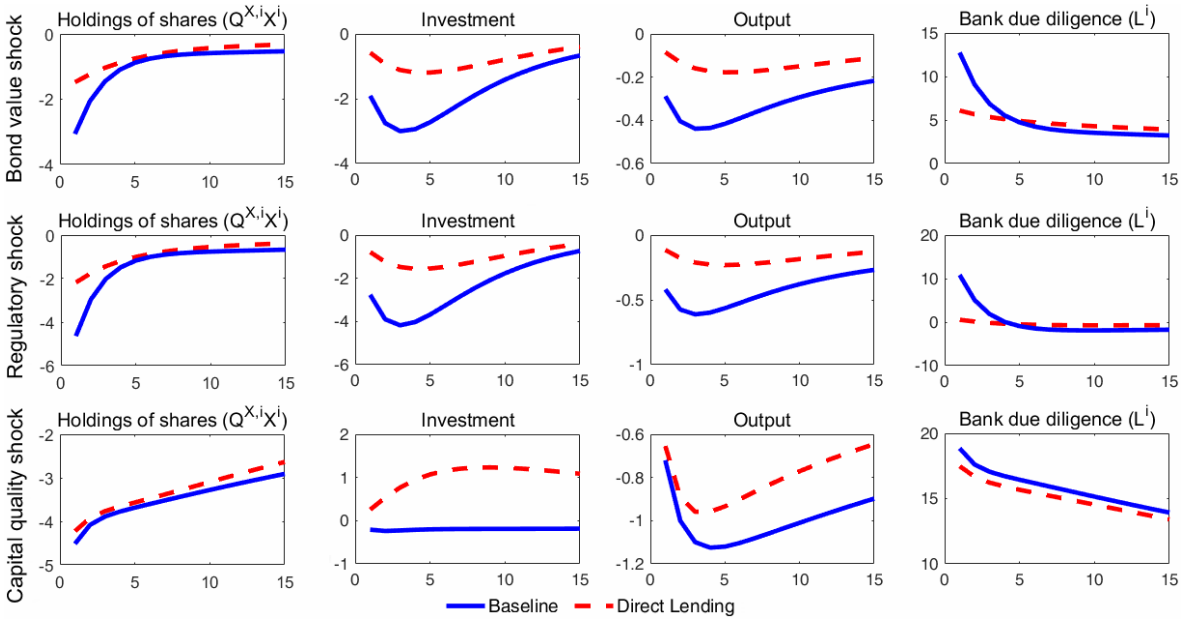
The figures below present a more complete set of IRFs to each shock when liquidity is provided to banks in the interbank market (Appendix Figure 3), when the government carries out equity injections into banks (Appendix Figure 4), and under a policy of direct lending to firms (Appendix Figure 5).



Appendix Figure 3 - Effects of liquidity provision to banks. The IRF of bank due diligence refers to investing islands whereas investment and output are aggregate.



Appendix Figure 4 - Effects of equity injections into banks. The IRF of bank due diligence refers to investing islands investment and output are aggregate.



Appendix Figure 5 - Effects of direct lending to firms. The IRF of bank due diligence refers to investing islands whereas investment and output are aggregate.

Appendix C – Further details and results for extensions

C1 - Details on knowledge accumulation (complements Section 7.1)

In the setting augmented with banks' knowledge accumulation, the representative bank solves the optimization problem:

$$V_{t-1}(\cdot) = E_{t-1}\Lambda_{t-1,t}\left[\sum_h \pi^h(1-\sigma)n_t^h + \max_{d_t,b_t,m_t^h,x_t^h,l_t^h,s_t^h}\sum_h \pi^h\sigma V_t(d_t,b_t,m_t^h,x_t^h,l_t^h,s_t^h)\right]$$

$$\text{s.t.} \quad Q_t^{X,h}x_t^h + Q_t^B b_t = n_t^h + d_t + m_t^h - W_t^L l_t^h, \qquad [\sigma\pi^h\lambda_t^h] \qquad \text{(C1)}$$

