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Financial and Production Integration in the Macroeconomy*

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Abstract

This paper studies how integration between the financial sector and production networks shapes business cycle transmission. We develop a dynamic model in which banks provide asset-based financing to firms embedded in supply chains. The model highlights two margins of bank–supply chain integration with opposite macroeconomic implications. Extensive-margin integration—captured by firms' access to banks specializing in different supply chain segments—amplifies negative banking shocks. By contrast, intensive-margin integration—captured by the diffusion of factoring and invoice discounting—attenuates banking disruptions. The model reveals that the stabilizing effects of integration dominate when firm production linkages are tight. The predictions are consistent with matched bank–firm data from Italy.

Keywords: Banks, Financial integration, Production networks, Factoring

JEL Classification Codes: E23, E32, E44

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1 Introduction

In recent decades, there has been a dramatic intensification in firm production and commercial linkages, with supply chains becoming longer and more ramified. These changes in the production structure have been accompanied by transformations in the financing of firms. Banks have increasingly tailored products and services to the needs of supply chain operations, leading to the diffusion of supply chain finance.[1] Appendix Figure B.1 shows the increase in factoring and invoice discounting in nine advanced economies over the 2005-2024 period. In 2024, the total value of factoring and invoice discounting reached 13.6 percent of GDP in Italy, 14.8 percent of GDP in France, 16.7 percent in Spain, 11.2 percent in the United Kingdom, and 9.3 percent in Germany, for instance. In parallel with the integration between banks and supply chains along this "intensive" margin through the provision of supply chain finance, the banking sector has also become more ramified, expanding its connections with firms beyond traditional areas of specialization. Facilitated by financial deregulation, banks have extended their lending activities to new industries, regions, and hence supply chain segments, representing an "extensive margin" of integration.

Despite the importance of these structural transformations, their macroeconomic implications remain insufficiently examined. The recurrent exposure of production and financial networks to systemic shocks[2] elicits questions on how the links between the banking sector and supply chains can influence macroeconomic stability. Does the increased integration between banks and supply chains strengthen or weaken resilience to aggregate shocks? Do the intensive and extensive margins of integration have the same impact on macroeconomic stability?

To address these fundamental questions, we develop a Dynamic Stochastic General Equilibrium model with banks and supply chains and test the consistency of its predictions with granular evidence from Italy. The core feature of our economy consists of the role of asset-based finance and the influence of bank-supply chain integration on the efficiency of asset-based funding. The model incorporates a vertical supply chain in which three types of firms—specifically, upstream, midstream, and downstream—sell intermediate inputs to each other and borrow from banks through bank loans and from suppliers through trade credit. When taking out bank loans, firms can pledge capital assets and trade credit invoices (accounts receivable) as collateral.[3] In addition to borrowing, firms can sell accounts receivable to banks. Thus, banks engage in invoice discounting and factoring. While factoring entails extra fees charged by banks, it enhances banks' experience with trade credit

[1] See, e.g., Blount (2008); Mathis and Cavinato (2010); FCI (2025).

[2] The 2020-2021 coronavirus pandemic disrupted supply chains. During the Great Recession, the aggregate shock originated in the financial sector.

[3] In the model, trade credit is backed by intermediate inputs purchased from suppliers.

suppliers and customers, making the discounting of invoices more efficient. When borrowing from banks, firms choose the shares of capital to pledge to banks specialized in the firms' own supply chain segment ("sector" banks) and to banks specialized in other supply chain segments ("non-sector" banks). In this setting, bank-supply chain integration occurs via changes in banks' ability to manage and liquidate firms' capital assets and accounts receivable and, hence, to offer asset-based funding.

We calibrate the model to data from Italy and then perturb the economy with negative banking shocks that reduce the supply of loans. We find that bank-supply chain integration along the extensive margin, in the form of greater ability to pledge capital assets to non-sector banks, amplifies the impact of banking shocks. In contrast, integration along the intensive margin, in the form of greater ability to pledge and factor invoices, can mitigate the transmission of shocks. The intuition revolves around the influence of the two dimensions of integration on banks' ability to provide asset-based funding. Both forms of integration enhance the pledgeability of one type of collateral asset by strengthening banks' skills in managing and liquidating collateral. In the extensive-margin case, the affected pledgeable assets primarily constitute the collateral of borrowers of funds (loan takers). Integration along the extensive margin, in particular, enhances the pledgeability of capital assets to banks specializing in different supply chain segments. Following a banking shock, the extensive-margin integration exacerbates the sensitivity of firms' demand for collateralizable capital to the loosening in borrowing constraints due to the reduced appetite for the costlier loans, amplifying the contraction of firms' capital investment and production. In contrast, in the intensive-margin case the affected pledgeable assets primarily constitute the collateral of lenders of funds (trade credit suppliers). Integration along the intensive margin, in particular, enhances the pledgeability of trade credit invoices through easier invoice discounting and factoring. When a banking shock hits downstream firms, the intensive-margin integration heightens the sensitivity of trade credit supply to the tightening of suppliers' borrowing constraints, incentivizing suppliers' extension of trade credit to downstream firms hit by the shock. The shock-hit firms, in turn, economize on this additional liquidity, curtailing their trade credit supply. The resulting increase in the net trade credit received by shock-hit firms enhances the resilience of their investment and production both directly and indirectly by encouraging the extension of bank loans (due to the stronger resilience of their investment in collateralizable capital). In further analysis, we find that these stabilizing effects of intensive-margin integration are more pronounced when firms' commercial links are stronger. Intuitively, a larger volume of inter-firm transactions expands the base of collateralizable invoices from which intensive-margin integration unlocks liquidity.

To better comprehend the strength of the contrasting effects of integration, we evaluate quantitatively the impact on aggregate volatility of the bank-supply chain integration process that occurred in Italy during the 2010-2024 period. Since the early 2000s, bank-mediated supply chain finance, including factoring, has gained prominence. Concurrently, the Italian banking sector has undergone significant deregulation, leading to enhanced geographic and sectoral integration. These developments have induced banks to expand their financing to new regions, industries, and supply chain segments. We discipline the transition from the beginning-of-the-period scenario in 2010 to the end-of-the-period scenario in 2024 with empirical targets constructed from our Italian data, capturing the structural shift toward a stronger integration between banks and supply chains.[4] We then feed the model with shocks to bank net worth estimated from bank balance-sheet data. The quantitative analysis predicts that, as a result of the integration process, the theoretical variances of aggregate output and total (bank and trade) credit would decrease by 5.70 percent and 4.73 percent, respectively, suggesting that overall the shift toward stronger bank-supply chain integration mitigated aggregate fluctuations. Moreover, stronger commercial links would have further enhanced the stabilizing contribution of intensive-margin integration: the model predicts that with a 4-percentage-point higher ratio of gross trade credit over assets (20 percent higher than the ratio was in 2010), the variance of output would have dropped by 8.39 percent, rather than by 5.70 percent, following the integration process during 2010-2024.

We verify the consistency of the model mechanisms with evidence from Italy. Our primary source of information is a large-scale survey of Italian firms, the MET survey, which covers approximately 37,000 firms in nine waves over the period 2006-2022. The survey provides details on firms' participation in supply chains and use of trade credit, and on the lending banks of the firms, allowing us to match firm-level information with information on lending banks, including banks' engagement in supply chain finance. As noted, the integration between banks and supply chains along the intensive and extensive margins makes Italy an ideal context in which to study how the integration between the banking sector and the production structure influences the transmission of shocks. Moreover, asset-based finance and collateralized borrowing constitute key aspects of the financing of Italian firms, predominantly comprised of small- and medium-sized firms.[5] We estimate the impact of an exogenous banking shock driven by the crisis of Monte dei Paschi (MPS), a major bank, that occurred around 2013. In line with the predictions of our model, the empirical results indicate a stabilizing influence of bank-supply chain integration along the intensive margin but a

[4] In particular, to capture the 2024 economy, we adjust key model parameters to match end-of-period targets while keeping other deep parameters constant.

[5] Degryse et al. (2025) document that secured lending accounts for about 70 percent of total credit in the euro area. Italy exhibits a similar reliance on collateralized lending, consistent with its bank-based financial system.

destabilizing influence of bank-supply chain integration along the extensive margin. Moreover, as predicted by our model, the stabilizing effect of intensive-margin integration occurs through a more countercyclical supply of trade credit by upstream firms to shock-hit firms when factoring and invoice discounting are used more intensely. These empirical results confirm the importance of the integration between the banking sector and the production structure in shaping the transmission of shocks.

Related literature The paper is related to several strands of the literature. The first strand studies the propagation of shocks in production networks. The importance of input-output linkages is at the core of the analyses of Acemoglu et al. (2016) and Barrot and Sauvagnat (2016), who examine how aggregate demand and supply shocks and firm-level idiosyncratic shocks propagate through production networks. Bigio and La'o (2020); Luo (2020) explore the propagation of financial shocks in production networks through bank credit or trade credit using static models. In our setting, we focus on the role of the integration between banks and production networks in the transmission of shocks, rather than on the integration among firms through production or trade credit links. We investigate different dimensions of bank-supply chain integration, uncover sharp asymmetries in their impact on macroeconomic stability, and quantify their relative strength in a dynamic general equilibrium setting.

The second strand of the literature examines the impact of financial integration on macroeconomic stability. Allen and Gale (2000); Castiglionesi and Eboli (2018) study how the structure of the banking network can either moderate or amplify shocks. Castiglionesi and Wagner (2013) investigate how interbank insurance through transfers can be socially efficient, while Castiglionesi et al. (2019) find that financial integration through interbank borrowing and lending can relieve local liquidity shocks. De Haas and Van Lelyveld (2010), Cetorelli and Goldberg (2012), and Cao et al. (2021) show that complex banks can operate internal capital markets and help withstand financial shocks. Our paper expands the analysis of financial integration to the interconnections between banks and supply chains. In doing so, we bridge the gap between micro-oriented studies in supply chain finance and the broad literature on the impact of banks on macroeconomic stability.

Finally, this paper also speaks to the literature on the interaction between bank credit and trade credit. Biais and Gollier (1997) and Burkart and Ellingsen (2004) show theoretically that trade credit can substitute for bank credit. Petersen and Rajan (1997) and Nilsen (2002) document evidence of a redistribution from bank credit to trade credit between firms. On the other hand, Love et al. (2007) and Love and Zaidi (2010) contend that there is no clear substitutability between bank credit and trade credit following financial shocks. The interaction between these two types of credit in aggregate dynamic contexts remains underexplored. This paper investigates the link between trade credit and bank credit associated with the various forms of supply chain finance, including factoring and invoice financing, and the implications for the role of supply chain finance in the transmission of aggregate shocks.

The remainder of the paper unfolds as follows. In Section 2, we describe the data that inform our calibration and empirical tests. Section 3 lays out the model. Section 4 presents the main results. Section 5 tests salient predictions of the model using the Italian data. Section 6 concludes. Additional details on model and data and further results are relegated to the Online Appendix.

2 Data and Empirical Setting

Our analysis combines several sources of firm-level and bank-level data from Italy. Small and medium-sized firms play a major role in the Italian business sector: small firms with 10 or fewer employees account for over 95 percent of businesses, and approximately 47 percent of total value added and 63 percent of employment (as of 2019). Smaller firms have limited access to bond and equity markets and, hence, are more vulnerable to banking shocks. In addition, as we elaborate below, small and medium-sized Italian firms are strongly integrated in supply chains.

2.1 Data sources

Our primary data source is the MET survey of Italian firms. The MET survey includes firms of all size classes and is fully representative along three dimensions: size (four size classes), location (20 NUTS-2 regions), and industry.[6] We use data from the 2008, 2009, 2011, 2013, 2015, 2017, 2019, 2021, and 2023 survey waves, each comprising approximately 24,000 firm-level observations and a substantial share of panel respondents. In each wave, firms provide details on their lender banks and on the duration of each bank-firm relationship. The survey also collects rich information on firm characteristics, including their supply chain links. We match the MET survey with the business register FrameSBS (Structural Business Statistics) of the Italian National Institute of Statistics (ISTAT), which contains yearly data on the sales, employees, age, industry, and location (at the NUTS-3 level) of the universe of Italian firms (excluding finance and public administration). We also complement the MET survey with balance-sheet data from the AIDA Bureau van Dijk database, which covers the universe of incorporated Italian firms. AIDA provides information on

[6] The MET survey covers firms in the manufacturing sector (60 percent of the sample) and the production-service sector (40 percent), stratified into 12 macro-sectors according to the NACE Rev. 2 classification.

investment, trade credit (accounts payable and receivable) and firm geolocation.

Finally, we complement the firm-level information with hand-collected data from banks' balance sheets on supply chain finance and other indicators of banks' operations with supply chains.

2.2 Supply chains and bank-supply chain integration

The sample with the most comprehensive set of variables comprises yearly data on about 37,000 firms over the period 2006-2022, with roughly 320,000 firm-year observations. The descriptives in Appendix Table B.1 confirm that our sample predominantly consists of medium-sized and small firms. The median firm has 15 workers and annual sales of 2 million euros, and is 23 years old.

Supply chain participation We construct an indicator of supply chain participation using data from the MET survey. This binary variable equals one if a firm reports having long-term and quantitatively relevant commercial relationships with other firms for the purchase or sale of semifinished goods or product components. This captures a stable and economically meaningful form of engagement in supply chains and is based on a taxonomy consistent with international standards. World Bank (2016) emphasizes the role of long-term commercial ties as a defining characteristic of supply chains, while Cafaggi and Iamiceli (2007) provide examples of such arrangements in the Italian context. The Italian National Institute of Statistics defines long-term chain relationships as stable commercial ties involving the sale or purchase of semifinished products or components.

In our sample, 34 percent of the firms engage in supply chain relationships. This significant supply chain participation is aligned with official estimates from ISTAT, which in its periodic analysis of Italian firms reports that approximately 35 percent of manufacturing firms with more than three employees engaged in stable supply chain linkages between 2011 and 2018. Supply chain participation is particularly common in sectors such as transportation and automotive, plastics, and chemicals.

Bank-supply chain integration Our data set includes firms borrowing from more than 175 banks.[7] Even when banks operate on a national scale, Italian banks' lending is unevenly distributed across regions and production segments. For instance, larger banks (e.g., Intesa Sanpaolo, UniCredit or MPS) operate across the country, yet their loan portfolios remain more concentrated in specific areas and industries. Around 15 percent of the sample firms borrow from cooperative banks. These banks have traditionally been tied to local markets and specialized in funding specific sectors and

[7] About 65 percent of the firms borrow from one bank, 21 percent from two, and 14 percent from three or more. Using data on the universe of Italian firms over the period 2008–2016, Bonaccorsi Di Patti et al. (2019) report analogous shares.

supply chain segments, such as agriculture, artisanal manufacturing, and small-scale services. As a result of these patterns, bank-firm relationships reflect a combination of sectoral specialization and geographic reach, including across upstream, midstream, and downstream supply chain segments.

In recent decades, Italy has experienced a significant process of integration between banks and supply chains along the intensive margin (banks' provision of supply chain finance). In the early 2020s, the Italian market for factoring and invoice discounting recorded a turnover of about €290 billion (above 13 percent of GDP), one of Europe's largest, and more than double the turnover in 2010 (Assifact, 2021).[8] This growth has largely reflected improvements in banks' ability to verify receivables and enforce their repayment. For example, the diffusion of credit registries has improved asset traceability, expanding banks' supply of receivables-based credit (FCI, 2025).

Since the late 1990s, the Italian banking sector has also experienced geographic and sectoral integration. Banks' geographic expansion translated into an expansion to new supply chain segments (extensive-margin integration) because Italian provinces are characterized by strong industrial specialization (Cafaggi and Iamiceli, 2007). As a result, a bank that expands its branch network across provinces necessarily extends credit to firms in supply chain segments different from its traditional stronghold. For instance, cooperative banks in the Veneto region (e.g. Cassa di Risparmio di Vicenza) initially concentrated over 70 percent of loans in the textile and footwear firms of the Vicenza province, but by the late 2000s they had expanded into Treviso and Verona, where they financed leather and light mechanical industries tied to the regional fashion cluster. Similarly, banks rooted in Emilia Romagna, including Banca Popolare dell'Emilia Romagna, moved from a strong specialization in Modena's mechanical district (more than 60 percent of their credit in the mid-1990s) toward Bologna and Reggio Emilia, extending credit to packaging and agri-food companies that rely on mechanical equipment. In the South, Banca Popolare di Bari, once highly concentrated in the agricultural firms of Bari province, increased its exposure to enterprises in Foggia and Taranto engaged in food processing and logistics, following the downstream stages of the agro-food value chain.

3 The Model

We consider an infinite-horizon economy in discrete time (see Figure 1 for an illustration). The economy is populated by infinitely lived households, firms, and banks. Households consume the final good, supply labor, and deposit savings in banks. The production structure consists of a vertical supply chain composed of three types of firms—upstream, midstream, and downstream.

[8] Small and medium-sized enterprises make up 63 percent of the users of these forms of financing.

Firms use capital, labor, and intermediate inputs to produce. A final good producer combines firms' outputs to produce the final good (the numeraire) used for consumption and capital investment.

Firms can borrow from banks and from intermediate input suppliers. Due to imperfect contract enforceability, loans from banks and trade credit from suppliers are collateralized by firms' assets. In particular, firms can pledge intermediate inputs as collateral for trade credit and capital and trade credit invoices (accounts receivable) as collateral for bank loans. In addition to granting loans, banks can engage in factoring, purchasing accounts receivable from firms.

3.1 Households

Building on the framework of Gertler and Karadi (2011), the representative household comprises two types of agents: a fraction b are bankers and the remaining $1-b$ are workers. Workers supply labor, while bankers operate financial intermediaries. In each period, individuals may switch roles with some exogenous probability. With probability σ, bankers continue their role in the following period, implying an expected survival time of bankers of $\frac{1}{1-\sigma}$ periods. In turn, a measure $(1-\sigma)b$ of workers is randomly reassigned as bankers, implying a stationary composition of the household. This turnover is to prevent banks from accumulating enough wealth, which would eventually make their financial (capital) constraints not binding. Exiting bankers transfer their net worth to households, except for a small fraction ι which is allocated as initial capital to entering bankers.

Households' preferences follow Greenwood et al. (1988). Their problem is

$$\max_{\{C_{t+j},L_{t+j},D_{t+j}\}_{j\geq 0}} E_t \sum_{j=0}^{\infty} \beta^j \frac{1}{1-\omega} \left[\left(C_{t+j} - k_c \frac{L_{t+j}^{1+\eta}}{1+\eta} \right)^{1-\omega} - 1 \right], \tag{1}$$

where C_t denotes consumption and L_t is the labor supply. β is the household's discount factor, ω governs the household's risk aversion, η is the inverse Frisch elasticity of labor supply, while k_c governs the relative utility weight of labor. The household's budget constraint reads

$$C_t + D_t = W_t L_t + \Pi_t + R_{t-1} D_{t-1}, \tag{2}$$

where W_t is the wage rate, D_t denotes households' deposits, and R_{t-1} is the gross deposit rate. Π_t captures the net transfer from bankers to households, defined as the difference between the dividends remitted by exiting bankers and the startup capital allocated to entering bankers.[9]

[9] We present most optimizing conditions of households, banks, and firms in the Appendix.

3.2 Banks

There are three representative banks—upstream (u), midstream (m), and downstream (d)—each partially specialized in financing a segment of the supply chain. The degree to which banks can fund firms not belonging to their corresponding supply chain segment (sector) will capture the extensive-margin integration between banks and supply chains. As noted, in recent decades banks have extended their financing to supply chain segments beyond their traditional areas of specialization.

Banks gather household deposits and leverage their own net worth, denoted by N_t^i, where $i \in \{u, m, d\}$, to extend loans to firms. While their primary lending relationships are with firms within their respective sectors, they are also capable of lending to firms in other supply chain segments. In addition to granting loans, banks can also purchase factored trade credit invoices originating within their own sector. Thus, we incorporate the notion that banks are specialized in evaluating the intermediate inputs that back trade credit invoices within their sector.

3.2.1 Upstream banks

The representative upstream bank chooses its lending to upstream firms (X_t^{uu}), midstream firms (X_t^{um}), and downstream firms (X_t^{ud}), as well as the volume of household deposits it gathers (D_t^u). It maximizes the expected present value of future transfers to households

$$V_t^u \equiv \max_{\{X_{t+j}^{uu}, X_{t+j}^{um}, X_{t+j}^{ud}, D_{t+j}^u\}_{j\geq 0}} E_t \sum_{j=0}^{\infty} (1-\sigma)\sigma^j \Lambda_{t,t+j+1} N_{t+j+1}^u, \tag{3}$$

where $\Lambda_{t,t+j+1}$ is the household's stochastic discount factor. The upstream bank can also purchase factored invoices from upstream firms. We denote by f^u the fraction of trade credit from upstream to midstream firms, valued at $f^u V_t^m$, that is factored. The upstream bank is repaid $pf^u R_t^{vm} V_t^m$ in the following period, where R_t^{vm} is the gross trade credit rate and $p-1$ is the factoring premium.[10]

The upstream bank's resource constraint equates the use of funds—comprising loans and factored invoices—with the sum of its net worth N_t^u and household deposits D_t^u:

$$X_t^{uu} + X_t^{um} + X_t^{ud} + f^u V_t^m + \sum_{j\in\{m,d\}} \frac{k^b}{2}(X_t^{uj} - \overline{X_t^{uj}})^2 = N_t^u + D_t^u \qquad [\lambda_t^u]. \tag{4}$$

The upstream bank incurs a small quadratic adjustment cost when lending to non-sector firms, governed by the parameter k^b.