$$R_t^D d_t + \xi R_t^M m_t^h \leq Q_t^B b_t + \zeta[Q_t^{X,h}(x_t^h + h_x s_{t-1})]^\phi (l_t^h)^{1-\phi}, \qquad [\sigma\pi^h\mu_t^h] \qquad \text{(C2)}$$

$$R_t^M m_t^h \leq \chi_t Q_t^B b_t, \qquad [\sigma\pi^h\gamma_t^h] \qquad \text{(C3)}$$

$$s_t^h = \rho_s s_{t-1} + (1-\rho_s)x_t^h. \qquad [\sigma\pi^h\nu_t^h] \qquad \text{(C4)}$$

The first order conditions for m_t^h, d_t and b_t remain unchanged, whereas the FOCs for x_t^h, l_t^h and s_t^h are

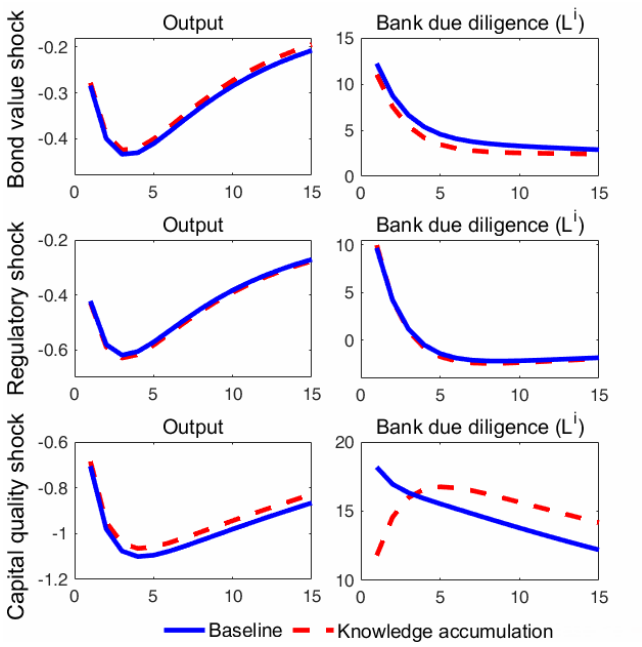
$$[\partial x_t^h]: \quad -Q_t^{X,h}\lambda_t^h + \zeta\phi\mu_t^h(Q_t^{X,h})^\phi(x_t^h + h_x s_{t-1})^{\phi-1}(l_t^h)^{1-\phi} +$$
$$+(1-\rho_s)\nu_t^h + E_t\Lambda_{t,t+1}\sum_{h'}\pi^{h'}[Z_{t+1} + (1-\delta)Q_{t+1}^{X,h'}]\psi_{t+1}(1-\sigma+\sigma\lambda_{t+1}^{h'}) = 0, \qquad \text{(C5)}$$

$$[\partial l_t^h]: \quad l_t^h = \left[\frac{\zeta(1-\phi)}{W_t^L}\right]^{\frac{1}{\phi}}\left[\frac{\mu_t^h}{\lambda_t^h}\right]^{\frac{1}{\phi}}\left[Q_t^{X,h}(x_t^h + h_x s_{t-1})\right], \qquad \text{(C6)}$$

$$[\partial s_t^h]: \quad \nu_t^h = E_t\Lambda_{t,t+1}\sum_{h'}\pi^{h'}\sigma\left\{\rho_s\nu_{t+1}^{h'} + h_x\phi\zeta\mu_{t+1}^{h'}(Q_{t+1}^{X,h'})^\phi(x_{t+1}^{h'} + h_x s_t^{h'})^{\phi-1}(l_{t+1}^{h'})^{1-\phi}\right\} = 0. \qquad \text{(C7)}$$