Because of regulatory or market requirements, the bank faces a capital constraint that limits its liabilities to a fraction ξ of its assets. These include loans to upstream, midstream, and downstream

[10]The premium could also be specified as an extra discount on the trade credit that upstream firms factor.

firms, at gross loan rates R_t^{uu}, R_t^{um}, and R_t^{ud} respectively, and factored invoices at R_t^{vm}[11]

$$R_t D_t^u \leq \xi \left(R_t^{uu} X_t^{uu} + R_t^{um} X_t^{um} + R_t^{ud} X_t^{ud} + h f^u R_t^{vm} V_t^m \right) \qquad [\mu_t^u]. \tag{5}$$

The upstream bank's net worth, N_{t+1}^u, is defined as the difference between total receivables from all firms—including factored trade credit—and gross deposit repayment obligations:

$$N_{t+1}^u = R_t^{uu} X_t^{uu} + R_t^{um} X_t^{um} + R_t^{ud} X_t^{ud} + p f^u R_t^{vm} V_t^m - R_t D_t^u. \tag{6}$$

3.2.2 Midstream and downstream banks

The midstream and downstream banks face a problem analogous to that of the upstream bank. The midstream bank takes deposits and grants loans to upstream (X_t^{mu}), midstream (X_t^{mm}), and downstream firms (X_t^{md}). It also purchases trade credit invoices $f^m V_t^d$ from midstream firms (with the profit margin $p-1$). The bank maximizes the expected discounted value of transfers to households:

$$V_t^m \equiv \max_{\{X_{t+j}^{mu}, X_{t+j}^{mm}, X_{t+j}^{md}, D_{t+j}^m\}_{j \geq 0}} E_t \sum_{j=0}^{\infty} (1-\sigma)\sigma^j \Lambda_{t,t+j+1} N_{t+j+1}^m \tag{7}$$

$$\text{s.t.} \quad X_t^{mu} + X_t^{mm} + X_t^{md} + f^m V_t^d + \sum_{j \in \{u,d\}} \frac{k^b}{2} (X_t^{mj} - \overline{X_t^{mj}})^2 = N_t^m + D_t^m \qquad [\lambda_t^m], \tag{8}$$

$$R_t D_t^m \leq \xi \left(R_t^{mu} X_t^{mu} + R_t^{mm} X_t^{mm} + R_t^{md} X_t^{md} + h f^m R_t^{vd} V_t^d \right) \qquad [\mu_t^m]. \tag{9}$$

The downstream bank chooses its lending to firms and deposit-taking from households. It does not hold trade credit assets, as downstream firms do not extend trade credit:

$$V_t^d \equiv \max_{\{X_{t+j}^{du}, X_{t+j}^{dm}, X_{t+j}^{dd}, D_{t+j}^d\}_{j \geq 0}} E_t \sum_{j=0}^{\infty} (1-\sigma)\sigma^j \Lambda_{t,t+j+1} N_{t+j+1}^d, \tag{10}$$

$$\text{s.t.} \quad X_t^{du} + X_t^{dm} + X_t^{dd} + \sum_{j \in \{u,m\}} \frac{k^b}{2} (X_t^{dj} - \overline{X_t^{dj}})^2 = N_t^d + D_t^d \qquad [\lambda_t^d], \tag{11}$$

$$R_t D_t^d \leq \xi \left(R_t^{du} X_t^{du} + R_t^{dm} X_t^{dm} + R_t^{dd} X_t^{dd} \right) \qquad [\mu_t^d]. \tag{12}$$

3.3 Firms

Firms are owned and operated by entrepreneurs with utility function

$$E_t \sum_{j=0}^{\infty} \beta_f^j \frac{(C_{t+j}^r)^{1-\theta} - 1}{1-\theta}, \tag{13}$$

[11] The parameter h can capture the treatment of factored trade credit in regulatory-based or market-based bank capital requirements. The extra factoring profits of upstream banks are not included in their capital constraints, as they are not typically classified as bank assets. We will come back to this point in the robustness analysis.

with $r \in \{u, m, d\}$. The discount factor satisfies $\beta_f < \beta$; that is, entrepreneurs are less patient than households. This is necessary for firms to be willing to borrow from banks around the steady state. θ governs the entrepreneurs' risk aversion.

Final producers aggregate the outputs of firms in the supply chain to produce the final good.

3.3.1 Upstream firms

The production flow of the supply chain starts from upstream firms. An upstream firm uses capital K^u_{t-1} and labor L^u_t to produce its output Y^u_t. Its production technology is

$$Y^u_t = z(K^u_{t-1})^{\alpha}(L^u_t)^{1-\alpha}, \tag{14}$$

where z denotes total factor productivity (TFP), and $0 < \alpha < 1$. The output of upstream firms is sold to midstream firms as intermediate goods and to the producers of the final good.

Upstream firms can obtain funds from upstream banks, which specialize in serving their sector, and also from banks specialized in other segments of the supply chain. In turn, they can extend trade credit to midstream firms. The upstream firm's budget constraint reads:

$$\begin{aligned} &C^u_t + K^u_t + R^{uu}_{t-1}X^{uu}_{t-1} + R^{mu}_{t-1}X^{mu}_{t-1} + R^{du}_{t-1}X^{du}_{t-1} + (1-f^u)V^m_t \\ &\quad = X^{uu}_t + X^{mu}_t + X^{du}_t + (1-\delta)K^u_{t-1} + (1-pf^u)R^{vm}_{t-1}V^m_{t-1} - W_tL^u_t + P^u_tY^u_t, \end{aligned} \tag{15}$$

where X^{uu}_t, X^{mu}_t, and X^{du}_t are the loans from upstream, midstream, and downstream banks, respectively. P^u_t is the price of the upstream good Y^u_t. Trade credit extended to midstream firms is represented by V^m_t. By factoring a fraction f^u of its accounts receivable, the upstream firm obtains $f^uV^m_t$ in exchange for the obligation to repay $pf^uR^{vm}_tV^m_t$.

The upstream firm must pledge collateral when borrowing from banks, in line, e.g., with Kiyotaki and Moore (1997). It can pledge capital to obtain loans from banks. In addition, it can borrow from its own sector banks by pledging non-factored accounts receivable (that is, by discounting invoices). Formally, the upstream firm faces the collateral constraints

$$R^{mu}_tX^{mu}_t + R^{du}_tX^{du}_t \le \kappa^n(1-S^u_t)K^u_t \qquad [\psi^{nu}_t], \tag{16}$$

$$R^{uu}_tX^{uu}_t \le \kappa S^u_tK^u_t\left(1 - \frac{cS^u_tK^u_t}{2\overline{K^u}}\right) + (1-f^u)\Omega(f^u)R^{vm}_tV^m_t \qquad [\psi^{uu}_t], \tag{17}$$

where $S^u_t \in [0,1]$ is the share of capital pledged to the upstream bank and $(1 - S^u_t)$ is the share pledged to non-sector banks. Since the upstream bank specializes in the upstream sector, pledging capital to the upstream bank is relatively easier ($\kappa > \kappa^n$). However, it encounters diseconomies of scale, so that the upstream firm can choose to partially resort to non-sector banks.[12] The parameter

[12]The intensity of these diseconomies of scale is governed by the parameter c.

κ^n will govern bank-supply chain integration along the extensive margin, capturing banks' ability to manage collateralized capital in supply chain segments outside their sector of specialization. The term $\Omega(f^u)$ captures the pledgeability of non-factored accounts receivable and will govern the integration between banks and supply chains along the intensive margin, as determined by banks' ability to manage collateralized invoices. The term $\Omega(f^u)$ depends on the fraction f^u of accounts receivable that is factored and sold to the upstream bank, as we will elaborate below.

Upstream firms maximize their utility in (13) by choosing consumption C_t^u, labor demand L_t^u, capital K_t^u, bank loans X_t^{uu}, X_t^{mu} and X_t^{du}, trade credit extended to midstream firms V_t^m, and the fraction of capital pledged to sector (upstream) banks S_t^u, subject to the budget constraint (15) and the collateral constraints (16) and (17). Their first-order conditions read

$$[\partial L_t^u] : P_t^u(1-\alpha)\frac{Y_t^u}{L_t^u} - W_t = 0 \tag{18}$$

$$[\partial K_t^u] : -(C_t^u)^{-\theta} + \psi_t^{nu}\kappa^n(1-S_t^u) + \psi_t^{uu}\left[\kappa S_t^u - \frac{\kappa c (S_t^u)^2 K_t^u}{\overline{K^u}}\right] + \beta_f E_t(C_{t+1}^u)^{-\theta}(P_{t+1}^u \alpha \frac{Y_{t+1}^u}{K_t^u} + 1 - \delta) = 0 \tag{19}$$

$$[\partial X_t^{uu}] : (C_t^u)^{-\theta} - \psi_t^{uu}R_t^{uu} - \beta_f E_t(C_{t+1}^u)^{-\theta}R_t^{uu} = 0 \tag{20}$$

$$[\partial X_t^{mu}] : (C_t^u)^{-\theta} - \psi_t^{nu}R_t^{mu} - \beta_f E_t(C_{t+1}^u)^{-\theta}R_t^{mu} = 0 \tag{21}$$

$$[\partial X_t^{du}] : (C_t^u)^{-\theta} - \psi_t^{nu}R_t^{du} - \beta_f E_t(C_{t+1}^u)^{-\theta}R_t^{du} = 0 \tag{22}$$

$$[\partial V_t^m] : (C_t^u)^{-\theta}\left[-(1-f^u)\right] + \psi_t^{uu}(1-f^u)\Omega(f^u)R_t^{vm} + \beta_f E_t(C_{t+1}^u)^{-\theta}(1-pf^u)R_t^{vm} = 0 \tag{23}$$

$$[\partial S_t^u] : -\psi_t^{nu}\kappa^n K_t^u + \psi_t^{uu}\kappa K_t^u\left(1 - \frac{c S_t^u K_t^u}{\overline{K^u}}\right) = 0 \tag{24}$$

Consider the demand for capital in (19). When investing in capital, upstream firms take into account not only its productivity but also its marginal value as collateral in relaxing borrowing constraints vis-a-vis sector (upstream) banks and non-sector banks. In a similar fashion, when deciding how much trade credit to supply (see (23)), upstream firms take into account not only the expected gross interests but also the marginal value of accounts receivable as collateral in relaxing borrowing constraints vis-a-vis sector banks. This marginal value is increasing in the Lagrangian multiplier ψ^{uu} and in the pledgeability $\Omega(f^u)$ of non-factored accounts receivable.

Finally, when choosing how to allocate collateralizable capital (see (24)), upstream firms equalize the marginal value of capital as collateral between sector and non-sector banks.

3.3.2 Midstream firms

Midstream firms use capital K_t^m, labor L_t^m and upstream firms' output Y_t^{iu} as inputs:[13]

$$Y_t^m = z({K_{t-1}^m}^{\alpha} {L_t^m}^{1-\alpha})^{1-\phi}(Y_t^{iu})^{\phi}. \tag{25}$$

Their output is sold to downstream firms and to final producers. Midstream firms can obtain loans X_t^{um}, X_t^{mm}, and X_t^{dm} from upstream, midstream, and downstream banks, respectively, and trade credit V_t^m from upstream firms. They can also supply trade credit V_t^d to downstream firms, a portion of which can be factored to midstream banks. Their budget constraint reads

$$\begin{aligned}
&C_t^m + K_t^m + R_{t-1}^{um}X_{t-1}^{um} + R_{t-1}^{mm}X_{t-1}^{mm} + R_{t-1}^{dm}X_{t-1}^{dm} + R_{t-1}^{v,m}V_{t-1}^m + (1-f^m)V_t^d = \\
&X_t^{um} + X_t^{mm} + X_t^{dm} + V_t^m + (1-pf^m)R_{t-1}^{vd}V_{t-1}^d + (1-\delta)K_{t-1}^m + P_t^m Y_t^m - W_t L_t^m - P_t^u Y_t^{iu},
\end{aligned} \tag{26}$$

where P_t^m is the price of their product. Midstream firms face the following borrowing constraints:

$$R_t^{um}X_t^{um} + R_t^{dm}X_t^{dm} \leq \kappa^n(1-S_t^m)K_t^m \qquad [\psi_t^{nm}], \tag{27}$$

$$R_t^{mm}X_t^{mm} \leq \kappa S_t^m K_t^m \left(1 - \frac{cS_t^m K_t^m}{2\overline{K^m}}\right) + (1-f^m)\Omega(f^m)R_t^{vd}V_t^d \qquad [\psi_t^{mm}], \tag{28}$$

$$R_t^{vm}V_t^m \leq \nu P_t^u Y_t^{iu} \qquad [\chi_t^m]. \tag{29}$$

The interpretation of the constraints (27) and (28) is analogous to that of upstream firms. Equation (29) is the borrowing constraint for trade credit: due to imperfect enforcement, midstream firms need to pledge a fraction ν of the intermediate inputs purchased from upstream firms as collateral.

Midstream firms maximize the entrepreneurs' utility (13), subject to the constraints (26)-(29). It is useful to report here the first-order conditions for their supply and demand of trade credit:

$$[\partial V_t^d] : (C_t^m)^{-\theta}\left[-(1-f^m)\right] + \psi_t^{mm}(1-f^m)\Omega(f^m)R_t^{vd} + \beta_f E_t(C_{t+1}^m)^{-\theta}(1-pf^m)R_t^{vd} = 0, \tag{30}$$

$$[\partial V_t^m] : (C_t^m)^{-\theta} - \chi_t^m R_t^{vm} - \beta_f E_t(C_{t+1}^m)^{-\theta}R_t^{vm} = 0. \tag{31}$$

The intuition for the trade credit supply in (30) is analogous to that of upstream firms. As for the demand in (31), midstream firms weigh the benefit of borrowing from suppliers against the costs of repaying trade credit and of tightening their trade credit constraint (with multiplier χ). Equations (30) and (31) imply that under certain parameterizations, midstream firms act as intermediaries of liquidity (simultaneously demanding and supplying trade credit) even when trade credit rates are equal along the chain. This is largely because trade credit can be pledged as collateral to sector banks (that is, invoices can be discounted). The Appendix provides a proof.

[13] As noted, a portion of the output Y_t^u of upstream firms, denoted Y_t^{fu}, is used directly in final good production, while the remainder, Y_t^{iu}, is used as intermediate inputs by midstream firms.

3.3.3 Downstream firms

Downstream firms use capital K_t^d, labor L_t^d, and midstream firms' output Y_t^{im} as inputs:[14]

$$Y_t^d = z({K_{t-1}^d}^{\alpha} {L_t^d}^{1-\alpha})^{1-\phi}(Y_t^{im})^{\phi}. \tag{32}$$

Their entire output Y_t^d is sold to the producers of the final good. In addition to taking loans from downstream banks (X_t^{dd}) and non-sector banks (X_t^{ud}, X_t^{md}), downstream firms can also receive trade credit from midstream firms (V_t^d). Their budget constraint is

$$C_t^d + K_t^d + R_{t-1}^{ud}X_{t-1}^{ud} + R_{t-1}^{md}X_{t-1}^{md} + R_{t-1}^{dd}X_{t-1}^{dd} + R_{t-1}^{vd}V_{t-1}^d = \\ X_t^{ud} + X_t^{md} + X_t^{dd} + V_t^d + (1-\delta)K_{t-1}^d + P_t^d Y_t^d - W_t L_t^d - P_t^m Y_t^{im}. \tag{33}$$

P_t^d is the price of the downstream firms' good. Downstream firms face financing constraints when borrowing from banks and midstream firms analogous to those discussed above:

$$R_t^{ud}X_t^{ud} + R_t^{md}X_t^{md} \leq \kappa^n(1-S_t^d)K_t^d \qquad [\psi_t^{nd}], \tag{34}$$

$$R_t^{dd}X_t^{dd} \leq \kappa S_t^d K_t^d \left(1 - \frac{cS_t^d K_t^d}{2\overline{K^d}}\right) \qquad [\psi_t^{dd}], \tag{35}$$

$$R_t^{vd}V_t^d \leq \nu P_t^m Y_t^{im} \qquad [\chi_t^d]. \tag{36}$$

3.3.4 Final good producers

A final producer uses a CES technology to aggregate the products of the firms in the supply chain and produce the final good Y_t. This is consumed by households and entrepreneurs and used for making capital investment. The problem of the final producer reads:

$$\max_{\{Y_t^{fu}, Y_t^{fm}, Y_t^d\}} Y_t - P_t^u Y_t^{fu} - P_t^m Y_t^{fm} - P_t^d Y_t^d \tag{37}$$

$$s.t. \quad Y_t = \left[\alpha_u (Y_t^{fu})^{\epsilon} + \alpha_m (Y_t^{fm})^{\epsilon} + (1-\alpha_u-\alpha_m)(Y_t^d)^{\epsilon}\right]^{\frac{1}{\epsilon}}, \tag{38}$$

where α_u and α_m are parameters between 0 and 1.

3.4 Equilibrium

In equilibrium, the total supply of household labor (L_t) equals the aggregate of labor employed by the upstream (L_t^u), midstream (L_t^m), and downstream (L_t^d) firms:

$$L_t = L_t^u + L_t^m + L_t^d. \tag{39}$$

[14] Midstream firms' output is sold to downstream firms and to final good producers ($Y_t^m = Y_t^{im} + Y_t^{fm}$).

The net worth evolution for the upstream and downstream banking sectors is

$$N_{t+1}^{u} = \sigma\left(\sum_{j\in\{u,m,d\}} R_t^{uj}X_t^{uj} + pf^u R_t^{vm}V_t^m - R_tD_t^u\right) + \iota\left(\sum_{j\in\{u,m,d\}} R_t^{uj}X_t^{uj} + pf^u R_t^{vm}V_t^m\right) + \bar{N}^u \upsilon_{t+1}^u, \tag{40}$$

$$N_{t+1}^{d} = \sigma\left(\sum_{j\in\{u,m,d\}} R_t^{dj}X_t^{dj} - R_tD_t^d\right) + \iota\left(\sum_{j\in\{u,m,d\}} R_t^{dj}X_t^{dj}\right) + \bar{N}^d \upsilon_{t+1}^d, \tag{41}$$

where υ_t^j is a shock to the net worth of the banks in a certain sector $j \in \{u, m, d\}$. The net worth evolution for the midstream banking sector is analogous to that of the upstream banking sector and is specified in Online Appendix A.

The social resource constraint reads

$$C_t + \sum_{j\in\{u,m,d\}} (C_t^j + K_t^j - (1-\delta)K_{t-1}^j) + \sum_{\substack{i,j\in\{u,m,d\}\\ i\neq j}} \frac{k^b}{2}(X_t^{ij} - \overline{X_t^{ij}})^2 = Y_t. \tag{42}$$

The Appendix presents the full set of first-order conditions and market clearing conditions.

3.5 Asset-based finance in supply chains

The specification of firms' borrowing constraints determines how firms' pledging or sale of assets unlocks funding.

Factoring and invoice discounting The functions $\Omega(f^u)$ and $\Omega(f^m)$ govern the pledgeability of firms' non-factored accounts receivable to banks. Following a broad literature in supply chain finance and in accordance with the view of practitioners, we allow a greater factoring intensity to boost banks' efficiency in managing and repossessing pledged invoices. A broad body of studies documents that, through their factoring activities, banks can acquire information and insight into the financial status and creditworthiness of suppliers and customers, build relationships with suppliers and customers, and collect data on customers' payment history and patterns (Klapper, 2006; CFO Selections, 2023; Factor Funding, 2025; Crestmont Capital, 2026). Thus, factoring banks also become more experienced in discounting invoices involving the same suppliers and customers.

Formally, similar to Diamond and Rajan (2002) and Diamond and Rajan (2001), we can think that in our setting a supplier can strategically default on loans collateralized by trade credit invoices. If this happens, the bank will be able to repossess the invoices pledged as collateral. However, only the original supplier can recover the invoices in full in the event of customer default. The bank's ability to collect invoices will instead depend on its knowledge of the customer: the deeper this knowledge, the lower the value lost in the collection process.

Consider an upstream bank, for example. Denote by f^u the degree of knowledge acquired by the bank on the customer per unit of factored trade credit. Intuitively, when a bank purchases invoices from a supplier, it gains knowledge about the customer to whom the trade credit was extended, the local intermediate goods markets, and the way the customer combines intermediate goods, acquiring the skills needed to collect invoices. Thus, the larger the amount of factoring carried out (f^u), the more the bank will be able to collect non-factored invoices, recovering a fraction f^u of the collateralized invoices $(1 - f^u)V_t^m R_t^{vm}$ in the event of customer default.[15] The original supplier will instead be able to recover the full value of the invoices. Similar to Diamond and Rajan (2001), the bank will bargain with the supplier over the surplus associated with the supplier's superior collection skills. Letting γ denote its bargaining power, the bank will obtain (per unit of collateralized invoices)

$$f^u + \gamma[1 - f^u]. \tag{43}$$

This implies that the pledgeability function $\Omega(f^u)$ can be written as

$$\Omega(f^u) = \gamma + f^u(1 - \gamma). \tag{44}$$

The parameter γ in (44) for the bank's bargaining power in the collection of non-factored invoices can capture the impact of technological and institutional factors on banks' ability to engage in invoice discounting.