Other IRFs (direct effect of knowledge accumulation) In the figure below we compare the IRFs in the baseline model in the cases with and without knowledge accumulation. This comparison captures the direct effect of knowledge accumulation in attenuating or amplifying the effect of shocks. The direct effect of knowledge accumulation in a model with banks' due diligence is the result of two contrasting forces. On the one hand, following each shock, the stock of knowledge accumulated works towards directly attenuating the tightening of the capital constraint. On the other hand, banks have a reduced incentive to step up their due diligence following shocks, due to the looser capital constraint (diluted liquidity channel), and, as noted in the main text, due diligence exerts a less sharp effect. Observe that the lower increase in due diligence is in line with the negative effect of lending experience on banks' due diligence effort estimated in the empirical analysis (see, e.g., Table 1, column 5). We obtain that overall knowledge accumulation attenuates the output effects of bond value and capital quality shocks, while it has a more ambiguous influence following regulatory

shocks.

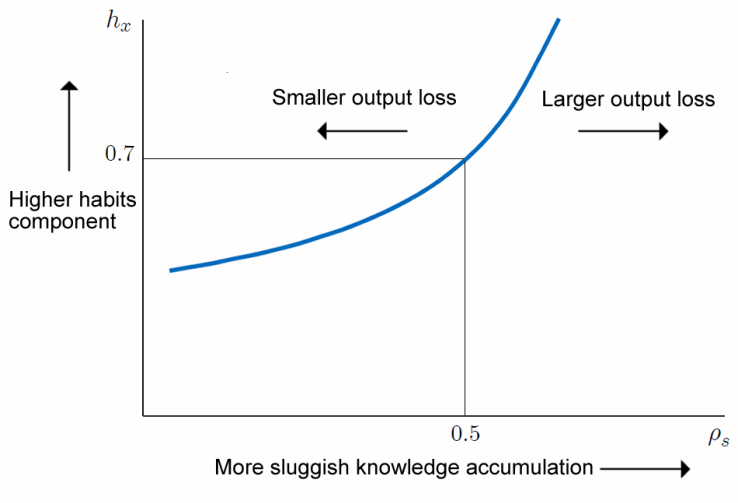


Appendix Figure 6 - Direct effect of bank due diligence.

The contribution of due diligence with knowledge accumulation As noted in the main text, the simulations reveal that, in the extended setting with sluggish knowledge accumulation, due diligence is somewhat less effective in attenuating the impact of liquidity shocks (see again Figure 9). We perform two further exercises to evaluate the role of due diligence in this extended economy. First, we repeat the exercise performed in Section 5.4, Figure 6, in this extended setting. In particular, we evaluate the contribution of due diligence to attenuating the drop in the pledgeable recovery value of firm shares in the baseline economy relative to the comparison economy with reduced due diligence. The exercise reveals that the contribution of due diligence is slightly lower in this extended setting with sluggish knowledge accumulation than in the setting without knowledge accumulation (on average, over the simulation horizon, due diligence contributes 88 percent, versus 89 percent, of the attenuation of the response of loan recovery values). This confirms that, by introducing a time-to-build component, sluggish knowledge accumulation somewhat weakens the contribution of due diligence.

Next, in a second exercise, we assess how the responses in the economy with sluggish knowledge accumulation change as we alter the values of the parameters governing the knowledge accumulation speed (ρ_s) and the contribution of the knowledge stock to loan recovery values (h_x). For example, Appendix Figure 7 summarizes this exercise for the case of the negative bond value shock. In particular, Appendix Figure 7 shows combinations of ρ_s and h_x under which the output response to a negative bond value shock remains unchanged. To the right of the graph, the output response is larger; to the left, the output response is instead

lower. The graph thus suggests that a higher persistence ρ_s (that is, a stronger time-to-build component) somewhat weakens the stabilizing role of due diligence after liquidity shocks.



Appendix Figure 7 - Speed of knowledge accumulation and output losses.

C2 - Details on due diligence and loan returns (complements Section 7.2)

In this extended setting, the Lagrangian can be written as

$$\mathcal{L} = E_{t-1}\Lambda_{t-1,t}\left\{\sum_h \pi^h(1-\sigma)n_t^h + \max_{d_t,b_t,l_t^h,e_t^h,m_t^h}\sum_h \pi^h\sigma\left[V_t(\cdot) + \lambda_t^h(...) + \mu_t^h(...) + \gamma_t^h(...)\right]\right\}. \tag{C8}$$

A bank's first order conditions are unchanged except those for the investment of funds e_t^h in loan production and for the hiring of loan officers l_t^h, which read

$$[\partial e_t^h]: \quad -\sigma\pi^h\lambda_t^h + \sigma\pi^h\mu_t^h\zeta\phi_2\left(\frac{l_t^h}{e_t^h}\right)^{1-\phi_2} + \sigma\pi^h\frac{\partial V_t}{\partial e_t^h} = 0, \tag{C9}$$

$$[\partial l_t^h]: \quad -\sigma\pi^h\lambda_t^h W_t^L + \sigma\pi^h\mu_t^h\zeta(1-\phi_2)\left(\frac{l_t^h}{e_t^h}\right)^{-\phi_2} + \sigma\pi^h\frac{\partial V_t}{\partial l_t^h} = 0. \tag{C10}$$

The first order conditions for e_t^h and l_t^h can then be rewritten as

$$[\partial e_t^h]: \quad -\lambda_t^h + \mu_t^h \zeta \phi_2 \left(\frac{l_t^h}{e_t^h}\right)^{1-\phi_2} + \\ + E_t \Lambda_{t,t+1} \sum_{h'} \pi^{h'} \frac{Z_{t+1} + (1-\delta) Q_{t+1}^{X,h'}}{Q_t^{X,h}} \psi_{t+1} \left(1 - \sigma + \sigma \lambda_{t+1}^{h'}\right) \phi_1 \left(\frac{l_t^h}{e_t^h}\right)^{1-\phi_1} = 0, \tag{C11}$$

$$[\partial l_t^h]: \quad -\lambda_t^h W_t^L + \mu_t^h \zeta (1-\phi_2) \left(\frac{l_t^h}{e_t^h}\right)^{-\phi_2} + \\ + E_t \Lambda_{t,t+1} \sum_{h'} \pi^{h'} \frac{Z_{t+1} + (1-\delta) Q_{t+1}^{X,h'}}{Q_t^{X,h}} \psi_{t+1} \left(1 - \sigma + \sigma \lambda_{t+1}^{h'}\right) (1-\phi_1) \left(\frac{l_t^h}{e_t^h}\right)^{-\phi_1} = 0 \tag{C12}$$

These equations imply that l_t^h / e_t^h is equal across banks on the same type of island h, regardless of their size (net worth). This result enables us to aggregate across different banks. Denoting by $E_{A,t}^h$ the aggregate version of e_t^h, the aggregate version of the FOCs for e_t^h and l_t^h are simply:

$$-\lambda_t^h + \mu_t^h \zeta \phi_2 \left(\frac{L_t^h}{E_{A,t}^h}\right)^{1-\phi_2} + \\ + E_t \Lambda_{t,t+1} \sum_{h'} \pi^{h'} \frac{Z_{t+1} + (1-\delta) Q_{t+1}^{X,h'}}{Q_t^{X,h}} \psi_{t+1} \left(1 - \sigma + \sigma \lambda_{t+1}^{h'}\right) \phi_1 \left(\frac{L_t^h}{E_{A,t}^h}\right)^{1-\phi_1} = 0, \tag{C13}$$

$$-\lambda_t^h W_t^L + \mu_t^h \zeta (1-\phi_2) \left(\frac{L_t^h}{E_{A,t}^h}\right)^{-\phi_2} + \\ + E_t \Lambda_{t,t+1} \sum_{h'} \pi^{h'} \frac{Z_{t+1} + (1-\delta) Q_{t+1}^{X,h'}}{Q_t^{X,h}} \psi_{t+1} \left(1 - \sigma + \sigma \lambda_{t+1}^{h'}\right) (1-\phi_1) \left(\frac{L_t^h}{E_{A,t}^h}\right)^{-\phi_1} = 0. \tag{C15}$$