Capital pledging In our specification, firms can pledge capital assets both to banks specialized in their supply chain segment and to banks specialized in other segments. In particular, capital pledgeability is initially larger for specialized banks. However, due to diseconomies of scale, at some point the marginal pledgeability of capital assets to specialized banks becomes equal to that of non-sector banks. This specification follows a broad literature that studies the allocation of capital as collateral among lenders with different collateral expertise (Aiyagari and Gertler, 1991; Hermalin et al., 1999). Intuitively, similar to several studies in this literature, one can think that initially the most specific projects and capital assets are pledged to specialized banks. However, as pledges increase, a firm will progressively pledge less specific projects and assets, for which specialized banks have a lower comparative advantage. Moreover, the scarce monitoring, expertise, and evaluation tools of specialized banks will become more strained as they have more collateral

[15] For instance, suppose that intermediate inputs are of different varieties and that the repossession and liquidation of an invoice is feasible as long as the liquidator has observed the intermediate input backing the invoice. If we let the intermediate goods be distributed over a unit continuum, a bank that factors a fraction f of the invoices will be able to observe the characteristics of a fraction f of the intermediate goods. When trying to collect non-factored invoices, the bank will then be able to repossess and liquidate a fraction f of the non-factored invoices.

capital to manage and repossess. Together, these forces will imply that the marginal benefit of borrowing from specialized banks will progressively decrease, leading to an interior allocation of collateralizable capital between sector and non-sector banks.

4 Model Analysis

We study the effects of financial shocks in the form of shocks to banks' net worth. We are interested in the mechanisms of transmission of the shocks and, particularly, in understanding how different margins of integration between the banking sector and supply chains shape this transmission, enhancing or reducing macroeconomic stability.

Inspired by the evidence presented in Sections 1 and 2, we highlight two dimensions of bank-supply chain integration. The first is bank-supply chain integration along the extensive margin, that is, the ability of firms to borrow from banks specialized in different segments of the supply chain (non-sector banks). The second is bank-supply chain integration along the intensive margin, that is, the intensity of use of bank supply chain finance (invoice discounting and factoring).

4.1 Calibration

Table 1 reports the calibrated values of the model parameters, while Table 2 displays the calibration targets. There are 23 parameters: 4 pertaining to the household sector, 14 to the firm sector, and 5 to the banking sector. For 14 of the 23 parameters we adopt standard values commonly used in the literature. On the household side, we set the household discount factor $\beta = 0.99$, which implies a steady-state annual deposit rate of approximately 4 percent, and impose log utility by fixing the parameter governing risk aversion $\omega = 1$. The labor-disutility weight $k_c = 5.584$ follows Gertler and Kiyotaki (2010), and the inverse Frisch elasticity $\eta = 0.75$ is consistent with Chetty et al. (2011).

On the banks' side, following, e.g., Gertler and Kiyotaki (2010), we set a survival rate $\sigma = 0.975$, which implies an expected banker tenure of roughly 10 years, and we choose a small entry transfer $\iota = 0.0001$ so that transfers to new bankers remain negligible. On the firms' side, we set the firm discount factor at $\beta_f = 0.98$, making firms slightly more impatient than households, and adopt a quarterly capital depreciation rate $\delta = 0.025$, as in a broad set of macroeconomic studies. We choose $\theta = 0$ to model all firms as risk neutral. The intermediate input share is set to $\phi = 0.5$ to reflect the significant role of intermediates in total costs (Leibovici, 2021; Nakamura and Steinsson, 2010; Atolia and Chahrour, 2020). We choose a value of α such that the share of gross revenues accruing to capital is in line with previous studies that incorporate intermediate inputs in production. Leibovici

(2021) sets a value of α such that capital accounts for one-fourth of gross revenues, while Atolia and Chahrour (2020) target a share of capital of about 13 percent (with intermediate inputs accounting for 60 percent of gross revenues). Bank of Italy (2022) estimates a share of capital of 22 percent using Italian data. We target a share of capital in the middle of the interval defined by these values, equal to 20 percent. For the final good producer, we set $\epsilon = 0.75$, which implies an elasticity of substitution in final good production $(1/(1-\epsilon))$ equal to 4. This value is commonly used in the literature to reflect moderate monopolistic competition among differentiated inputs. The CES weights for upstream and midstream goods in final good production, $\alpha_u = 0.20$ and $\alpha_m = 0.35$, are motivated by input-output data from the World Input-Output Database (WIOD) and the Organisation for Economic Cooperation and Development (OECD), which show that downstream sectors—being closer to final consumption—contribute more to final output production (Antràs et al., 2012).

The remaining nine parameters (ξ, κ, κ^n, γ, c, f^u, f^m, ν, and p) are specific to our model and are chosen to match empirical targets in our Italian data around 2010. The parameters κ, κ^n and c govern the pledgeability of capital assets and, hence, influence the tightness of firms' borrowing constraints vis-a-vis banks. ξ determines the weight on assets in the capital constraints of banks and, hence, the tightness of capital constraints. ν affects the tightness of firms' borrowing constraints vis-a-vis suppliers. The parameter p governs the profit margin of banks in factoring. The parameters f^u and f^m denote the fraction of accounts receivable that is factored and sold to upstream banks and midstream banks, respectively. Since we do not intend to finely distinguish the factoring intensity among supply chain segments, we let the factoring intensity be the same for the two bank types and denote it by f.

The internally calibrated parameters are chosen to match the following targets: banks' leverage ratio, firms' leverage ratio, firms' ratio of accounts payable to bank borrowing, firms' ratio of net trade credit to bank borrowing, banks' ratio of factored invoices to total invoices, the spread between loan and deposit rates, the spread between trade credit rate and loan rate, and the profit margin in factoring. We target a leverage ratio of banks of 5, which is approximately the mean leverage ratio observed in our sample of Italian banks and is also consistent with the leverage ratio in Gertler and Kiyotaki (2010). We target a leverage ratio of firms of 0.58.[16] In our Italian data, the ratio of accounts payable to bank borrowing is 29 percent, while firms' ratio of net trade credit to bank borrowing is 7 percent. We target a ratio of banks' factored invoices to total trade credit

[16] Graham et al. (2015) report that the debt-to-asset ratio is 28-32 percent for US public firms. Fan et al. (2012) find that Western European firms typically have a 30–45 percent debt-to-asset ratio. Ulbert et al. (2022) report a debt-to-equity ratio of 1.38 based on 4,550 firm-year observations.

invoices of 65 percent (Assifact, 2025). In our data, the annual loan-deposit spread and the trade credit-loan spread are equal to 1.3 percent and 2 percent, respectively. Finally, the parameter p for the profit margin in factoring is set at a very small value. This approximates the highly competitive Italian factoring market, which is characterized by a structurally fragmented supply of factoring services and intense competition among factoring banks (Assifact, 2025; PwC, 2022; KPMG and Assifact, 2020).

Given these targets, we set $\kappa = 0.6$ and $\kappa^n = 0.5$. Further, we set $\gamma = 0.0857$ and $f = 0.65$. Together, the chosen values of $\gamma = 0.0857$ and $f = 0.65$ imply that the effective pledgeability of non-factored accounts receivable $\Omega(f) = \gamma + f(1-\gamma)$ equals 0.68; that is, one additional unit of pledged invoices unlocks an additional bank funding of 0.68. The calibrated value of $\nu = 1.5$ implies that two-thirds of accounts payable need to be backed by intermediate inputs.

4.2 The response to banking shocks

In what follows, we present the baseline results for the effects of a banking shock and then investigate the influence of the extensive-margin and intensive-margin bank-supply chain integration.

4.2.1 Baseline results

We perturb the economy with a banking shock that reduces the net worth of banks. We focus on a 10 percent shock to midstream banks' net worth,[17] υ_t^m. Our focus on midstream banks is primarily motivated by the empirical evidence: as we will see, our empirical banking shock measure is constructed from the crisis of a major Italian bank that has traditionally focused on lending to midstream industries (e.g., agribusiness processing, leather and tanning, and intermediate manufacturing such as machinery for textiles and ceramics). Bank net worth shocks can reflect drops in bank capitalization due to crises in asset markets in which banks have relevant involvement, such as the markets for sovereign debt and for real estate-related securities. They can also capture drops in banks' capitalization due to bank managers' misbehavior, ineffective bank investment and acquisition activities (as in the case of our empirical shock), or siphoning of resources from banks.

Figure 2 and Appendix Figure A.1 display the impulse responses of key variables—bank net worth (N), bank lending (X), interest rates (R), trade credit (V), total bank borrowing by firm ($ULoan$, $MLoan$, $DLoan$), capital (K), the multipliers on firms' borrowing constraints (ψ), the share of capital pledged to the sector bank (S), and output (Y).[18] The contraction in midstream banks' net worth leads to a decline in their loan supply to midstream firms (X^{mm}), inducing an

[17] We set the shock persistence to 0.85.

[18] In all figures, changes in all the interest rates are measured in percentage points.

increase in the loan rate R^{mm}. Midstream firms tilt their borrowing toward non-sector banks: they attempt to replace the now costlier midstream banks' loans with other loans by reshuffling the capital pledges from midstream to upstream and downstream banks (S^m drops). However, the increase in loans from upstream and downstream banks (X^{um} and X^{dm}) is modest and insufficient to compensate for the loan contraction of midstream banks: the total bank lending to midstream firms ($MLoan$) declines (by 18.72 percent at the trough). Intuitively, upstream and downstream banks focus on funding their sector firms, mitigating the loan shortfall induced by the shock to midstream banks. The trade credit extended by upstream firms to midstream firms (V^m) drops too (by 2.81 percent at the trough), exacerbating the financial shortage of midstream firms. As a result, both their purchase of intermediate inputs and capital and their production drop (the latter by 4.52 percent at the trough).

Upstream and downstream firms rely on in-sector finance to partially buffer the disturbance. This partial buffering is facilitated by the increase in the net worth of their sector banks, which benefit from the higher loan rate they can charge to midstream firms. The bottom row of Figure 2 shows that, especially due to the output contraction of midstream firms, the shock leads to an overall output loss for the economy (by 2.06 percent at the trough). Bank-supply chain integration along the extensive and intensive margins can significantly affect these baseline effects of a banking shock.

4.2.2 Bank-supply chain integration

As we shall see, the extensive and intensive margins of bank-supply chain integration have sharply asymmetric consequences for the amplification of banking shocks. This asymmetric influence can be traced back to the same logic: the influence of integration on banks' skills and experience in providing asset-based collateralized finance. In both cases, integration improves the pledgeability of a type of collateral, as it enhances banks' ability to manage and liquidate collateral, and hence extend asset-based funding. In the extensive-margin case, the affected pledgeable assets primarily constitute the collateral of borrowers of funds (loan takers). Extensive-margin integration, in fact, improves the pledgeability of capital assets to banks traditionally specialized in different supply chain segments. Following supply-side banking shocks, this exacerbates the sensitivity of the demand for capital as collateral to loosenings in firms' borrowing constraints due to the reduced appetite for the costlier loans. This further depresses capital investment and production. In contrast, in the intensive-margin case the affected pledgeable assets primarily constitute the collateral of lenders of funds (trade credit suppliers). Thus, intensive-margin integration increases the sensitivity of trade credit supply to tightenings of suppliers' borrowing constraints that occur following loan supply shocks to downstream firms. This stimulates suppliers' extension of trade credit, also driving up bank loans (due to the stronger resilience of the investment in collateralizable capital). We elaborate on these mechanisms below, starting with the intensive margin.

4.2.3 Intensive margin of integration

A first form of bank-supply chain integration along the intensive margin can be captured by the parameter γ, which governs banks' ability to manage and repossess collateralized accounts receivable. A second form of this integration can be reflected in the parameter f, which governs the intensity of factoring. Banking industry technologies and regulations lead to significant variation in the use of invoice discounting and factoring (see below for details on the Italian case).

Figure 3 contrasts impulse responses under high versus low pledgeability of accounts receivable (γ). In this experiment, we compare the baseline scenario with an alternative in which the value of γ is altered to 0.6, implying that the effective pledgeability of accounts receivable, $\Omega(f)$, is 0.86 rather than 0.68 (about 25 percent higher than the baseline).[19] Following a negative shock to midstream banks' net worth, a higher γ implies that the trade credit extended by upstream firms to midstream firms (V^m) drops less (by 2.59 percent rather than 2.81 percent at the trough), and the trade credit rate (R^{vm}) decreases more. Moreover, there is an increased reliance of midstream firms on the loans of their sector banks (S^m drops less) and a smaller contraction in the total loans to midstream firms ($MLoan$ drops by 16.4 percent instead of 18.72 percent at the trough). Overall, these effects lead to a stronger resilience of the production of midstream firms (Y^M) and of the total output of the economy (Y).

To gain intuition on these effects, observe that a higher pledgeability of accounts receivable increases the sensitivity of trade credit supply to changes in the tightness (Lagrangian multiplier) of firms' borrowing constraints, as induced, e.g., by changes in the supply of credit by banks. This can be understood by recalling upstream firms' first-order condition (23) for the supply of trade credit to midstream firms. Recalling our assumption $\theta = 0$, after some algebraic manipulations:

$$R_t^{vm} = \frac{1-f}{\beta_f(1-pf) + \psi_t^{uu}[\gamma + f(1-\gamma)](1-f)}. \tag{45}$$

Following the shock to midstream banks' net worth, the Lagrangian multiplier ψ^{uu} on the borrowing constraint of upstream firms rises (see again Figure 3).[20] From equation (45), an increase in the

[19] To continue to match data targets, when changing γ we accordingly adjust the parameter h. Note that for this experiment we consider plausible differences in the degree of pledgeability of invoices across scenarios but we do not target such differences. We will target them in the quantitative analysis of Section 4.3.

[20] For example, recall that upstream banks experience an increase in net worth, thanks to the reduction in the cost

multiplier ψ^{uu} exerts greater downward pressure on the trade credit rate demanded by upstream firms when γ is higher. Intuitively, any increase in the multiplier on upstream firms' borrowing constraint gets amplified by a larger γ as a larger γ implies that upstream firms have a stronger incentive to extend trade credit in order to pledge it as collateral. In Figure 3, we can see this in the higher amount (smaller reduction) of trade credit offered to the shock-hit midstream firms.

For the midstream firms, the smaller contraction in the trade credit received also acts as a buffer against contractions in bank credit. While there is no support in terms of additional loans offered by non-sector banks, due to the stronger resilience of midstream firms' investment in collateralizable capital, the increased trade credit received from upstream firms also enhances midstream firms' ability to borrow from their own sector banks, partially insulating them from the loan crunch.

Figure 4 studies the influence of the second form of bank-supply chain integration along the intensive margin, the intensity of factoring (as governed by the parameter f). Factoring may reduce or increase the role of accounts receivable as collateral (see again equation (45)). There is a boost in the pledgeability of accounts receivable due to the experience associated with factoring activities (recall that $\Omega(f)$ is increasing in f). However, factoring pushes accounts receivable off firms' balance sheets, reducing their use as collateral. Moreover, factored trade credit enters banks' capital constraint, since it constitutes an asset for regulatory purposes.

Figure 4 shows the net effect of these opposing forces by comparing the responses of key variables for alternative levels of the factoring intensity (f). The figure compares the baseline scenario with an alternative in which the value of f is altered to 0.9, implying that the effective pledgeability of accounts receivable, $\Omega(f)$, is 0.91 rather than 0.68 (approximately 32 percent higher than the baseline). We see that a higher factoring intensity tends to enhance resilience in a similar way to a higher pledgeability of accounts receivable. Indeed, a higher f leads to a greater experience of banks in managing invoice discounting, enhancing the pledgeability of invoices. This, in turn, increases the sensitivity of upstream firms' trade credit supply to the increase in the tightness (Lagrangian multiplier) of their borrowing constraint following the shock, facilitating the financing of the shock-hit midstream firms. The collateral share pledged by midstream firms to their sector banks (S^m) increases by more, too, and overall the decline in bank financing to midstream firms ($MLoan$) is also mitigated, supporting their production and the total output of the economy Y.

of deposits and to the higher loan rates they can charge on midstream firms (which are starved for credit following the midstream banks' shock). This increase in net worth allows them to expand their credit supply, leading to a drop in the loan rates charged to upstream firms and, hence, to an increase in the Lagrangian multiplier ψ^{uu}.

Do shock-hit firms economize on liquidity? Midstream firms act as "middlemen," simultaneously receiving and extending trade credit. The reader can wonder whether the additional funds these firms receive from suppliers under stronger intensive-margin integration, that is, with a higher γ or f, could be at least partially lent to downstream firms. Figures 3 and 4 show that this is not the case: under stronger integration (higher γ or f) not only do midstream firms obtain more trade credit from upstream firms, but also they supply less trade credit to downstream firms. This results in a more pronounced increase in the net trade credit they receive (for example in the left panel of Figure 5, their net trade credit rises by 2.62 percent instead of 2.0 percent at the peak).

The intuition for the lower supply of trade credit by midstream firms is akin to that seen above. Following the midstream banks' loan supply shock, there is a loosening in midstream firms' borrowing constraint, as reflected in the drop of the Lagrangian multiplier (ψ^{mm}) on their borrowing constraint. In fact, as the supply of midstream banks' loans shrinks, raising their loan rate (R^{mm}), the appetite of midstream firms for their costlier loans decreases. The loosening of midstream firms' borrowing constraint reduces their incentive to accumulate invoices as collateral, depressing their trade credit supply. This effect is stronger when γ or f is greater, as can also be seen from the formula for the trade credit rate charged by midstream firms:

$$R_t^{vd} = \frac{1-f}{\beta_f(1-pf) + \psi_t^{mm}[\gamma + f(1-\gamma)](1-f)}. \tag{46}$$

A reduction in the multiplier ψ^{mm} drives this rate up especially when γ or f is higher, capturing a more pronounced inward shift of midstream firms' trade credit supply.

Commercial links and intensive-margin integration The tightness of commercial links along the supply chain interacts with the intensive-margin integration between banks and supply chains. The parameter ν captures the extent to which intermediate inputs can be pledged as collateral and, hence, governs the use of trade credit along the supply chain.[21]

In Figure 6, we display the first-differenced impulse response functions relative to γ and f for different values of ν. We observe that a more intense use of trade credit (higher ν) enhances the stabilizing effects of the intensive margin of bank-supply chain integration. For example, the lower contraction of trade credit from upstream firms to midstream firms observed when γ is higher is more evident when ν is larger.[22] And the attenuation of the total drop in output is also reinforced by a larger ν. In the bottom row of Figure 6, we reach similar conclusions when inspecting the influence of ν on the stabilizing effect of factoring intensity (f). Intuitively, the mechanisms discussed above

[21] The parameter ϕ, on the other hand, governs the reliance of firms on intermediate inputs offered by suppliers. We focus our attention on ν, which more directly determines the use of trade credit.

[22] The mitigation of the loan contraction to midstream firms is also more evident.

are accentuated when trade credit is used more intensely in the supply chain, as trade credit will weigh more in the total funding of firms. Moreover, midstream firms' trade credit demand will be more sensitive to the trade credit rate, implying that any additional supply of trade credit by upstream firms will have a stronger impact on the trade credit taken by midstream firms.[23]

Robustness to alternative specifications of factoring In recent years, as part of the revision of bank capital regulation, a debate has emerged on the treatment of income on factored assets in capital requirements. In particular, policymakers debate whether bank profits on factoring activities should be treated as assets pledgeable by banks for capital adequacy compliance. In Appendix Figure A.4, we consider an alternative scenario in which profits on factoring are incorporated into the assets pledgeable by banks in their capital constraints. All the results are robust to this specification. Moreover, the quantitative difference in the results appears to be small.[24]

4.2.4 Extensive margin of integration

We contrast the effects of bank-supply chain intensive-margin integration with those of extensive-margin integration. Integration along the extensive margin can be represented as a higher value of the parameter κ^n: a higher κ^n implies that non-sector banks get closer to the efficiency of sector banks in managing capital as collateral. Figure 7 compares impulse responses across alternative levels of κ^n following a 10 percent shock to midstream banks' net worth. The figure compares the baseline scenario with a scenario in which κ^n equals 0.43, implying an effective pledgeability of capital to non-sector banks 14 percent lower than in the baseline calibration. We observe that stronger extensive-margin integration (higher κ^n) can amplify the shock. The midstream firms hit by the shock reduce their capital pledges and their investment by more. They also tend to shift more of their capital pledging from sector to non-sector banks (S^m drops by more). However, non-sector banks do not compensate for the drop in loans from sector banks. In fact, they focus more on serving the firms operating in their own supply chain segments (upstream and downstream), while cutting credit to midstream firms: under a higher κ^n, the loan rate charged to midstream borrowers increases by more and the initial expansion in X^{um} and X^{dm} is reduced.[25] Taken together, these adjustments depress collateral demand more, as evidenced by the sharper contraction in midstream firms' capital investment (K^m). The production of midstream firms drops more significantly, and

[23] Clearly, commercial links also have direct effects on shock transmission through input-output connections.

[24] In the baseline model, we also assumed that the additional fees associated with banks' factoring activities $(p-1)$ are entirely borne by suppliers. In additional experiments (available from the authors), we show that the effects of intensive-margin integration carry through if the payment of these fees is shared between suppliers and customers.

[25] On the bank side, the reduction in the net worth N^m of midstream banks is larger under stronger extensive-margin integration. Upstream and downstream banks experience somewhat larger increases in net worth.

overall there is a larger decrease in total output Y. These effects contrast with what was observed under a stronger intensive-margin integration (larger γ or larger f). In that case, in fact, the investment and output of midstream firms as well as the total output of the economy dropped by a smaller amount.

Digging deeper into the mechanisms, a higher κ^n tends to raise the sensitivity of the demand for collateralizable capital to changes in the tightness of firms' borrowing constraints (as reflected in their multipliers). This can be seen by combining midstream firms' first-order condition for capital demand with their first-order condition for the allocation of collateralized capital to sector and non-sector banks (that is, the counterparts of upstream firms' conditions in (19) and (24), respectively; See the Appendix). We obtain

$$E_t P^m_{t+1}(1-\phi)\alpha \frac{Y^m_{t+1}}{K^m_t} = \frac{1-\psi^{nm}_t \kappa^n}{\beta_f} - 1 + \delta. \tag{47}$$

Consider the effect of a negative shock to the net worth of midstream banks. As noted, the Lagrangian multiplier (ψ^{mm}) on midstream firms' borrowing constraint drops, as their appetite for the now costlier midstream banks' loans decreases. The Lagrangian multipliers ψ^{nm} and ψ^{mm} are naturally tied to each other through the first-order conditions for firms' borrowing, implying that ψ^{nm} drops too. The effect of this drop in the borrowing constraint multiplier ψ^{nm} of midstream firms is amplified by a larger κ^n, leading to a larger reduction in their incentive to demand capital as collateral and, hence, a larger drop in their capital investment (see equation (47)).

A larger κ_n also leads to a bigger reshuffling of the pledging of capital toward non-sector banks, further worsening midstream banks' net worth status. This happens because the reduction in the tightness of the borrowing constraint reduces the gap in capital pledgeability between sector and non-sector banks, as can be understood by rearranging midstream firms' first-order condition for the capital share pledged to midstream banks (S^m):

$$\frac{c S^m_t K^m_t}{\overline{K^m}} = 1 - \frac{\psi^{nm}_t \kappa^n}{\psi^{mm}_t \kappa}. \tag{48}$$

However, the reshuffling does not result in a larger loan extension by non-sector banks, as noted.

Interestingly, when κ^n is higher, the responses of the investment and loan flows of the various types of firms to the shock would suggest a stronger segmentation across supply chain layers. This contrasts with the view that bank–supply chain integration along the extensive margin could improve risk sharing following shocks, but is fully consistent with the relevance of asset-based funding in the model economy.

4.3 A quantitative assessment

To provide a quantitative assessment of the effects, in this section we focus on the structural transformations that occurred in the Italian financial system over the course of 15 years (between 2010 and 2024). As discussed in Section 2, these transformations simultaneously enhanced the integration between the Italian banking sector and supply chains on the extensive and intensive margins. The primary objective of this quantitative exercise is to measure the macroeconomic impact of the bank-supply chain integration process. Secondarily, by examining the combined effect of the extensive and intensive margins, we aim to determine which force prevails in shaping aggregate stability when both dimensions of integration expand simultaneously.

Calibration to institutional changes The transition from the benchmark (2010) to the alternative (2024) scenario is disciplined by empirical targets constructed from our Italian data set. The data reveal a significant deepening of bank-supply chain integration during this period. On the intensive margin, the use of supply chain finance increased significantly. Between 2010 and 2024, the volumes of factoring and invoice discounting more than doubled, as noted in Section 2. Moreover, the ratio of factored invoices to total invoices increased from about 0.65 in 2010 to 0.78 in 2024 (Assifact, 2025). On the extensive margin, the banking sector became less segmented, with banks increasingly financing firms outside of traditional areas of specialization. Given the significant industry specialization of Italian provinces, the geographic penetration of bank branches across provinces also captures the extent to which banks expanded their lending beyond traditional strongholds in specific sectors and supply chain segments (see Section 5.1 for a further discussion).[26] The share of non-sector loans to total loans rose from 40.1 percent in 2010 to 60.6 percent in 2024, where sector loans are defined as loans extended by banks to firms active in their areas of specialization.

The baseline calibration in Table 1 captures the 2010 economy. To capture the 2024 economy, we adjust key model parameters to match salient end-of-period targets while keeping other deep parameters constant. Specifically, we set the extensive margin parameter $\kappa^n = 0.535$, the trade credit pledgeability parameter $\gamma = 0.43$, and the factoring participation rate $f = 0.78$. This parameterization allows the alternative steady state of the model to closely replicate the 2024 empirical landscape: a factoring-to-invoices ratio of 0.78 (as in the data), an accounts payable-to-loan ratio of 0.277 (close to the data 0.326), and a non-sector loan share of 0.597 (vs. data 0.606). In this alternative steady state, the effective pledgeability of invoices, $\Omega(f)$, equals 0.875 (about

[26]When in Section 5.1 we use a sectoral measure of extensive-margin integration, our results are very similar.

28 percent higher than in the baseline 2010 scenario), while the effective pledgeability of capital to non-sector banks, κ^n, is 0.535 (about 7 percent higher than the baseline).

Quantifying the impact of the institutional changes To simulate business cycle dynamics, we estimate an AR(1) process for banks' net worth disturbances. Specifically, we use the series of regulatory Tier 1 capital to risk-weighted assets of the Italian banking sector compiled by the Bank of Italy, covering the period from 2011Q1 to 2025Q2. The data are log-transformed and HP-filtered to isolate the cyclical component. The estimated process yields a persistence of 0.557 and an innovation standard deviation of 0.027.

We start by inspecting the dynamic adjustment following a shock to banks' net worth. Figure 8 plots the impulse responses of total output and total credit (bank loans plus trade credit) to a negative bank net worth shock for the baseline economy reflecting the 2010 scenario and for the alternative economy reflecting the 2024 scenario. The contraction of these variables is smaller in the alternative economy than in the benchmark, suggesting that overall the integrated bank-supply chain structure tended to mitigate downturns by boosting credit provision.

We next turn to quantifying the stability of the economy by computing the variances of aggregate output and total credit under the 2010 benchmark and the 2024 alternative calibration. As reported in Panel A of Table 3, the alternative model representing the 2024 economy yields lower variances for these aggregate variables relative to the 2010 benchmark. The results suggest that overall, following the bank-supply chain integration process, the theoretical variances of aggregate output and total credit drop, by 5.70 percent and 4.73 percent, respectively. A similar pattern can be observed when considering their conditional variances at different horizons. This decrease in unconditional and conditional variances indicates that overall the structural shift toward a stronger bank-supply chain integration mitigated aggregate fluctuations induced by banking shocks.

This quantitative assessment thus suggests that the stabilizing impact of the intensive-margin integration induced by the deepening of supply chain finance could have outweighed the destabilizing effects of the extensive-margin integration, moderating the transmission of banking shocks. Moreover, tighter inter-firm commercial links could have further strengthened the stabilizing influence of intensive-margin integration. Panel B of Table 3 shows that the reduction in output volatility induced by the bank-supply chain integration process could have been more pronounced in the presence of stronger commercial links. For example, with a value of $\nu = 1.82$ (gross trade credit over assets of 22.9 percent), output volatility would have dropped by 8.39 percent, versus 5.70 percent with the baseline value of $\nu = 1.5$ (gross trade credit over assets of 19.0 percent, that is, about 20 percent lower).

5 From Model to Data

We verify the consistency of the key mechanisms of the model with granular evidence from Italy. The estimation sample combines the data sources described in Section 2.1. After matching the MET survey with FrameSBS and AIDA balance-sheet data, the final sample includes an unbalanced panel of about 37,000 firms over the period 2006–2022.

Our empirical strategy exploits the distress of the major Italian bank Monte dei Paschi di Siena (MPS) as a source of a plausibly exogenous banking shock. MPS has historically exhibited a marked focus on funding midstream industries within the Tuscan and Central Italian production system (see Appendix Figure B.2 for the distribution of MPS branches).[27] Its lending is anchored in the productive fabric of central Italy, where firms are typically positioned in intermediate stages of supply chains. Unlike cooperative banks that often serve farmers or raw-material producers, MPS is closely tied to manufacturing and processing companies—textiles in Prato, leather in Tuscany, machinery and equipment in Emilia and Marche—that transform inputs into higher-value goods. In particular, a substantial share of its lending is directed toward agribusiness processing (wine, olive oil, and food transformation), leather and tanning, and intermediate manufacturing such as machinery for textiles and ceramics—sectors that are neither purely upstream suppliers nor final consumer industries, but critical nodes in regional value chains (fi-compass, 2020). Accordingly, on the one hand the MPS bank's distress constitutes a major systemic shock: for example, more than 17 percent of the firms in our sample had a credit relationship with MPS in 2012 (Appendix Table B.1). On the other hand, the shock disproportionately affected midstream industries structurally dependent on the credit of MPS.

5.1 Measurement

Identifying a banking shock The MPS crisis constitutes a major episode in the Italian banking sector (see Appendix Table B.2 for a chronology). Its origins trace back to late 2007, when MPS acquired Banca Antonveneta for 9 billion euros, a price well above its market value. The acquisition was largely financed through debt, significantly weakening the bank's capital position. Between 2008 and 2011, mounting losses from the acquisition, combined with the emergence of complex and opaque derivative transactions (the "Alexandria" and "Santorini" deals), further impaired the

[27] The left panel reports the number of MPS branches by province, while the right panel presents the spatial distribution of $\%\text{MPS}_{p(i)}$, which measures the share of MPS branches relative to all branches in the province.

bank's balance sheet. In 2012, Italian regulators launched investigations into these transactions, leading to increased scrutiny. The crisis escalated in early 2013 with the disclosure of previously hidden losses. Over the subsequent years, MPS implemented a restrictive credit policy and offloaded non-performing loans to meet capital requirements, resulting in a substantial contraction of credit supply. Crucially, this adjustment was driven by internal financial constraints rather than changes in borrower creditworthiness or macroeconomic fundamentals. We argue that the resulting contraction in credit supply represents a large, yet idiosyncratic, bank-specific event that allows for credible identification of the real effects of a banking shock. The shock spread beyond firms directly borrowing from MPS, affecting broader segments of the corporate sector through supply chain links. We use this setting to examine how bank disruptions translate into firm-level outcomes—focusing on sales (the counterpart of firms' output in the model) and trade credit.[28]

In our tests, we implement a difference-in-differences framework that compares pre- and post-MPS-shock firm outcomes. We define 2012 as the final pre-treatment year, as it marks the period before the disclosure of hidden losses, which triggered the MPS bank's lending retrenchment.

Bank-supply chain integration In addition to the supply chain participation indicator discussed in Section 2, we exploit various measures of bank-supply chain integration. To capture integration on the intensive margin, we construct measures of the intensity of bank factoring and invoice discounting. Exploiting details on the firm–bank relationships in the MET survey, for each lender bank of a firm we compute the ratio of factored and discounted accounts receivable to total bank loans (as of 2010). This ratio is fixed pre-crisis to allay concerns about endogeneity. We then compute the average of this ratio across a firm's lender banks.[29] The variable *Int-Integ* ranges from negligible values to 8 percent in the sample. In further tests, we interact this indicator with the intensity of the use of supply chain finance in the firm sector, *High supply chain finance (SCF)*, defined as a dummy for firms in the top 10 industries by the use of factoring and discounting (Assifact, 2024).

The variable *Ext-Integ* captures the degree of extensive-margin integration. We construct two firm-level indicators of such integration: a geographic measure and a sectoral measure (see also the Appendix). For the geographic measure, we collected information on the universe of bank branches in Italy between 2006 and 2012. For each bank b, we compute the share of its branches in each Italian region r. We then compute the cosine similarity between the branch distribution of MPS and that of each other bank and define the geographic distance of a bank from MPS as

[28] The results for firm employment are very similar to those for firm sales.

[29] The amount of factoring and invoice discounting was hand-collected from banks' online balance-sheet statements.

$Dist_b^{Geo} = 1 - Cosine_b^{Geo}$. Higher values of this distance indicate branches concentrated in regions that differ more substantially from those in which MPS operates. We construct an analogous measure at the sectoral level based on loan portfolios. Using the MET survey, we identify the set of firms connected to each bank in the pre-shock period and compute the distribution of clients across two-digit industries. Higher values of the sector-based distance indicate banks whose client base is concentrated in industries that differ more markedly from those served by MPS. We then map these bank-level measures into firm-level indicators. For each firm i, we compute the average distance from MPS across all the banks with which the firm has a credit relationship in the pre-shock period, that is, $Dist_i = \frac{1}{N_i} \sum_{b \in \mathcal{B}_i} Dist_b$, where $\mathcal{B}_i$ is the set of banks connected to firm i and N_i is the number of relationships. Finally, we define $Ext\text{-}Integ_i = \mathbf{1}\left(Dist_i > P75(Dist_i)\right)$, where $P75(Dist_i)$ is the 75th percentile of the cross-sectional distribution of firm-level (geographic or sectoral) distance. Higher values of $Ext\text{-}Integ_i$ capture firms that borrow from banks specialized in areas (regions, industries, and, hence, supply chain segments) different from the areas of specialization of MPS.

Endogeneity of supply chain participation In our regressions we use the supply chain participation indicator described in Section 2. Although we use pre-crisis values of this indicator to mitigate simultaneity bias, firms may still self-select into supply chains based on unobserved characteristics, which could also influence their exposure to banking shocks and subsequent performance. To address this concern, we implement an instrumental variables strategy that exploits variation in firms' access to digital infrastructure. Specifically, using geolocation data for firms and Strategic Geographical Units (SGUs), we construct an instrument for chain participation, SC_i, based on the geographical distance between each firm and the nearest SGU offering advanced IT services.

The identifying assumption is that proximity to digital infrastructure facilitates integration into supply chains by lowering coordination and transaction costs, without directly affecting firm outcomes such as sales or employment. This assumption is supported by prior research showing that access to IT infrastructure reduces barriers to inter-firm coordination and promotes the formation of production networks (Brynjolfsson and Hitt, 2000; Freund and Weinhold, 2004; Cusolito et al., 2016). The Italian context is especially well-suited to this strategy, as the rollout of digital infrastructure varies substantially across provinces. Crucially, this variation is largely driven by differences in local bureaucratic capacity and historical patterns of administrative responsiveness, rather than by firm-level strategic location choices.[30] As documented by Perri and Vaciago (2023)

[30]The results are robust to using an alternative instrument obtained by interacting the distance from SGU with a measure of IT usage at the sectoral level. Specifically, we use data from the EU-EFIGE/Bruegel-UniCredit survey conducted in 2010, which reports the share of firms in each sector that regularly use IT for commercial transactions.

and Ghezzi (2023), many Italian municipalities display persistent gaps in digital readiness, often due to cultural conservatism and uneven investment in digital transformation. Moreover, given that most firms in our sample are small, family-owned businesses that tend to remain rooted in their place of origin, it is unlikely that firms systematically sort into locations based on the quality of digital infrastructure. This reduces concerns that our instrument might capture unobserved firm-level characteristics rather than exogenous variation in supply chain participation.[31]

5.2 Empirical models and results

The impact on shock-hit firms We begin by studying the differential effects of the MPS banking shock on the firms directly exposed to MPS, that is, the empirical counterpart of midstream firms in the theoretical model. We implement a difference-in-differences specification:

$$Y_{i,t} = \alpha + \beta_1 \left(\text{MPS}_i \times \text{Post}_t\right) + \beta_2 \left(\text{Int-Integ}_{b(i)} \times \text{Post}_t\right) + \beta_3 \left(\text{Int-Integ}_{b(i)} \times \text{MPS}_i \times \text{Post}_t\right)$$
$$+ \beta_4 \left(\text{Ext-Integ}_i \times \text{MPS}_i \times \text{Post}_t\right) + \zeta^\top X_{i,t-1} + \mu_i + \theta_{b(i)} + \lambda_t + \varepsilon_{i,t}, \tag{49}$$

where $Y_{i,t}$ is a salient outcome of firm i in year t (e.g., sales or net trade credit). MPS_i is an indicator that takes a value of one if the firm was a client of MPS pre-crisis (in 2012). $Post_t$ is a post-shock dummy taking a value of one after 2012. $\textit{Int-Integ}_{b(i)}$ proxies for the degree of intensive-margin integration, namely, the intensity of factoring and discounting activities of firm i's lender banks, $b(i)$, prior to the crisis (in 2010), normalized by their activity in extending loan credit. $\textit{Ext-Integ}_i$ is the measure of extensive-margin integration of firm i, as detailed above. The time-varying firm controls $X_{i,t-1}$ include lagged values of log sales and firm age. These variables help account for pre-determined firm characteristics (size and maturity) that may be correlated with performance outcomes. We include a rich set of fixed effects to further address potential confounding factors. Firm fixed effects μ_i absorb time-invariant unobserved heterogeneity across firms, such as managerial ability, long-run productivity, or persistent access to external finance; year fixed effects λ_t control for aggregate macroeconomic trends and common policy shocks; lender fixed effects $\theta_{b(i)}$ account for time-invariant characteristics of firms' main banks, including their business model.

Table 4 presents the estimates. The preliminary tests in columns 1-2 show a negative association between MPS exposure and, respectively, the logarithm of bank debt and the logarithm of firm sales. We can also assess the consistency of the estimates in column 2 with the quantitative effect

[31] In the regressions we also control for a firm-specific measure of e-commerce usage drawn from the MET survey. This can account for possible alternative channels of influence of the instrument on firm performance via firms' direct digital commercial channels.

of a banking shock in our theoretical model. The estimates suggest that the (largely midstream) MPS clients experienced an average reduction in sales 3.4 percent larger than other sample firms following the shock. We fed the theoretical model with a shock to the midstream banks' net worth of the size of that experienced by MPS in 2013 (a net worth loss about 24 percent of the pre-shock net worth), using the shock persistence estimated in our quantitative exercise for the period 2010-2024. In the model, following such a shock, the drop in midstream firms' output over the seven years post shock turns out to be 2.8 percent larger than the drop in upstream and downstream firms' output. This magnitude is in the ballpark of that estimated in column 2 (3.4 percent). In column 3-4, we augment the regression in column 2 with the proxies for intensive- and extensive-margin bank-supply chain integration. In line with the theoretical predictions, we detect a shock-attenuating effect of intensive-margin integration (see the positive coefficient on the interaction term $\textit{Int-Integ}_{b(i)} \times MPS_i \times Post_t$): in column 3, with a one standard deviation increase in intensive-margin integration, the differential negative effect of the shock on the sales of MPS clients is reduced by 3.1 percentage points. By contrast, we estimate an amplifying effect of the extensive-margin integration: the coefficient on $\textit{Ext-Integ}_i \times MPS_i \times Post_t$ is negative.[32]

In the theoretical model, a key mechanism through which intensive-margin integration enhances the resilience of shock-hit midstream firms is by incentivizing suppliers' extension of trade credit. In column 5 of Table 4, the dependent variable is now $NetPayables_{i,t}$, defined as the difference between accounts payable and accounts receivable of firm i in year t. In line with the predictions of the model, we obtain that following the shock MPS clients received more net trade credit and especially so in the presence of a stronger integration of lending banks with supply chains.

We further investigate this mechanism by focusing on the subsample of firms in upstream industries. These are the firms that are predicted to supply more trade credit to shock-hit midstream firms. We classify a firm as upstream if it operates in agriculture, forestry and fishing, mining and quarrying, or basic manufacturing (NACE Rev. 2 divisions 01–25). These sectors sit at the beginning of the value chain, producing primary goods, raw materials, and processed intermediates — such as food products, textiles, chemicals, rubber, non-metallic minerals, and base metals — that flow downstream as inputs into further stages of production traditionally financed by MPS. In columns 6-7, we test the following empirical model:

$$\begin{aligned} \textit{Receivables}_{i,t} = \alpha &+ \gamma_1 \left(\text{Int-Integ}_{b(i)} \times \text{Post}_t\right) + \gamma_2 \left(\text{Int-Integ}_{b(i)} \times \text{SC}_i \times \text{Post}_t\right) \\ &+ \gamma_3 \left(\text{SC}_i \times \text{Post}_t\right) + \zeta^\top X_{i,t-1} + \mu_i + \theta_{b(i)} + \lambda_t + \varepsilon_{i,t}. \end{aligned} \tag{50}$$

[32] Having banks with geographical or sectoral specialization different from MPS is associated with an additional decline of the sales of MPS clients by 8 percentage points.

The dependent variable, $Receivables_{i,t}$, is now the value of accounts receivable of firm i in year t (scaled by the firm's assets). We define the supply chain participation of a firm with a pre-crisis indicator, SC_i, measured before the onset of the MPS shock (i.e., in 2012) and instrument it as detailed above. The values of the F-test from the first-stage estimates are above conventional thresholds for weak instruments. The second-stage estimates show that, following the MPS shock, upstream firms that participated in supply chains and whose banks were more involved in factoring and discounting activities extended more trade credit to their midstream customers.[33]

Altogether, in line with the predictions of the theoretical model, the results in Table 4 point to a shock-attenuating influence of the intensive margin of integration working through trade credit extension from upstream firms to shock-hit midstream firms. The results, on the other hand, point to a shock-amplifying influence of the extensive margin of bank-supply chain integration.

The broader impact of the shock We expand the view on the effects of the MPS banking shock on all firms by testing the following empirical model:

$$\begin{aligned} Y_{i,t} = \alpha &+ \delta_1 \left(\text{Commercial-Link}_{s(i)} \times \text{Post}_t\right) + \delta_2 \left(\text{Commercial-Link}_{s(i)} \times \text{SC}_i \times \text{Post}_t\right) \\ &+ \delta_3 \left(\text{SC}_i \times \text{Post}_t\right) + \delta_4 \left(\text{Int-Integ}_{b(i)} \times \text{Post}_t\right) + \delta_5 \left(\text{Int-Integ}_{b(i)} \times \text{SC}_i \times \text{Post}_t\right) \\ &+ \delta_6 \left(\text{Ext-Integ}_{p(i)} \times \text{Post}_t\right) + \delta_7 \left(\text{Ext-Integ}_{p(i)} \times \text{SC}_i \times \text{Post}_t\right) \\ &+ \zeta^\top X_{i,t-1} + \mu_i + \theta_{b(i)} + \lambda_t + \varepsilon_{i,t}, \end{aligned} \tag{51}$$

where $Y_{i,t}$ is the logarithm of sales of firm i in year t.[34] $Commercial\text{-}Link_{s(i)}$ reflects the exposure of firm i's sector, $s(i)$, to MPS-dependent sectors through input-output (supply chain) links. To construct this variable, for each 2-digit NACE Rev. 2 sector we calculate the share of firms borrowing from MPS prior to the shock (based on MET data). We then use the 2012 ISTAT input–output matrix to measure the degree to which each sector relies on other sectors for intermediate input purchases and output sales. These inter-sectoral weights allow us to build, for each firm, pre-shock measures of upstream linkages (through input purchases) and downstream linkages (through output sales) to sectors more affected by the MPS shock. In this empirical model, the $Ext\text{-}Integ_{p(i)}$ variable is constructed using bank-based indicators at the provincial or sectoral level. In particular, we consider the share of MPS branches in the firm's province in 2012 and the share of businesses in a firm's industry financed by MPS in 2012. Given the marked industry specialization of Italian provinces, the geographic penetration of MPS branches across provinces also reflects the extent to which its lending extends beyond traditional sectoral strongholds and specialization in specific

[33] In columns 6 and 7, we experiment with alternative definitions of upstream sectors, as reported in the table.