The aggregate resource constraint for each type $h \in \{i, n\}$ reads:

$$E_{A,t}^h + \pi^h Q_t^B B_t = N_t^h + \pi^h D_t + M_t^h - W_t^L L_t^h. \tag{C16}$$

The aggregate bank net worth evolves as:

$$N_t^h = \pi^h \left\{ (\sigma + \theta)[Z_t + (1-\delta) Q_t^{X,h}] \psi_t X_{t-1} + (\sigma + \theta) \psi_t^{B_g} B_{t-1} - \sigma R_{t-1}^D D_{t-1} \right\}, \tag{C17}$$

where $X_t = X_t^i + X_t^n$ and $X_t^h = (E_{A,t}^h)^{\phi_1} (L_t^h)^{1-\phi_1} / Q_t^{X,h}$.

In this modified setting, the social resource constraint reads:

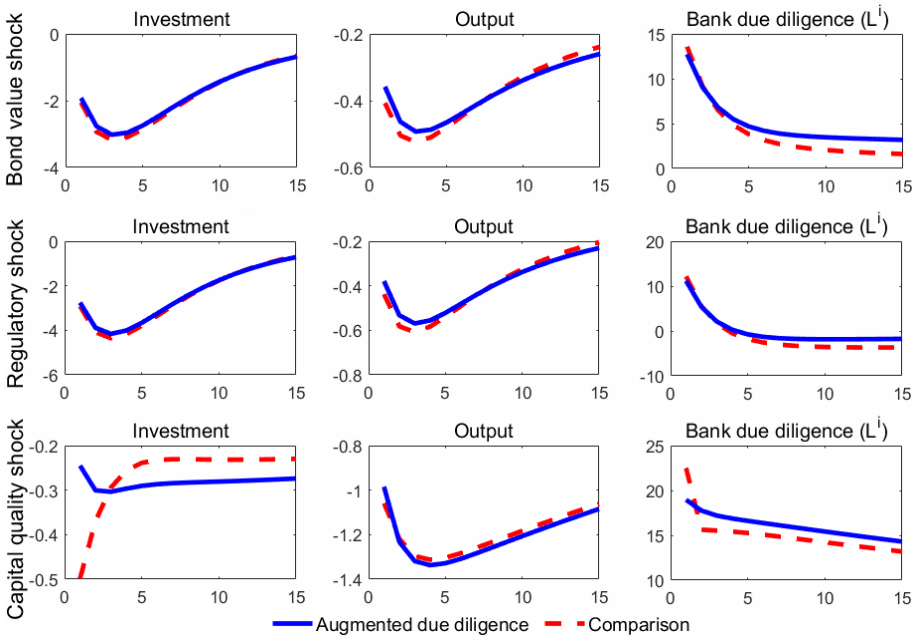
$$C_t + \left[1 + F\left(\frac{I_t}{I_{t-1}}\right)\right] I_t + G_t = Y_t + \textstyle\sum_h \left[(E_{A,t}^h)^{\phi_1} (L_t^h)^{1-\phi_1} - E_{A,t}^h \right]. \tag{C18}$$

In this extended setting, the parameters ϕ_1 and ω in (34) govern the contribution of due diligence to loan