[34] The vectors of time-varying firm controls $X_{i,t-1}$ and fixed effects are as in the tests in Table 4.

supply chain segments. Alternatively, as an inverse measure of extensive-margin integration, we use the Herfindahl index of bank branches in the province.

Figure B.3 assesses the plausibility of the parallel trends assumption. It plots coefficients from a dynamic specification in which the post-shock dummy is replaced by a period-specific indicator for the extensive-margin integration variable $\textit{Ext-Integ}_{p(i)}$ (left panel) and the commercial link variable *Commercial-Link* (right panel). The pre-treatment coefficients (periods -2 and -1) are relatively stable and do not exhibit a systematic diverging trend, suggesting that differences in pre-shock levels across firms do not translate into differential pre-existing trends. The figure displays a break and clear shift in the post-treatment period, supporting a causal interpretation of the estimates.

Table 5 presents the estimates. In line with the predictions of the model, we detect a weaker sales performance for firms in supply chains and with commercial links to industries hit by the MPS shock (see the negative coefficient on $\textit{Commercial-Link}_{s(i)} \times SC_i \times Post_t$). Most interestingly for our purposes, we detect a shock-attenuating effect of the intensive margin bank-supply chain integration, as captured by the term $\textit{Int-Integ}_{b(i)} \times SC_i \times Post_t$. And if we interact the lender banks' intensity of supply chain finance with the sectoral indicator for supply chain finance intensity ($\textit{Int-Integ}_{b(i)} \times \textit{High supply chain finance}_{s(i)} \times Post_t$ in columns 2-3), we find that this attenuation is more pronounced in industries in which factoring and discounting is typically used more intensely. By contrast, again in line with the model, we estimate an amplifying effect of extensive-margin integration, as captured by the term $\textit{Ext-Integ}_{p(i)} \times SC_i \times Post_t$.[35]

6 Conclusion

The growing integration between banks and supply chains is redefining the mechanisms of firm financing. In this paper, we investigate the transmission of business cycles in an economy where banks finance supply chains. The results reveal strikingly different implications of different forms of bank-supply chain integration for macroeconomic stability. On the one hand, larger banking integration across the supply chain, that is, banks' ability to serve different segments of a supply chain, leads to stronger amplification of banking shocks. On the other hand, integration between banks and supply chains along an intensive margin, in the form of easier use of bank-mediated supply chain finance, enhances macroeconomic resilience in the face of banking shocks, both when it takes the form of a greater use of invoice discounting and of factoring. Empirical evidence from matched bank-firm data from Italy confirms the implications of the model.

[35] In Appendix Table B.3 we show robustness to using a time-varying measure of supply chain participation. Finally, in Appendix Table B.4 we use a shorter time window around the shock.

Our analysis leaves open questions for future research. One such question concerns the possible mechanisms through which the integration between banks and global value chains could influence the transmission of trade shocks, for example, in the form of higher tariffs imposed on the purchase of intermediate inputs from international suppliers. This could provide new insights into the impact of international financial integration on the integration or fragmentation of trade flows. We leave this and other relevant issues to future research.

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Table 1: Model Parameters. Baseline Calibration

	Households	
β	0.99	Household discount factor
ω	1	Household CRRA
k_c	5.584	Relative utility weight of labor
η	0.75	Inverse Frisch elasticity of labor supply
	Banks	
σ	0.975	Survival rate of bankers
ξ	0.8	Weight of bank assets in capital constraint
ι	0.0001	Proportional transfer to entering bankers
ρ	0.85	Persistence of banking shock
p	1.00001	Banks' gross profit margin for factoring
	Firms	
β_f	0.98	Firm discount factor
δ	0.025	Depreciation rate
α	0.4	Capital share before intermediate input
α_u	0.2	Share of Y^u for production of Y
α_m	0.35	Share of Y^m for production of Y
θ	0	Firm CRRA
ϕ	0.5	Share of input Y^{iu}, Y^{im} for production of Y^m, Y^d
κ	0.6	Efficiency of sector banks in collateralized capital management
κ^n	0.5	Efficiency of non-sector banks in collateralized capital management
c	0.3	Diseconomies of scale in collateral management
γ	0.0857	Efficiency of invoice discounting
f	0.65	% of invoices factored to bank
ν	1.5	% of input inventory liquidated for trade credit default
ε	0.75	Substitution parameter

Notes: This table reports the calibrated parameter values for the baseline model.

Table 2: Model Targets and Data Comparison

Target	**Baseline Model**	**Data**
Bank Leverage Ratio *((R*X+f*Rv*V)/N)*		
Bank Average (weighted by assets)	4.735	4.9
Firm Leverage Ratio *((R*X+Rv*V)/(K+(1-f)*Rv*V+P*Y))*		
Firm Average (weighted by assets)	0.597	0.58
Firm TC Borrowing / Bank Loans *(Rv*V/R*X)*		
Firm Average (weighted by assets)	0.288	0.28
Firm Net TC / Bank Loans *((Rvm*Vm - Rvd*Vd)/R*X)*		
Midstream Firm	0.064	0.07
Factored Invoices / Invoices *(f)*	0.65	0.65
Loan–Deposit Spread	0.012	0.013
Trade Credit–Loan Spread	0.0094	0.020

Notes: Comparison between the baseline model targets and the data.

Table 3: Variances of the Aggregate Variables: 2010 vs. 2024

Panel A: Conditional and Unconditional Variances ($\nu = 1.5$)

			Conditional Variances (Horizon)				
Variable	Model	Uncond.	*4*	*8*	*16*	*32*	*60*
Aggregate	Benchmark (2010)	0.143	0.016	0.048	0.091	0.127	0.141
Output (Y)	Alternative (2024)	0.135	0.015	0.044	0.085	0.120	0.133
Total	Benchmark (2010)	0.312	0.049	0.117	0.206	0.280	0.308
Credit (CR)	Alternative (2024)	0.297	0.046	0.110	0.197	0.268	0.294

Panel B: Change in Aggregate Output (Y) from 2010 to 2024

Metric	$\nu = 1.5$	$\nu = 1.65$	$\nu = 1.7$	$\nu = 1.82$
Gross Trade Credit / Asset	0.1899	0.2082	0.2143	0.2289
Variance Change (%)	-5.70	-7.00	-7.41	-8.39

Note: In Panel A, variances are multiplied by 10^3. The benchmark model is calibrated to 2010 data targets, while the alternative model matches 2024 targets. Panel B reports the weighted average of the gross trade credit to asset ratio and the percentage change in the unconditional variance of aggregate output from 2010 to 2024 across different values of ν.

Table 4: MPS Banking Shock, Bank-Supply Chain Integration, and Impact on MPS Clients

	Panel A: Full Sample					**Panel B: Upstream**	
	Bank debt	Sales	Sales	Sales	Net payables	Receivables	Receivables
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Direct exposure to MPS shock							
$\text{MPS}_i \times \text{Post}_t$	-0.127*	-0.0340**	-0.0891***	-0.0911***	0.00951**		
	[0.0707]	[0.0137]	[0.0251]	[0.0252]	[0.00405]		
Intensive margin bank-supply chain integration							
$\text{Int-Integ}_{b(i)} \times \text{MPS}_i \times \text{Post}_t$			3.155**	3.265***	0.470**		
			[1.261]	[1.258]	[0.207]		
$\text{Int-Integ}_{b(i)} \times \text{Post}_t$			-0.624	-0.623	0.371***	-1.533***	-6.439***
			[0.398]	[0.398]	[0.0615]	[0.276]	[2.444]
$\text{Supply chain}_i \times \text{Int-Integ}_{b(i)} \times \text{Post}_t$						4.197***	15.04**
						[1.215]	[6.032]
$\text{Supply chain}_i \times \text{Post}_t$						-0.0874***	0.157
						[0.0270]	[0.129]
Extensive margin bank-supply chain integration							
$\text{Ext–Int}_i \times \text{MPS}_i \times \text{Post}_t$			-0.0813**	-0.0607**	-0.000580		
			[0.0343]	[0.0309]	[0.00494]		
Ext-Int_i			Geographic	Sectoral	Geographic		
Firm controls	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y	Y	Y
Observations	430,357	717,820	677,907	677,907	674,944	231,660	312,162
Adj R-squared	0.730	0.767	0.769	0.769	0.547	-0.074	-0.906
Underidentification p-value						0.000	0.000
Kleibergen–Paap rk Wald F						60.132	9.684
Cragg–Donald Wald F statistic						787.707	13.676

Notes: Panel A is estimated on the full sample. In column 1, the dependent variable is the logarithm of bank debt. The dependent variable is the logarithm of sales in columns 2–4, and net payables scaled by total assets in column 5. Ext–Int_i denotes firms' exposure to banks whose pre-determined external integration differs from that of MPS. $\text{Int-Integ}_{b(i)}$ denotes bank integration with factoring activities. Panel B reports IV estimates for accounts receivable scaled by total assets. The endogenous variables are $\text{Supply chain} \times \text{Int-Integ}_{b(i)} \times \text{Post}_t$ and $\text{Supply chain}_i \times \text{Post}_t$. Column 6 restricts the sample to sectors classified as upstream using the input–output measure. Column 7 restricts the sample to upstream sectors based on the NACE Rev. 2 classification. All specifications include firm controls, firm fixed effects, year fixed effects, and bank fixed effects. Robust standard errors clustered at the firm level are reported in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5: MPS Shock and Bank-Supply Chain Integration. Broad Impact

	Sales				
	(1)	(2)	(3)	(4)	(5)
Commercial exposure to MPS shock					
Commercial-Link$_{s(i)}$ × Supply chain$_i$ × Post$_t$	-4.611***	-4.582***	-0.490***	-4.336***	-4.278***
	[0.965]	[0.962]	[0.0862]	[0.816]	[0.831]
Intensive margin bank-supply chain integration					
Int-Integ$_{b(i)}$ × Post$_t$	-5.657*	-0.168	-0.532	-0.955**	-0.955**
	[2.940]	[0.486]	[0.383]	[0.377]	[0.377]
Int-Integ$_{b(i)}$ × Supply chain$_i$ × Post$_t$	21.99**				
	[10.22]				
Int-Integ$_{b(i)}$ × High supply chain finance$_{s(i)}$ × Post$_t$		2.815***	2.036***	2.339***	2.342***
		[0.557]	[0.434]	[0.426]	[0.427]
High supply chain finance$_{s(i)}$ × Post$_t$		0.379***	0.159***	0.152***	0.153***
		[0.0516]	[0.0222]	[0.0213]	[0.0213]
Extensive margin bank-supply chain integration					
Ext-Integ$_{p(i)}$ × Post$_t$	0.621***	0.616***	1.417***	0.0665***	0.0112
	[0.134]	[0.133]	[0.243]	[0.0172]	[0.00816]
Ext-Integ$_{p(i)}$ × Supply chain$_i$ × Post$_t$	-1.826***	-1.807***	-6.114***	-0.180***	-0.0362*
	[0.381]	[0.379]	[1.038]	[0.0481]	[0.0201]
Ext-Integ$_{p(i)}$	Geographic	Geographic	Sectoral	Low-HHI (p75)	Low-HHI (p50)
Firm controls	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y
Observations	451,678	451,678	456,144	451,682	451,682
Underidentification p-value	0.000	0.000	0.000	0.000	0.000
Kleibergen-Paap rk Wald F	16.313	21.867	187.132	351.739	353.575
Cragg-Donald Wald F statistic	18.017	24.101	215.725	477.073	469.395

Notes: This table reports estimates for the effects of the MPS banking shock and the extensive and intensive margin of bank–supply chain integration on firms' sales. Columns (4) and (5) use alternative measures of extensive integration based on local banking-market concentration (HHI). In all regressions, Supply chain is instrumented as detailed in Section 5.1. See Section 5.1 for details on measurement and Section 5.2 for details on the empirical model. All the regressions include $Supplychain_i \times Post_t$ and $Commercial - Link_{s(i)} \times Post_t$. Robust standard errors in brackets. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

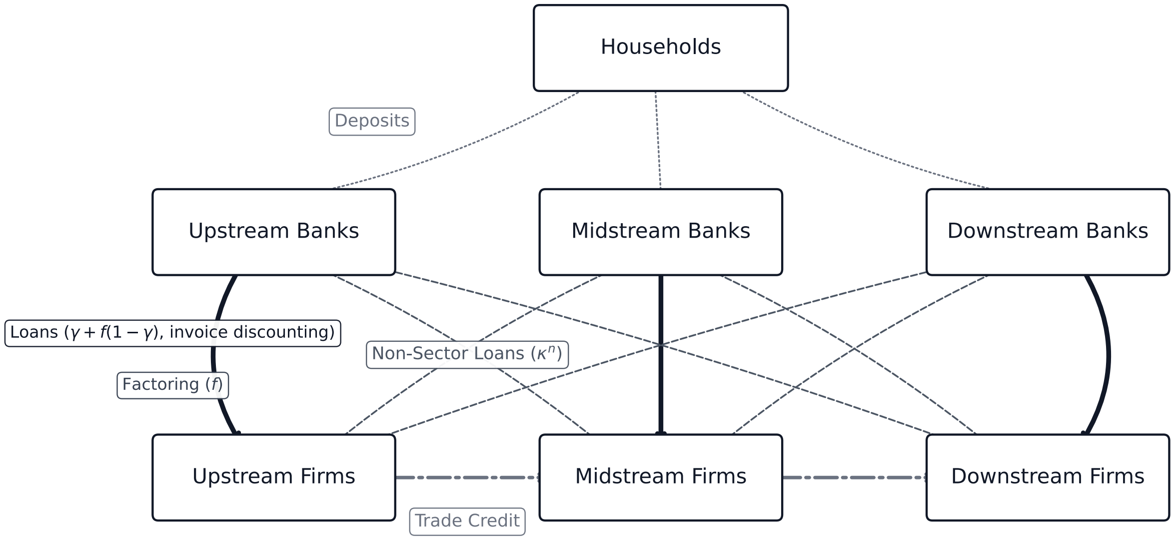

Figure 1: Flow of Funds: Firms, Banks, and Households

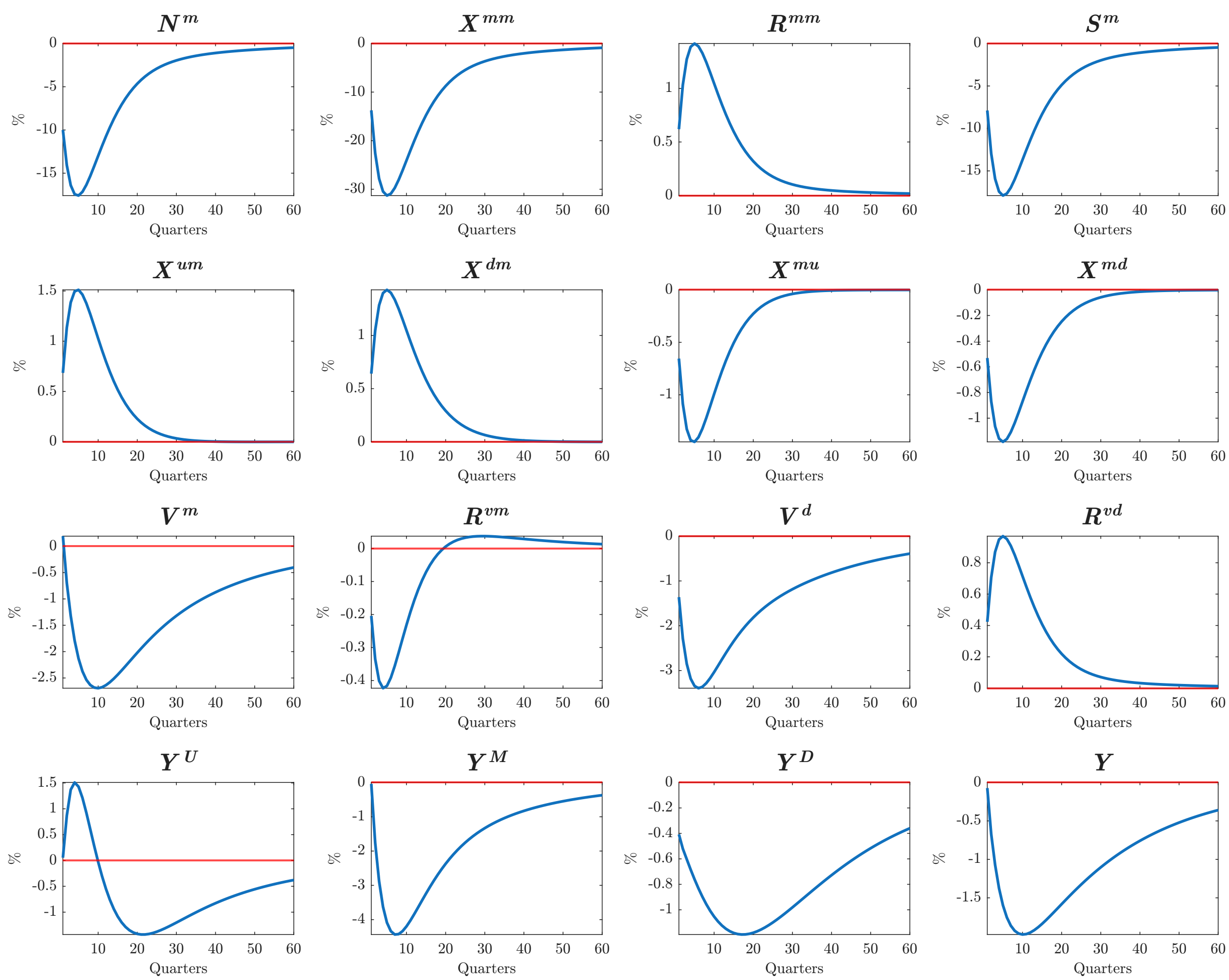

Figure 2: Responses to a Banking Shock. Baseline Results

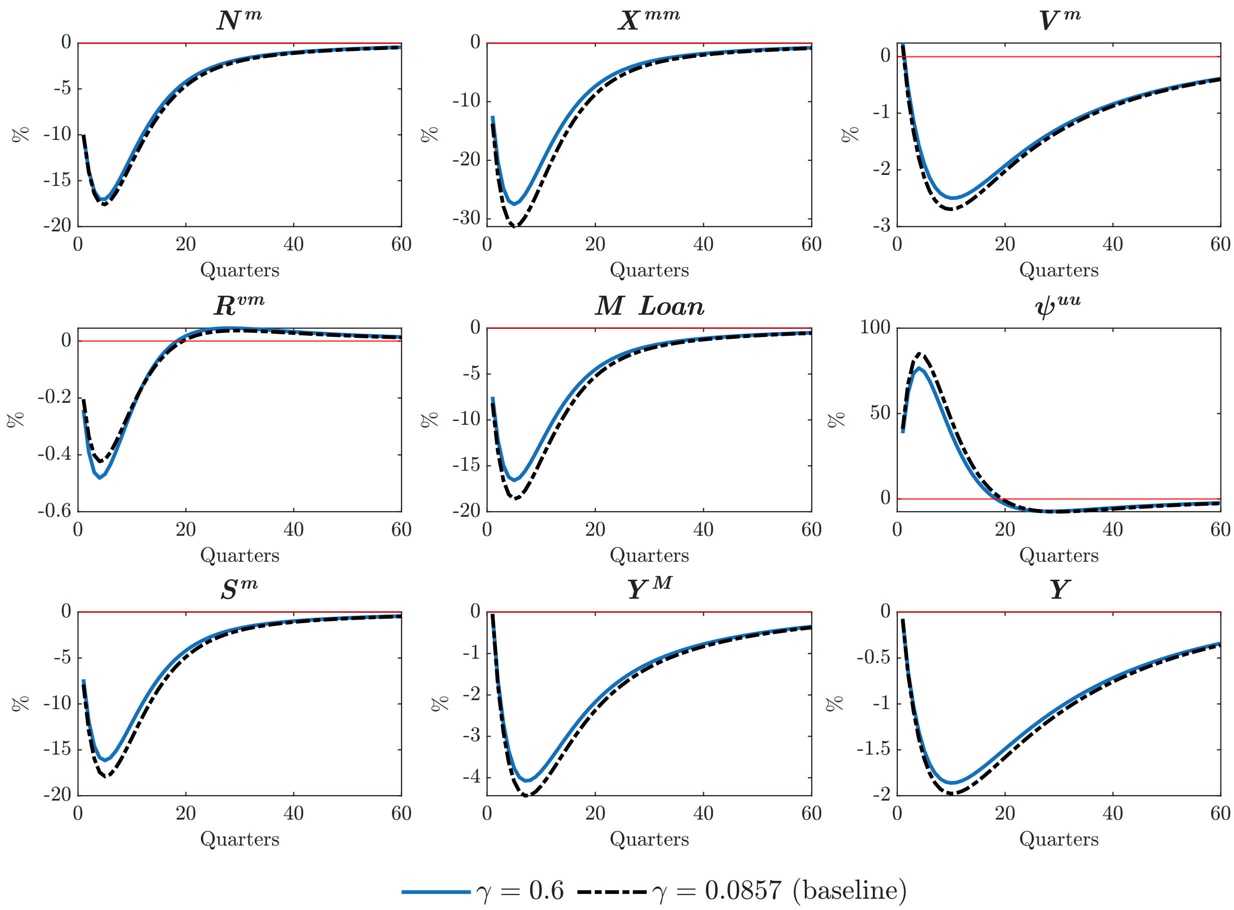

Figure 3: The Role of Intensive-Margin Integration (Invoice Discounting)

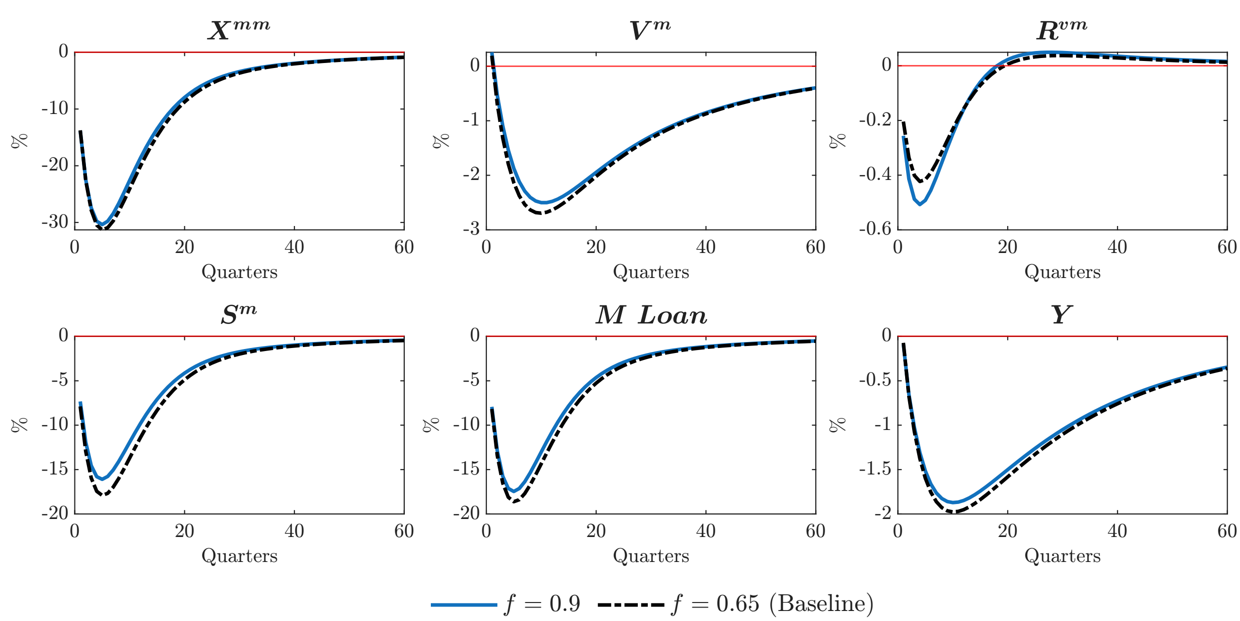

Figure 4: The Role of Intensive-Margin Integration (Factoring)

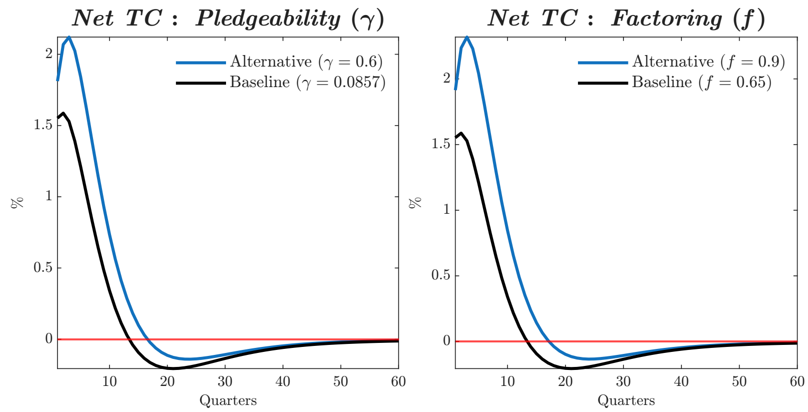

Figure 5: Response of Net Trade Credit and Intensive-Margin Integration

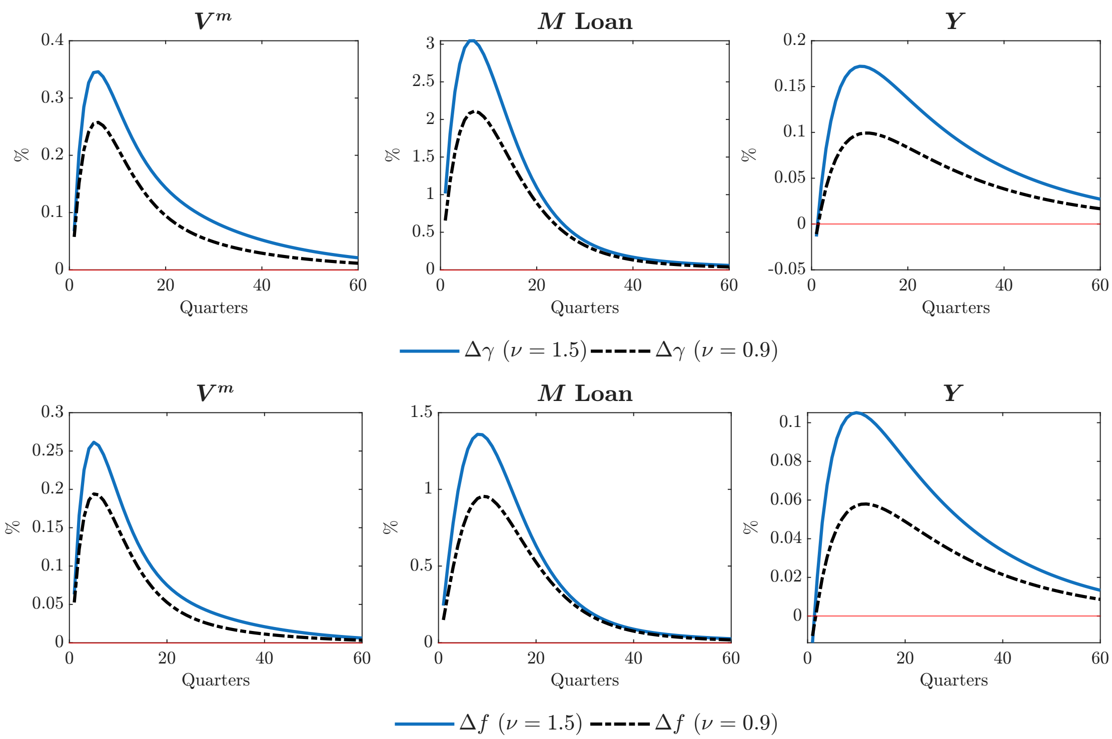

Figure 6: Commercial Links and Intensive-Margin Integration

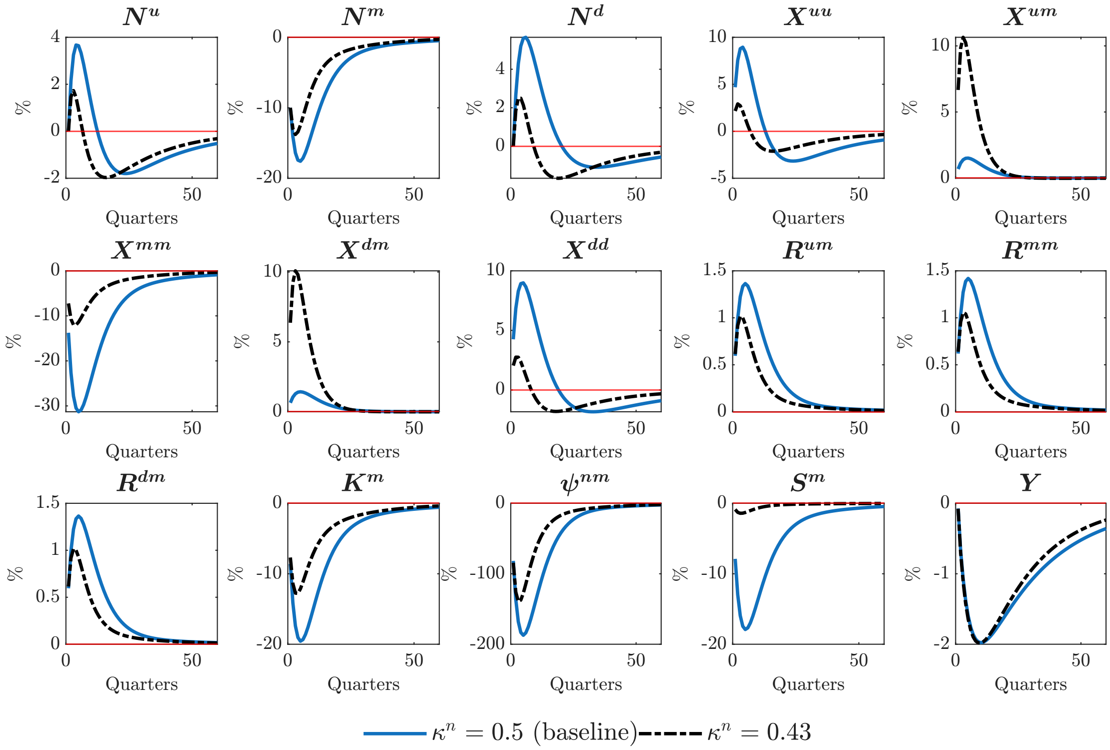

Figure 7: The Role of Extensive-Margin Integration

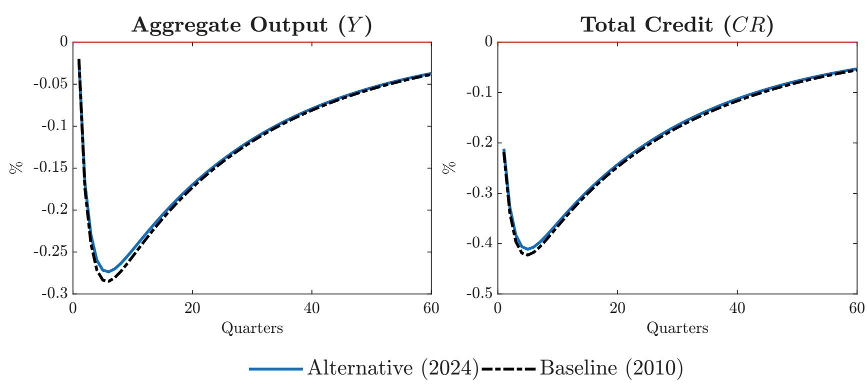

Figure 8: Aggregate Responses in Baseline and Counterfactual Economies

Online Appendix

This Online Appendix presents further details on the model solution (Appendix A) and additional details on data and empirical results (Appendix B).

A Further Details on Model Solution and Results

This online Appendix A contains more details on the model solution and figures with additional results of the model.

Details on full set of model equations

The equilibrium consists of 70 variables and 70 equations as shown in the following.

Variables:

Quantities:

$$C_t,\, C_t^u,\, C_t^m,\, C_t^d, \quad L_t,\, L_t^u,\, L_t^m,\, L_t^d, \quad K_t^u,\, K_t^m,\, K_t^d,$$
$$X_t^{uu},\, X_t^{um},\, X_t^{ud},\, X_t^{mu},\, X_t^{mm},\, X_t^{md},\, X_t^{du},\, X_t^{dm},\, X_t^{dd},$$
$$V_t^m,\, V_t^d, \quad Y_t^U,\, Y_t^{IU},\, Y_t^{FU},\, Y_t^M,\, Y_t^{IM},\, Y_t^{FM},\, Y_t^D,\, Y_t,$$
$$D_t,\, D_t^u,\, D_t^m,\, D_t^d, \quad N_t^u,\, N_t^m,\, N_t^d, \quad S_t^u,\, S_t^m,\, S_t^d$$

Prices:

$$R_t,\, R_t^{uu},\, R_t^{um},\, R_t^{ud},\, R_t^{mu},\, R_t^{mm},\, R_t^{md},\, R_t^{du},\, R_t^{dm},\, R_t^{dd},$$
$$R_t^{vm},\, R_t^{vd}, \quad W_t, \quad P_t^U,\, P_t^M,\, P_t^D,$$
$$\psi_t^{uu},\, \psi_t^{nu},\, \psi_t^{mm},\, \psi_t^{nm},\, \psi_t^{dd},\, \psi_t^{nd},$$
$$\chi_t^m,\, \chi_t^d, \quad \lambda_t^u,\, \lambda_t^m,\, \lambda_t^d, \quad \mu_t^u,\, \mu_t^m,\, \mu_t^d$$

Households. Budget constraint and labor aggregation:

$$C_t + D_t = W_t L_t + \Pi_t + R_{t-1} D_{t-1},$$
$$L_t = L_t^u + L_t^m + L_t^d,$$
$$D_t = D_t^u + D_t^m + D_t^d.$$

Π_t is the difference between net worth of exiting bankers and transfers to new bankers:

$$\Pi_{t+1} = (1-\sigma)\left(\sum_{j \in \{uu,um,ud,mu,mm,md,du,dm,dd\}} R_t^j X_t^j + pf^u R_t^{vm} V_t^m + pf^m R_t^{vd} V_t^d - R_t D_t \right)$$
$$- \iota \left(\sum_{j \in \{uu,um,ud,mu,mm,md,du,dm,dd\}} R_t^j X_t^j + pf^u R_t^{vm} V_t^m + pf^m R_t^{vd} V_t^d \right).$$

First-order conditions:

$$[\partial L_t]: \quad U^H_{C,t}\big(W_t - k_c L_t^{\eta}\big) = 0,$$

$$[\partial D_t]: \quad E_t[\Lambda_{t,t+1}]\, R_t = 1,$$

with

$$U^H_{C,t} = \left[C_t - k_c \frac{L_t^{1+\eta}}{1+\eta}\right]^{-\omega}, \qquad \Lambda_{t,t+1} = \frac{\beta\, U^H_{C,t+1}}{U^H_{C,t}}.$$

Banks. First-order conditions:

Upstream bank

$$[\partial X^{uu}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{uu}_t(1-\sigma+\sigma\lambda^u_{t+1}) - \lambda^u_t + \mu^u_t \xi R^{uu}_t = 0,$$

$$[\partial X^{um}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{um}_t(1-\sigma+\sigma\lambda^u_{t+1}) - \lambda^u_t + \mu^u_t \xi R^{um}_t - k_b \lambda^u_t (X^{um}_t - \overline{X^{um}_t}) = 0,$$

$$[\partial X^{ud}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{ud}_t(1-\sigma+\sigma\lambda^u_{t+1}) - \lambda^u_t + \mu^u_t \xi R^{ud}_t - k_b \lambda^u_t (X^{ud}_t - \overline{X^{ud}_t}) = 0,$$

$$[\partial D^u_t]: \; -R_t E_t[\Lambda_{t,t+1}](1-\sigma+\sigma\lambda^u_{t+1}) + \lambda^u_t - \mu^u_t R_t = 0.$$

Midstream bank

$$[\partial X^{mu}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{mu}_t(1-\sigma+\sigma\lambda^m_{t+1}) - \lambda^m_t + \mu^m_t \xi R^{mu}_t - k_b \lambda^m_t (X^{mu}_t - \overline{X^{mu}_t}) = 0,$$

$$[\partial X^{mm}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{mm}_t(1-\sigma+\sigma\lambda^m_{t+1}) - \lambda^m_t + \mu^m_t \xi R^{mm}_t = 0,$$

$$[\partial X^{md}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{md}_t(1-\sigma+\sigma\lambda^m_{t+1}) - \lambda^m_t + \mu^m_t \xi R^{md}_t - k_b \lambda^m_t (X^{md}_t - \overline{X^{md}_t}) = 0,$$

$$[\partial D^m_t]: \; -R_t E_t[\Lambda_{t,t+1}](1-\sigma+\sigma\lambda^m_{t+1}) + \lambda^m_t - \mu^m_t R_t = 0.$$

Downstream bank

$$[\partial X^{du}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{du}_t(1-\sigma+\sigma\lambda^d_{t+1}) - \lambda^d_t + \mu^d_t \xi R^{du}_t - k_b \lambda^d_t (X^{du}_t - \overline{X^{du}_t}) = 0,$$

$$[\partial X^{dm}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{dm}_t(1-\sigma+\sigma\lambda^d_{t+1}) - \lambda^d_t + \mu^d_t \xi R^{dm}_t - k_b \lambda^d_t (X^{dm}_t - \overline{X^{dm}_t}) = 0,$$

$$[\partial X^{dd}_t]: \; E_t[\Lambda_{t,t+1}]\, R^{dd}_t(1-\sigma+\sigma\lambda^d_{t+1}) - \lambda^d_t + \mu^d_t \xi R^{dd}_t = 0,$$

$$[\partial D^d_t]: \; -R_t E_t[\Lambda_{t,t+1}](1-\sigma+\sigma\lambda^d_{t+1}) + \lambda^d_t - \mu^d_t R_t = 0.$$

Aggregate net worth dynamics (survivors + transfers):

$$N^u_{t+1} = \sigma\left(\sum_{j\in\{uu,um,ud\}} R^j_t X^j_t + pf^u R^{vm}_t V^m_t - R_t D^u_t\right) + \iota\left(\sum_{j\in\{uu,um,ud\}} R^j_t X^j_t + pf^u R^{vm}_t V^m_t\right) + \bar{N}^u \upsilon^u_{t+1},$$

$$N^m_{t+1} = \sigma\left(\sum_{j\in\{mu,mm,md\}} R^j_t X^j_t + pf^m R^{vd}_t V^d_t - R_t D^m_t\right) + \iota\left(\sum_{j\in\{mu,mm,md\}} R^j_t X^j_t + pf^m R^{vd}_t V^d_t\right) + \bar{N}^m \upsilon^m_{t+1},$$

$$N^d_{t+1} = \sigma\left(\sum_{j\in\{du,dm,dd\}} R^j_t X^j_t - R_t D^d_t\right) + \iota\left(\sum_{j\in\{du,dm,dd\}} R^j_t X^j_t\right) + \bar{N}^d \upsilon^d_{t+1}.$$

Upstream firms. First-order conditions:

$$[\partial L_t^u]: \; P_t^u(1-\alpha)\frac{Y_t^u}{L_t^u} - W_t = 0,$$

$$[\partial K_t^u]: \; -(C_t^u)^{-\theta} + \psi_t^{nu}\kappa^n(1-S_t^u) + \psi_t^{uu}\left[\kappa S_t^u - \frac{\kappa c(S_t^u)^2 K_t^u}{\overline{K^u}}\right] + \beta_f E_t\big[(C_{t+1}^u)^{-\theta}\big]\left(P_{t+1}^u\alpha\frac{Y_{t+1}^u}{K_t^u} + 1 - \delta\right) = 0,$$

$$[\partial X_t^{uu}]: \; (C_t^u)^{-\theta} - \psi_t^{uu}R_t^{uu} - \beta_f E_t\big[(C_{t+1}^u)^{-\theta}\big]R_t^{uu} = 0,$$

$$[\partial X_t^{mu}]: \; (C_t^u)^{-\theta} - \psi_t^{nu}R_t^{mu} - \beta_f E_t\big[(C_{t+1}^u)^{-\theta}\big]R_t^{mu} = 0,$$

$$[\partial X_t^{du}]: \; (C_t^u)^{-\theta} - \psi_t^{nu}R_t^{du} - \beta_f E_t\big[(C_{t+1}^u)^{-\theta}\big]R_t^{du} = 0,$$

$$[\partial V_t^m]: \; (C_t^u)^{-\theta}(-1+f^u) + \psi_t^{uu}\Omega(f^u)(1-f^u)R_t^{vm} + \beta_f E_t\big[(C_{t+1}^u)^{-\theta}\big](1-pf^u)R_t^{vm} = 0,$$

$$[\partial S_t^u]: \; -\psi_t^{nu}\kappa^n K_t^u + \psi_t^{uu}\left[\kappa K_t^u - \frac{\kappa c S_t^u(K_t^u)^2}{\overline{K^u}}\right] = 0.$$

Midstream firms. First-order conditions:

$$[\partial L_t^m]: \; P_t^m(1-\phi)(1-\alpha)\frac{Y_t^m}{L_t^m} - W_t = 0,$$

$$[\partial K_t^m]: \; -(C_t^m)^{-\theta} + \psi_t^{nm}\kappa^n(1-S_t^m) + \psi_t^{mm}\left[\kappa S_t^m - \frac{\kappa c(S_t^m)^2 K_t^m}{\overline{K^m}}\right] + \beta_f E_t\big[(C_{t+1}^m)^{-\theta}\big]\left[1 - \delta + P_{t+1}^m(1-\phi)\alpha\frac{Y_{t+1}^m}{K_t^m}\right] = 0,$$

$$[\partial X_t^{um}]: \; (C_t^m)^{-\theta} - \psi_t^{nm}R_t^{um} - \beta_f E_t\big[(C_{t+1}^m)^{-\theta}\big]R_t^{um} = 0,$$

$$[\partial X_t^{mm}]: \; (C_t^m)^{-\theta} - \psi_t^{mm}R_t^{mm} - \beta_f E_t\big[(C_{t+1}^m)^{-\theta}\big]R_t^{mm} = 0,$$

$$[\partial X_t^{dm}]: \; (C_t^m)^{-\theta} - \psi_t^{nm}R_t^{dm} - \beta_f E_t\big[(C_{t+1}^m)^{-\theta}\big]R_t^{dm} = 0,$$

$$[\partial V_t^m]: \; (C_t^m)^{-\theta} - \chi_t^m R_t^{vm} - \beta_f E_t\big[(C_{t+1}^m)^{-\theta}\big]R_t^{vm} = 0,$$

$$[\partial V_t^d]: \; (C_t^m)^{-\theta}(-1+f^m) + \psi_t^{mm}\Omega(f^m)(1-f^m)R_t^{vd} + \beta_f E_t\big[(C_{t+1}^m)^{-\theta}\big](1-pf^m)R_t^{vd} = 0,$$

$$[\partial Y_t^{iu}]: \; (C_t^m)^{-\theta}\left(P_t^m\phi\frac{Y_t^m}{Y_t^{iu}} - P_t^u\right) + \chi_t^m\nu P_t^u = 0.$$