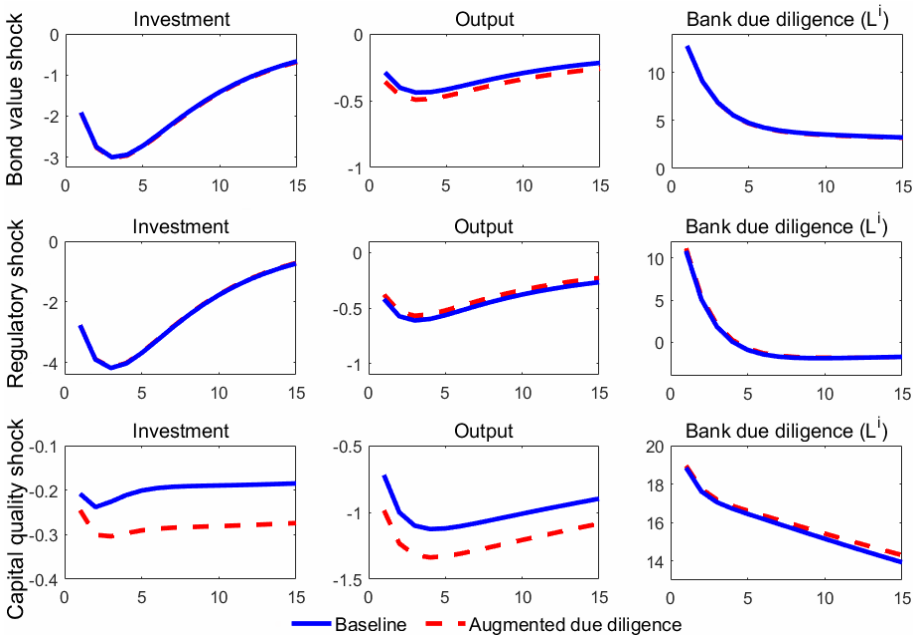
portfolio production and returns, relative to its contribution to loan recovery value and pledgeability in markets for liquidity. We calibrate ϕ_1 and ω in a way such that in steady state the former effect weighs for approximately one third and the latter effect for approximately two thirds in banks' demand for loan officers. More formally, (C19) below summarizes this decomposition:

$$[\partial l_t^h]: \underbrace{\mu_t^h \zeta (1-\phi_2)\left(\frac{l_t^h}{e_t^h}\right)^{-\phi_2}}_{Baseline\ effect \cong 2/3} + \underbrace{E_t \Lambda_{t,t+1} \sum_{h'} \pi^{h'} \frac{Z_{t+1} + (1-\delta) Q_{t+1}^{X,h'}}{Q_t^{X,h}} \psi_{t+1} \left(1 - \sigma + \sigma \lambda_{t+1}^{h'}\right)(1-\phi_1)\left(\frac{l_t^h}{e_t^h}\right)^{-\phi_1}}_{Additional\ effect\ in\ extended\ economy \cong 1/3} = \lambda_t^h W_t^L. \tag{C19}$$

Appendix Figure 8 shows the IRFs in this extended economy and in a comparison economy with due diligence lower by one percentage point along the simulation horizon. Appendix Figure 9 shows the IRFs in the baseline model economy and in this extended economy. As noted in the main text, in this extended setting due diligence retains a countercyclical behavior and a stabilizing effect on macroeconomic variables. At the same time, as Appendix Figure 8 reveals, the stabilizing effect of due diligence appears to be somewhat less persistent than in the baseline setting.