Downstream firms. First-order conditions:

$$
\begin{aligned}
&[\partial L_t^d]:\ P_t^d(1-\phi)(1-\alpha)\frac{Y_t^d}{L_t^d} - W_t = 0,\\
&[\partial K_t^d]:\ -(C_t^d)^{-\theta} + \psi_t^{nd}\kappa^n(1-S_t^d) + \psi_t^{dd}\left[\kappa S_t^d - \frac{\kappa c(S_t^d)^2 K_t^d}{\overline{K^d}}\right]\\
&\qquad\qquad + \beta_f E_t\big[(C_{t+1}^d)^{-\theta}\big]\left[1-\delta+P_{t+1}^d(1-\phi)\alpha\frac{Y_{t+1}^d}{K_t^d}\right] = 0,\\
&[\partial X_t^{ud}]:\ (C_t^d)^{-\theta} - \psi_t^{nd}R_t^{ud} - \beta_f E_t\big[(C_{t+1}^d)^{-\theta}\big]R_t^{ud} = 0,\\
&[\partial X_t^{md}]:\ (C_t^d)^{-\theta} - \psi_t^{nd}R_t^{md} - \beta_f E_t\big[(C_{t+1}^d)^{-\theta}\big]R_t^{md} = 0,\\
&[\partial X_t^{dd}]:\ (C_t^d)^{-\theta} - \psi_t^{dd}R_t^{dd} - \beta_f E_t\big[(C_{t+1}^d)^{-\theta}\big]R_t^{dd} = 0,\\
&[\partial V_t^d]:\ (C_t^d)^{-\theta} - \chi_t^d R_t^{vd} - \beta_f E_t\big[(C_{t+1}^d)^{-\theta}\big]R_t^{vd} = 0,\\
&[\partial Y_t^{im}]:\ (C_t^d)^{-\theta}\left(P_t^d\phi\frac{Y_t^d}{Y_t^{im}} - P_t^m\right) + \chi_t^d\nu P_t^M = 0.
\end{aligned}
$$

Final good producer. First-order conditions:

$$
\begin{aligned}
&[\partial Y_t^{fu}]:\ \frac{1}{\varepsilon}Y_t^{1-\varepsilon}\,\alpha_u\varepsilon(Y_t^{fu})^{\varepsilon-1} - P_t^u = 0,\\
&[\partial Y_t^{fm}]:\ \frac{1}{\varepsilon}Y_t^{1-\varepsilon}\,\alpha_m\varepsilon(Y_t^{fm})^{\varepsilon-1} - P_t^m = 0,\\
&[\partial Y_t^{d}]:\ \frac{1}{\varepsilon}Y_t^{1-\varepsilon}\,(1-\alpha_u-\alpha_m)\varepsilon(Y_t^{d})^{\varepsilon-1} - P_t^d = 0.
\end{aligned}
$$

More details on model properties and on microfoundations

Loan rates and trade credit rates

In the model, each of the three banks sets three firm-specific loan rates, for a total of nine. Banks' first-order conditions imply within-bank equalization in steady state: a given bank charges the same loan rate to all firms it lends to. For example, the upstream bank's steady-state first-order condition for lending to the upstream firm yields

$$
R^{uu} = \frac{\lambda^u}{\beta\big[(1-\sigma+\sigma\lambda^u)(1-\xi)+\xi\lambda^u\big]},
$$

and the same expression applies to R^{um} and R^{ud}. Analogous conditions hold for the midstream and downstream banks.

Firms' first-order conditions then imply cross-bank equalization. Combining equations (21) and (22) shows that the upstream firm faces the same loan rate from the midstream and downstream banks in steady state. Applying the same argument to the remaining firms implies that all nine loan rates coincide in steady state. It follows that the six firm-side Lagrange multipliers on borrowing constraints, ψ, also equalize.

There are two trade-credit rates, R^{vm} and R^{vd}. The steady-state first-order conditions with respect to V^m and V^d imply

$$R^{vm} = \frac{(C^u)^{-\theta}(1-f^u)}{\psi^{uu}\,\Omega(f^u)(1-f^u) + \beta_f(C^u)^{-\theta}(1-pf^u)},$$
$$R^{vd} = \frac{(C^m)^{-\theta}(1-f^m)}{\psi^{mm}\,\Omega(f^m)(1-f^m) + \beta_f(C^m)^{-\theta}(1-pf^m)}.$$

From the firms' first-order conditions, the multipliers equalize in steady state, $\psi^{uu} = \psi^{mm}$. Therefore, under our parameterization, the two right-hand sides coincide, so $R^{vm} = R^{vd}$. This means there is a single steady-state price of inter-firm credit, and upstream and midstream firms face the same marginal cost of extending or factoring trade credit.

The equalization of loan rates is driven by the integration at the extensive margin between banks and the supply chain. If credit markets are fragmented and firms borrow only from their sector bank, with $\kappa^n = 0$, then cross-bank arbitrage cannot operate and loan rates across banks need not coincide. A similar logic applies to trade-credit rates. When credit markets are segmented, the firm-side multipliers ψ need not equalize. Consequently, the two trade-credit rates need not coincide.

Midstream firms' trade credit demand and supply

In the steady state of the model, midstream firms simultaneously borrow from upstream firms and extend trade credit to downstream firms, even though the interest rates are identical ($R^{vm} = R^{vd}$). This arises primarily from the assumption that trade credit extended to downstream firms can be pledged as collateral when borrowing from sector banks (invoice discounting).

To better illustrate this point, we show that without invoice discounting ($\Omega(.) = 0$), midstream firms would not simultaneously borrow and extend trade credit. Specifically, under the assumption that no profits are generated from factoring ($p = 1$), the steady-state first-order conditions (30) and (31) reduce to

$$-(C^m)^{-\theta} + \beta_f(C^m)^{-\theta}R^{vd} + \zeta = 0,$$
$$(C^m)^{-\theta} - \chi^m R^{vm} - \beta_f(C^m)^{-\theta}R^{vm} = 0,$$

where ζ_t is the multiplier on the non-negativity constraint $V^d \geq 0$ introduced into the midstream firm's problem for this illustration. Using the result $R^{vm} = R^{vd}$, these first-order conditions imply that $\zeta = \chi^m R^{vm} > 0$ if and only if $\chi^m > 0$. In other words, whenever the borrowing constraint to borrow from upstream firms is binding ($\chi^m > 0$), the midstream firms will not extend trade credit to downstream firms ($\zeta > 0$ and $V^d = 0$).

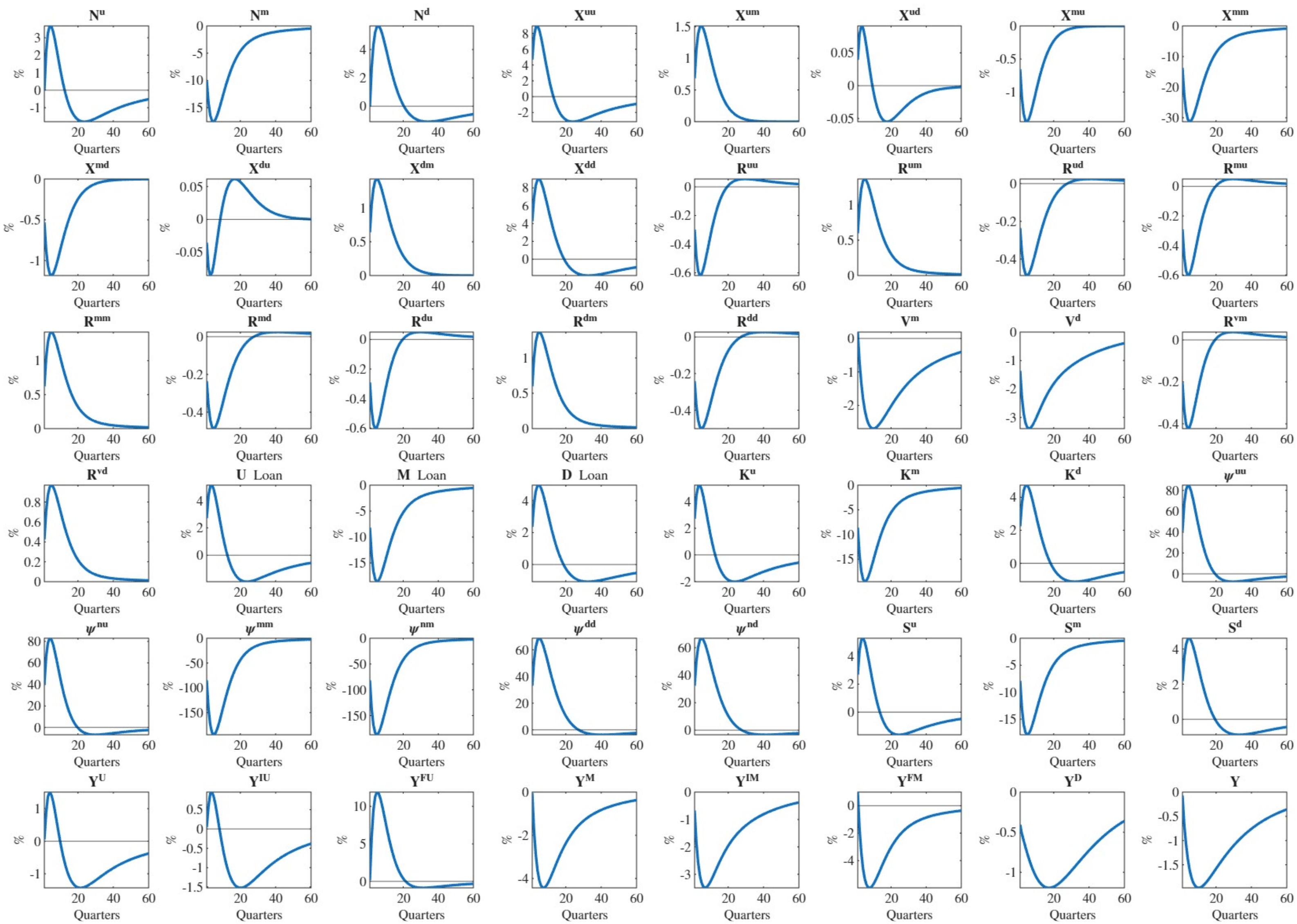

Figure A.1: Responses to a Banking Shock. Full Set of Baseline Results

Note: Interest rates R_t^{uu} to R_t^{vd} show the response in percentage points.

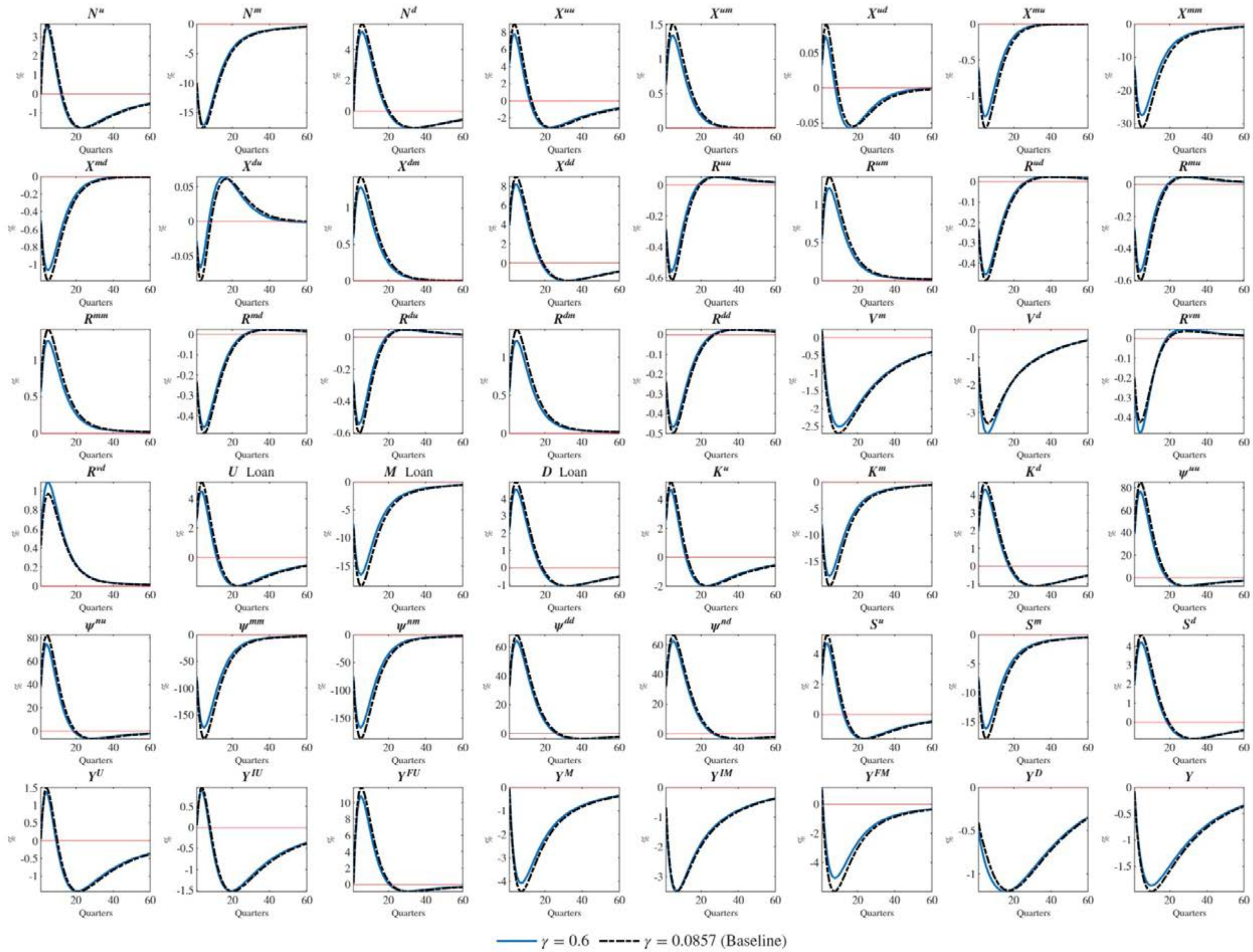

Figure A.2: Intensive margin (γ). Full Set of Impulse Responses

Note: Interest rates R_t^{uu} to R_t^{vd} show the response in percentage points.

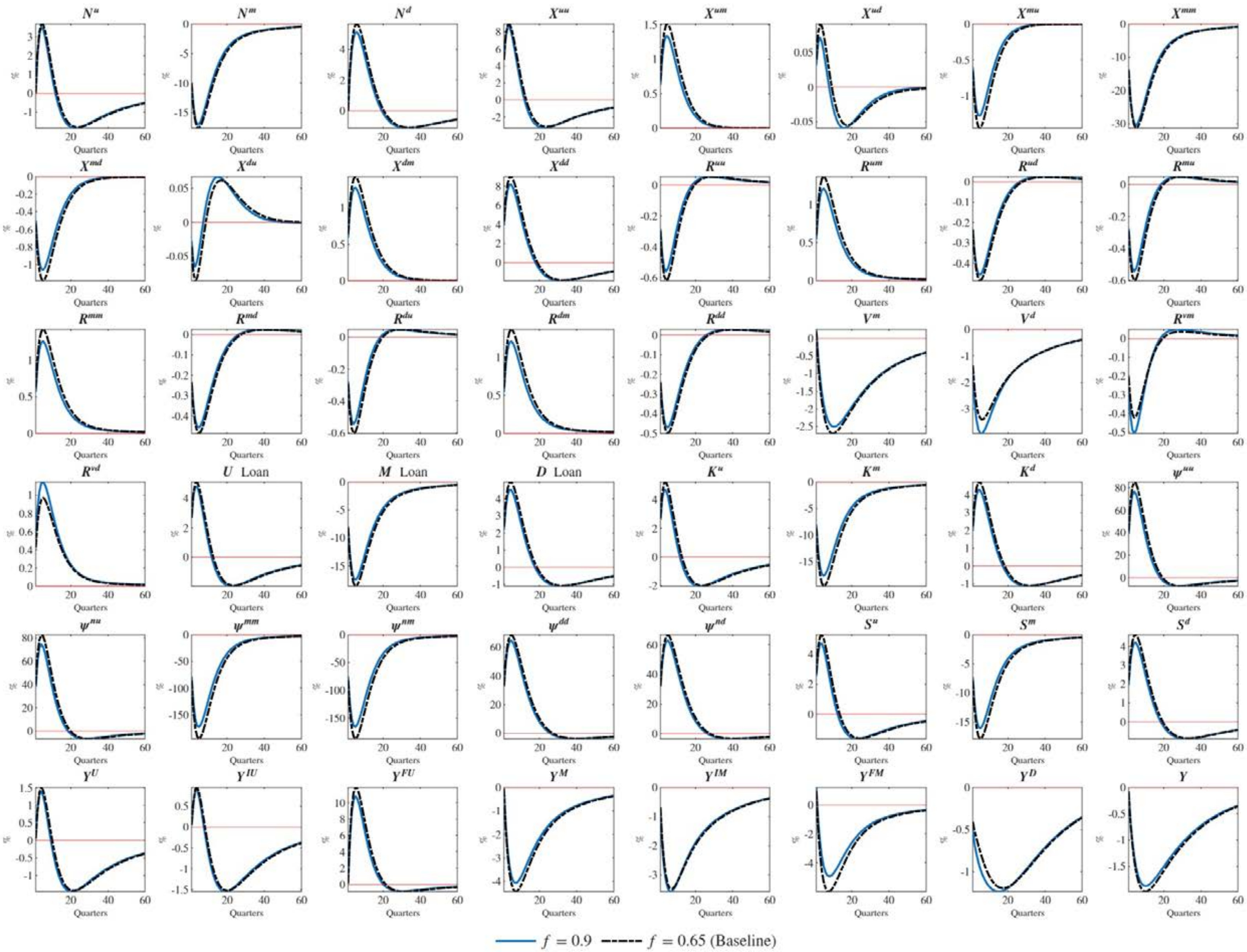

Figure A.3: Intensive margin (f). Full Set of Impulse Responses

Note: Interest rates R_t^{uu} to R_t^{vd} show the response in percentage points.

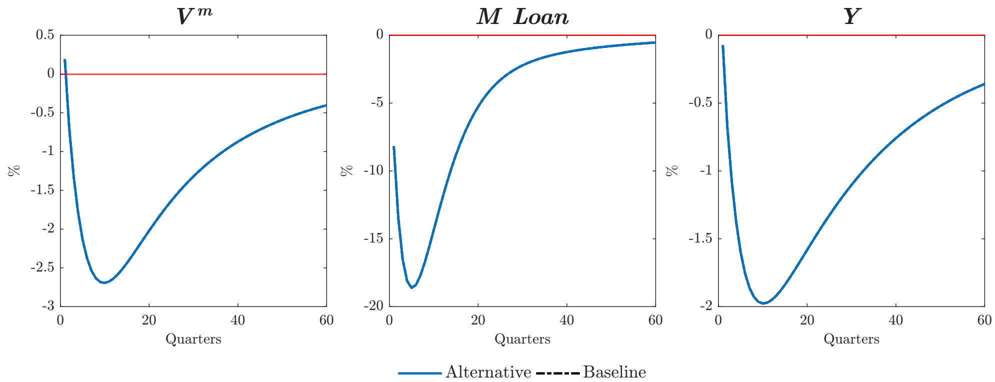

Figure A.4: Double-Difference IRFs: Factoring (f) Across Profit Margins (p)

Note: Profit margins treated as a pledgeable asset in capital requirements.

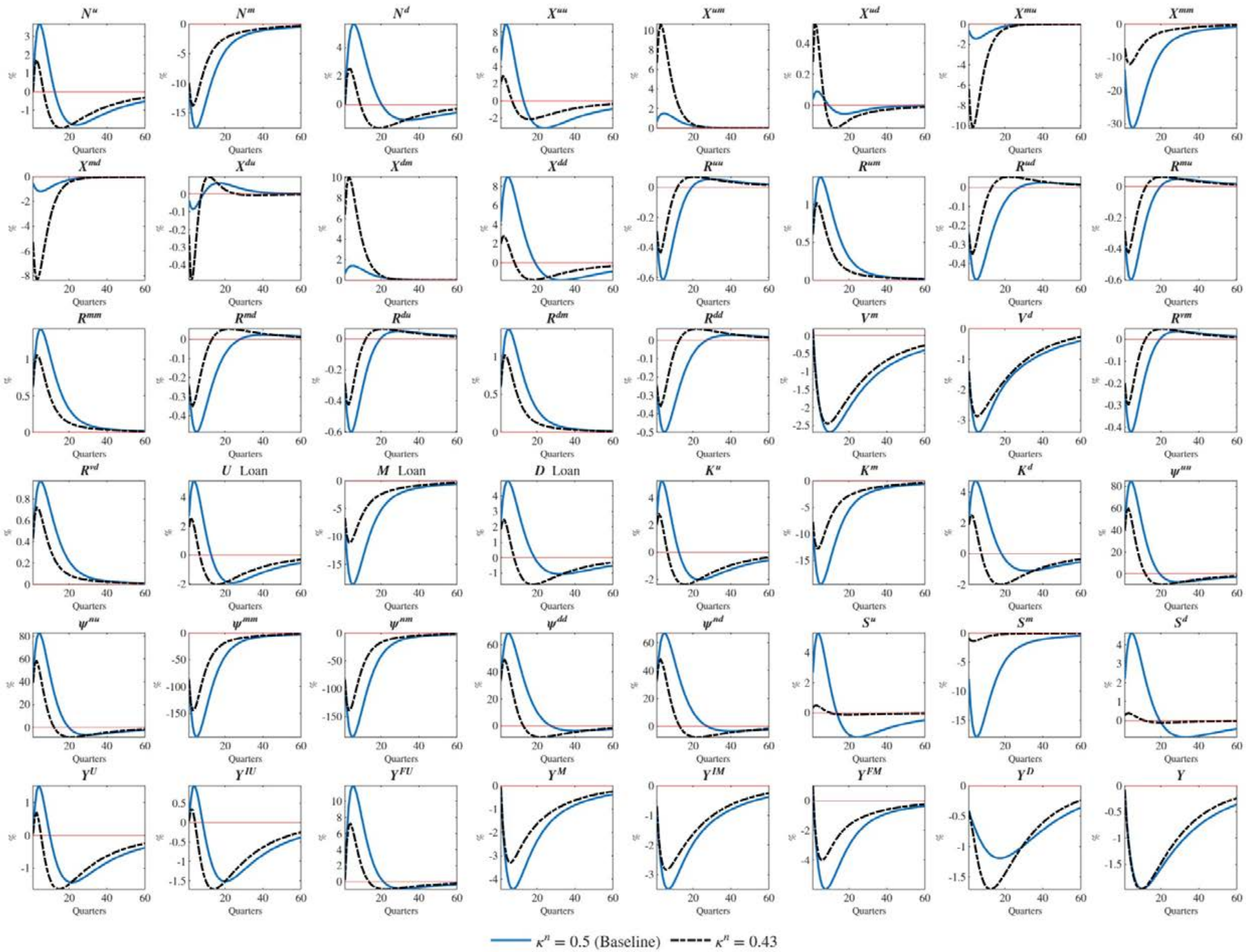

Figure A.5: Extensive Margin. Full Set of Impulse Responses

Note: Interest rates R_t^{uu} to R_t^{vd} show the response in percentage points.

B Further Details on Data and Empirical Results

Further details on data sources

MET Survey (Monitoraggio Economia e Territorio) Our primary data source is the MET survey, a large-scale survey of Italian firms conducted in multiple waves (2008–2023), each covering approximately 24,000 firms. The survey is representative along firm size, geographic location (NUTS-2 regions), and industry. It provides detailed information on firms' participation in supply chains, use of trade credit, financial constraints, and—crucially—the identity of lending banks and the duration of each credit relationship. These features allow us to construct a panel of firm–bank linkages and to observe firms' exposure to supply chain finance.

ISTAT FrameSBS (Structural Business Statistics) We complement the MET survey with administrative data from ISTAT's FrameSBS, which covers the universe of Italian firms in manufacturing and services. This dataset provides yearly information on firms' sales, employment, age, sector, and geographic location (at the NUTS-3 level). We use FrameSBS to obtain accurate measures of firm size and performance and to ensure consistency with official statistics. For sensitivity reasons, data from ISTAT FrameSBS are accessible only upon formal request for authorization and exclusively within the ISTAT secured laboratories (*Laboratorio ADELE*).

AIDA (Bureau van Dijk) We further integrate firm-level balance-sheet data from the AIDA database, which includes the universe of incorporated Italian firms. AIDA provides detailed financial information, including investment, accounts receivable and payable, and other balance-sheet variables. These data are used to construct measures of trade credit and to complement survey-based information with accounting-based indicators.

Bank balance-sheet data and factoring activity Finally, we use detailed bank-level data on balance sheets and factoring activity. These data allow us to measure banks' involvement in supply chain finance and to construct indicators of bank specialization and exposure to factoring. Combined with the MET survey, they enable us to link firm-level outcomes to the characteristics and activities of lending banks.

Further details on the effect of the MPS shock on MPS clients

In 2012, MPS was the third-largest banking group in Italy in terms of total assets, and approximately 17 percent of firms in our sample reported having an active credit relationship with the bank. We rely on pre-crisis information to define this exposure as a precautionary measure to mitigate concerns about endogenous bank selection—since more creditworthy firms may have had the ability to drop MPS as a lender after the shock and switch to better-capitalized banks. Reassuringly, the risk of selection through switching is limited in our context: as documented by D'Auria et al. (1999), Italian firms tend to maintain stable banking relationships over time and typically add, rather than replace, banking partners. Consistent with this evidence, actual switching is negligible in our data, with fewer than 0.05 percent of firms reporting a change in their main bank over the sample period.

Details on extensive-margin integration measure

We provide more details on the construction of the firm-level geographic and sectoral measures of banks-supply chain integration.

Geographic measure. We begin by collecting information on the universe of bank branches operating in Italy between 2006 and 2012. For each bank b, we compute the share of its branches located in each Italian region r:

$$s_{br} = \frac{\text{Branches}_{br}}{\sum_r \text{Branches}_{br}}.$$

Similarly, we compute the regional distribution of branches for MPS, denoted by $s_{MPS,r}$. We then measure the similarity between bank b and MPS using the cosine similarity between their regional branch distributions:

$$Cosine_b^{Geo} = \frac{\sum_r s_{br} s_{MPS,r}}{\sqrt{\sum_r s_{br}^2}\sqrt{\sum_r s_{MPS,r}^2}}.$$

The geographic distance from MPS is defined as

$$Dist_b^{Geo} = 1 - Cosine_b^{Geo}.$$

Higher values indicate branch networks concentrated in regions that differ more substantially from those in which MPS operates.

Sectoral distance. We construct an analogous measure based on banks' lending portfolios. Using the MET survey and detailed information on firms' banking relationships in the pre-shock period, we identify the set of firms connected to each bank and compute the distribution of clients across two-digit industries. For each bank b, let

$$q_{bs} = \frac{\text{Clients}_{bs}}{\sum_s \text{Clients}_{bs}},$$

where Clients_{bs} denotes the number of client firms of bank b operating in industry s. We compute the corresponding distribution for MPS, denoted by $q_{MPS,s}$. Using the same approach as above, we define

$$Cosine_b^{Sect} = \frac{\sum_s q_{bs} q_{MPS,s}}{\sqrt{\sum_s q_{bs}^2}\sqrt{\sum_s q_{MPS,s}^2}},$$

and

$$Dist_b^{Sect} = 1 - Cosine_b^{Sect}.$$

Higher values indicate banks whose client base is concentrated in industries that differ more markedly from those served by MPS.

Firm-level indicators. We then map these bank-level measures into firm-level indicators. For each firm i, we compute the average distance from MPS across all banks with which the firm maintains a banking relationship in the pre-shock period:

$$Dist_i = \frac{1}{N_i} \sum_{b \in \mathcal{B}_i} Dist_b,$$

where $\mathcal{B}_i$ denotes the set of banks connected to firm i and N_i is the number of such relationships. Finally, we define

$$Ext\text{-}Integ_i = \mathbf{1}\left(Dist_i > P75(Dist_i)\right),$$

where $P75(Dist_i)$ denotes the 75th percentile of the cross-sectional distribution of firm-level distance.

We construct this indicator separately using the geographic and sectoral distance measures. The geographic version identifies firms connected to banks whose branch networks differ substantially from that of MPS, while the sectoral version identifies firms connected to banks whose client portfolios are concentrated in industries that differ markedly from those served by MPS. In both cases, higher values capture firms with access to banks with different specializations than MPS.

Further details on data and MPS shock

Table B.1: Descriptive Statistics for Empirical Sample

	Mean	Median	Stdev	Min	Max
Firm outcomes and attributes					
Sales (log)	14.28	14.55	2.92	0.00	24.35
Age (log)	3.06	3.18	0.67	0.00	5.08
Employment (log)	2.85	2.77	1.40	0.00	10.87
Supply Chain	0.34	0.00	0.47	0.00	1.00
Payables	0.11	0.01	0.15	0.00	0.72
Receivables	0.15	0.00	0.21	0.00	0.84
E-commerce	0.31	0.00	0.46	0.00	1.00
Direct or commercial exposure to MPS shock					
MPS_i	0.17	0.00	0.38	0.00	1.00
$\text{Commercial-Link}_{s(i)}$	0.08	0.08	0.06	0.00	0.44
Bank-supply chain integration					
$\text{Int-Integ}_{b(i)}$	0.02	0.01	0.01	0.00	0.08
High supply chain $\text{finance}_{s(i)}$	0.33	0.00	0.47	0.00	1.00
Ext-Integ_i (Geographic)	0.42	0.00	0.49	0.00	1.00
Ext-Integ_i (Sectoral)	0.42	0.00	0.49	0.00	1.00
$\text{Ext-Integ}_{p(i)}$ (Geographic)	0.07	0.06	0.06	0.00	0.45
$\text{Ext-Integ}_{p(i)}$ (Sectoral)	0.11	0.11	0.02	0.09	0.13

Notes: Descriptive statistics for the main variables employed in the analysis.

Table B.2: Timeline of the MPS crisis

Year	**Event**	**Implications**
2007	MPS acquires Banca Antonveneta from Banco Santander for 9 billion euros, significantly higher than Santander's purchase price. The acquisition was debt-financed, relying heavily on complex derivatives, raising concerns about financial stability.	Increased financial strain due to high acquisition costs and reliance on derivatives.
2008-11	MPS uses opaque derivative contracts (Alexandria, Santorini, Nota Italia) with Deutsche Bank and Nomura to conceal losses.	delayed recognition of financial distress and risk exposure.
2012	New leadership acknowledges accounting irregularities and launches recapitalization efforts. The Italian government provides a 4 billion euros bailout via Monti Bonds, highlighting systemic vulnerabilities.	Demonstrates reliance on state support and systemic risks within the banking sector.
2013	Investigations reveal fraudulent reporting and supervisory violations. Former executives face charges of false accounting and market manipulation. Record losses prompt restructuring efforts, including branch closures and asset sales.	Exposes deep financial vulnerabilities and governance failures.
2014-16	Despite two capital increases (5 billion euros in 2014, 3 billion euros in 2015), MPS remains financially fragile. The ECB requires significant reduction in non-performing loans, further straining the balance sheet.	Continued financial fragility and regulatory pressures.
2017	The Italian government acquires a 68% stake in MPS, injecting 5.4 billion euros in public funds. This includes a large-scale disposal of 26 billion euros in NPLs and a restructuring plan.	Highlights need for state intervention and restructuring.
2018-21	Efforts to privatize MPS, including negotiations with UniCredit, fail due to disagreements over financial conditions. However, the bank shows signs of recovery, reducing NPL exposure and returning to profitability in 2021.	Gradual recovery but ongoing challenges in privatization efforts.
2021-24	In 2022, MPS completes a 2.5 billion euros capital increase with significant state participation. Discussions explore potential mergers or acquisitions to facilitate the bank's exit from government ownership.	Ongoing efforts to restore market confidence and exit state ownership.

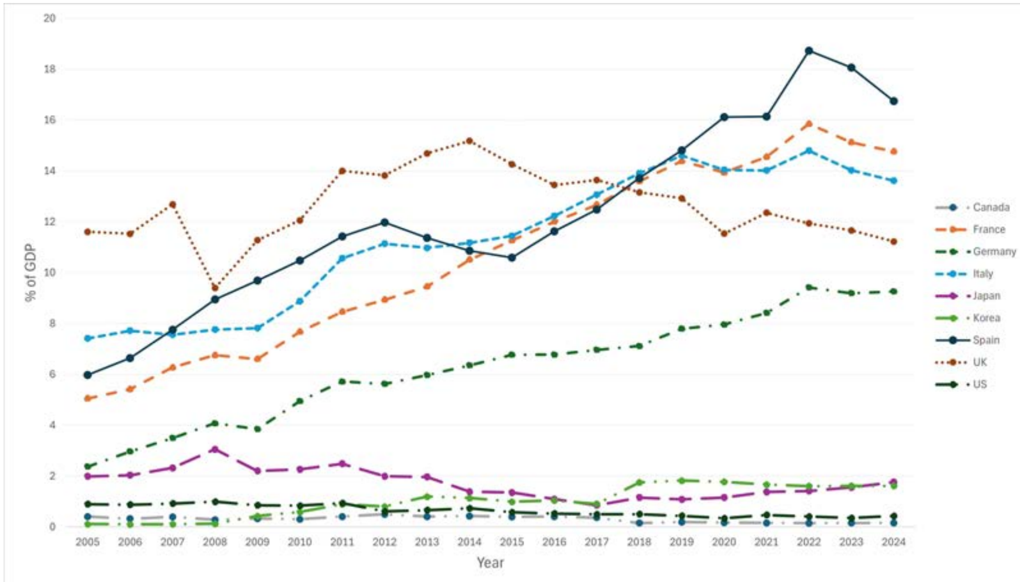

Figure B.1: Factoring and Commercial Finance (in Percent of GDP)

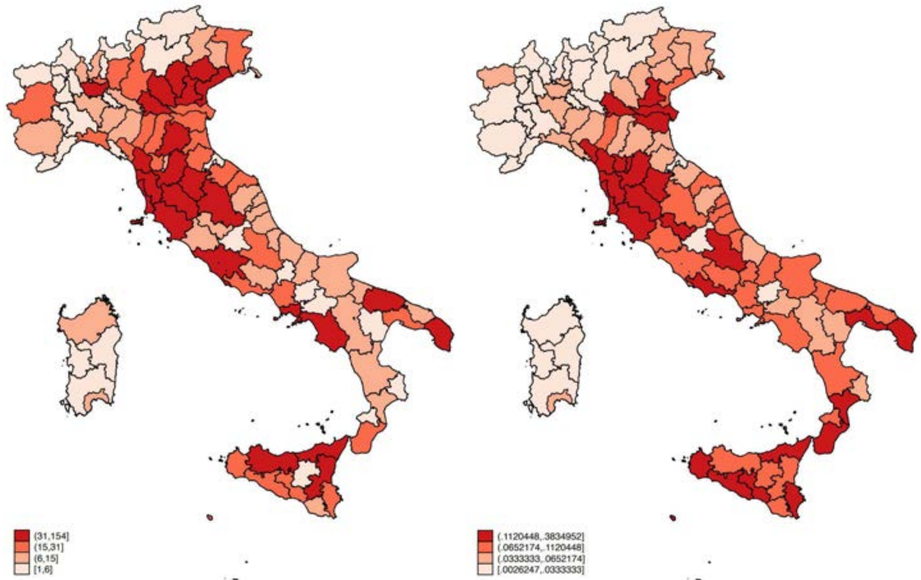

Figure B.2: Diffusion of MPS branches.

Notes: The left plot reports the total number of MPS branches by Italian province (as of 2012). The right plot, reports the MPS branch share of the province's overall branches.

Additional empirical results

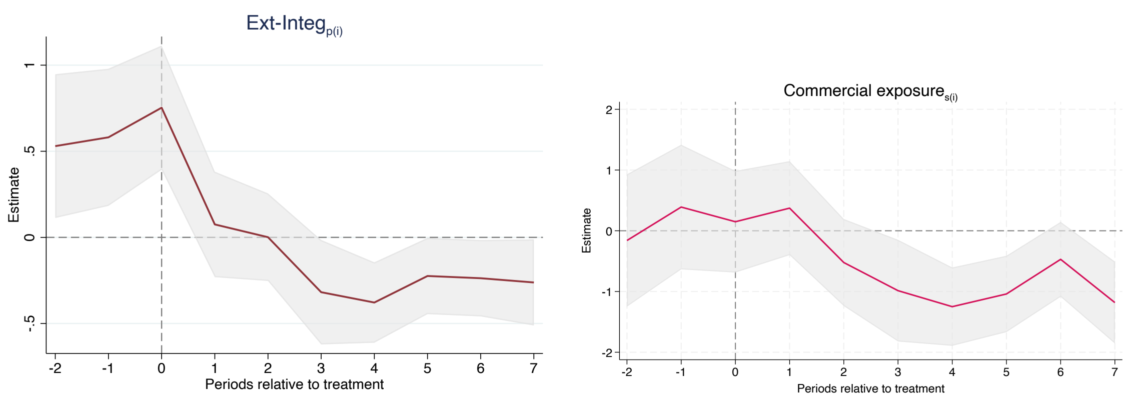

Figure B.3: Pre-trends.

Notes: The dependent variable is (log) firm sales. The left and right panels display, respectively, the point coefficient estimates of Ext-Integ$_{p(i)}$ and Commercial exposure$_{s(i)}$ across periods relative to treatment, while the shaded regions indicate the 95% confidence intervals.

Table B.3: Robustness: Time-varying Measures of Supply Chain Participation

	Sales		
	(1)	(2)	(3)
Supply chain$_i$	-1.189***	-1.158***	-0.413***
	[0.224]	[0.220]	[0.0750]
Commercial exposure to MPS shock			
Commercial-Link$_{s(i)}$ $\times$ Supply chain$_i$ $\times$ Post$_t$	-2.188***	-2.138***	-0.603***
	[0.425]	[0.418]	[0.116]
Intensive margin bank-supply chain integration			
Int-Integ$_{b(i)}$ $\times$ Post$_t$	-5.522*	-0.832	-0.808
	[3.150]	[0.554]	[0.524]
Int-Integ$_{n(i)}$ $\times$ Supply chain$_i$ $\times$ Post$_t$	18.41*		
	[9.615]		
Int-Integ$_{b(i)}$ $\times$ High supply chain finance$_{s(i)}$ $\times$ Post$_t$		3.558***	3.513***
		[0.629]	[0.588]
High supply chain finance$_{s(i)}$ $\times$ Post$_t$		0.281***	0.144***
		[0.0411]	[0.0310]
Extensive margin bank-supply chain integration			
Ext-Integ$_{p(i)}$ $\times$ Post$_t$	0.274***	0.268***	1.701***
	[0.0595]	[0.0584]	[0.319]
Ext-Integ$_{p(i)}$ $\times$ Supply chain$_i$ $\times$ Post$_t$	-0.790***	-0.768***	-6.878***
	[0.157]	[0.154]	[1.312]
Supply chain	Time-varying (pre-determined)		
Ext-Integ$_{p(i)}$	Provincial	Provincial	Sectoral
Firm controls	Y	Y	Y
Firm FE	Y	Y	Y
Year FE	Y	Y	Y
Bank FE	Y	Y	Y
Observations	296,364	296,364	299,018
Underidentification p-value	0.000	0.000	0.000
Kleibergen-Paap rk Wald F	22.866	30.954	47.869
Cragg-Donald Wald F statistic	37.476	50.685	68.517

Notes: This table displays robustness results using time-varying measures of supply chain participation. Robust standard errors in brackets. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table B.4: MPS Shock and Bank-Supply Chain Integration. Broad Impact ($T < 2020$)

	Sales				
	(1)	(2)	(3)	(4)	(5)
Commercial links to MPS-served industries					
Commercial-Link$_{s(i)}$ × Supply chain$_i$ × Post$_t$	-4.742***	-4.764***	-0.481***	-0.476***	-0.590***
	[1.189]	[1.199]	[0.102]	[0.126]	[0.229]
Intensive margin bank-supply chain integration					
Int-Integ$_{b(i)}$ × Post$_t$	-7.992**	-0.153	-0.780*	-1.402**	0.0867
	[3.604]	[0.570]	[0.425]	[0.561]	[0.782]
Int-Integ$_{b(i)}$ × Supply chain$_i$ × Post$_t$	30.22**				
	[12.72]				
Int-Integ$_{b(i)}$ × High supply chain finance$_{s(i)}$ × Post$_t$		2.843***	2.121***	3.035***	0.557
		[0.607]	[0.478]	[0.642]	[1.070]
High supply chain finance$_{s(i)}$ × Post$_t$		0.416***	0.194***	0.179***	0.228***
		[0.0644]	[0.0267]	[0.0351]	[0.0417]
Extensive margin bank-supply chain integration					
Ext-Integ$_{p(i)}$ × Post$_t$	0.606***	0.608***	1.325***	1.492***	1.341**
	[0.157]	[0.158]	[0.272]	[0.377]	[0.570]
Ext-Integ$_{p(i)}$ × Supply chain$_i$ × Post$_t$	-1.792***	-1.792***	-5.732***	-5.977***	-6.179**
	[0.447]	[0.450]	[1.163]	[1.486]	[2.511]
Ext-Integ$_{p(i)}$	Provincial	Provincial	Sectoral	Sectoral	Sectoral
Collateral reliance				High	Low
Firm controls	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y
Observations	370,992	370,992	374,840	202,611	165,450
Underidentification p-value	0.000	0.000	0.000	0.000	0.000
Kleibergen-Paap rk Wald F	11.730	15.469	156.935	81.137	41.888
Cragg-Donald Wald F statistic	12.546	16.530	169.090	81.541	49.628

Notes: This table reports estimates for the effects of the MPS banking shock and the extensive and intensive margins of bank–supply chain integration on firms' sales for the subsample $T < 2020$. Columns (1)–(3) reproduce the main estimates. Columns (4)–(5) extend the sectoral specification with high factoring sector interactions by splitting firms according to their dependence on collateral assets. In all regressions, supply chain is instrumented as detailed in Section 5.1. See Section 5.1 for details on measurement and Section 5.2 for details on the empirical model. All the regressions include $Supplychain_i \times Post_t$ and $Commercial - Link_{s(i)} \times Post_t$. Robust standard errors in brackets. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.