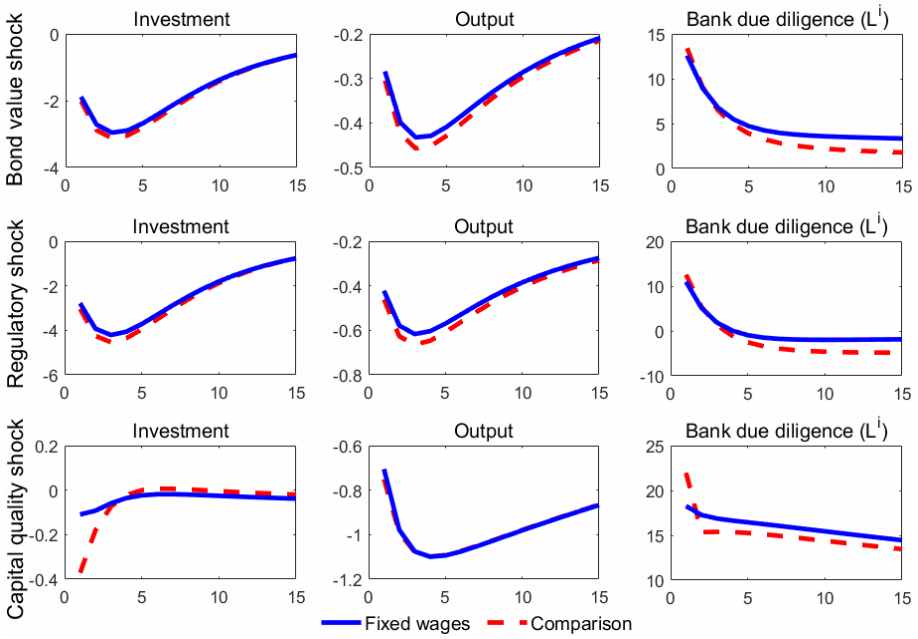
Appendix Figure 8 - Responses of the model with due diligence affecting loan returns for different shocks.



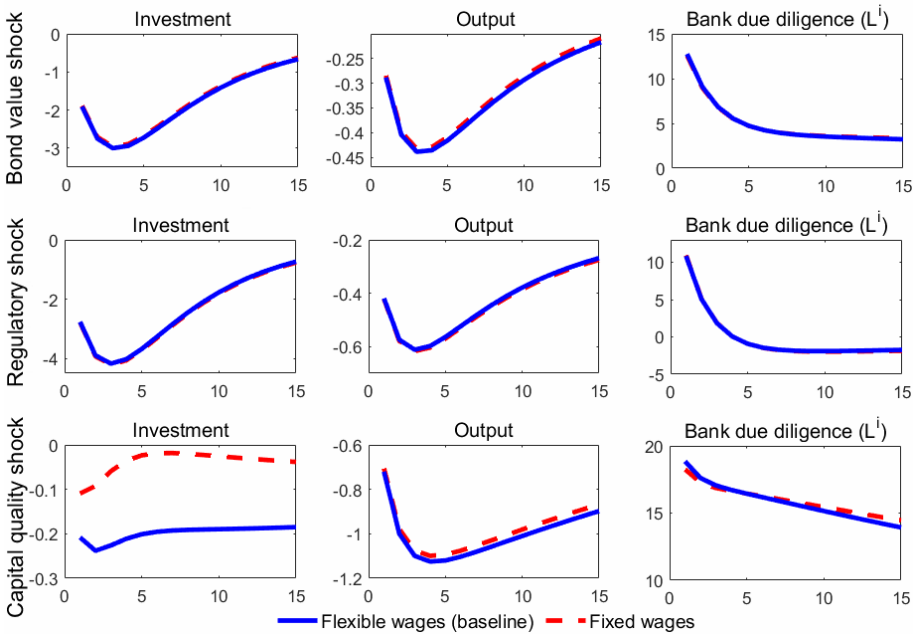
Appendix Figure 9 - Comparison between the responses of the baseline model vs. the model with due diligence affecting loan returns for different shocks.

C3 - The cost of due diligence (complements Section 7.3)

Appendix Figure 10 shows the IRFs in the model with fixed wages (with due diligence and in the comparison with due diligence lower by one percentage point along the simulation horizon). Appendix Figure 11 shows the IRFs in the baseline model and in the model with fixed wages and due diligence. As noted in the main text, in the fixed wage economy the output drop is somewhat smaller than in the baseline following bond value shocks, while it is slightly larger following regulatory shocks.



Appendix Figure 10 - Responses of the model with fixed wages for different shocks.



Appendix Figure 11 - Comparison between the responses of the model with flexible wages (baseline) vs. the model with fixed wages for different shocks.

Supplementary references

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