The Geography of the Financial Accelerator[†]

Alexander Haas **Rustam Jamilov**

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Abstract

This paper studies aggregate implications of the geography of firms' financial frictions in Europe. Using proprietary data from the European Central Bank's Survey on the Access to Finance of Enterprises (SAFE), we document three new facts. First, there is substantial cross-country heterogeneity in the access to external finance. Second, this heterogeneity is persistent across time and cannot be explained by sectoral composition or firm size. Third, European countries that are less financially constrained are more responsive to identified ECB monetary policy shocks. To rationalize these empirical results, we develop and calibrate a tractable New Keynesian model of a monetary union with 26 countries, heterogeneous firms, and regional differences in financial frictions. High-risk countries are less responsive to monetary shocks because their firms face a steeper marginal cost curve and a lower marginal propensity to invest. Convergence experiments show that continuous financial market integration raises the power of monetary policy, but at a potential cost to financial stability.

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Haas: Monash University. Email: alexander.haas@monash.edu.

Jamilov: University of Oxford and CEPR. Email: rustam.jamilov@all-souls.ox.ac.uk.

1 Introduction

Financial frictions faced by firms are not uniformly distributed across Europe. As a result, in response to symmetric aggregate disturbances — such as monetary shocks — regional investment responses may differ systematically. In the cross-section, it is not immediately clear whether high- or low-risk regions are more responsive to aggregate shocks. Furthermore, the overall response will depend on the spatial distribution of financial frictions, which may vary over time. Therefore, studying the geography of financial frictions is essential for understanding the monetary transmission mechanism.

In this paper, we study empirically and theoretically how regional heterogeneity in external finance premia determines aggregate fluctuations and monetary policy transmission in Europe in general and the eurozone in particular. The external finance premium represents the additional cost a firm incurs when raising capital externally. It shapes the canonical financial accelerator mechanism, which has the power to impact significantly macroeconomic fluctuations (Bernanke et al., 1999). A key assumption of our setup is that external finance premia are not distributed across regions homogeneously.

Empirically, we use granular data from the European Central Bank's (ECB) Survey on the Access to Finance of Enterprises (SAFE) and document three new stylized facts. First, using detailed survey questions and answers, we identify the share of firms that have either applied for bank loans and been rejected or that are discouraged. We show that there is substantial cross-country heterogeneity in the share of financially constrained firms. Second, this heterogeneity is very sticky across time, suggesting the presence of persistent, permanent region-specific characteristics that drive spatial differences in financial frictions. This heterogeneity is mostly due to country-specific factors, and industrial composition or firm size play a mute role.

Third, we employ Jordà (2005) local projections and show that European countries that are less financially constrained are more responsive to identified ECB monetary policy shocks. This finding echoes the influential result in Ottonello and Winberry (2020), who show that in the United States financially constrained firms are *less* responsive to monetary shocks of the Federal Reserve. This important finding is robust to us controlling for the country-level share of hand-to-mouth households, a measure constructed by Almgren et al. (2022) for the euro area. This suggests that the firm financial risk channel of monetary policy is separate from the canonical marginal propensity to consume mechanism that is relevant for understanding household behavior (Kaplan et al., 2018).

To formalize our empirical findings, we develop a multi-region New Keynesian model of a monetary union. Our framework features 26 asymmetric countries that are ex-

ante heterogeneous in size and the loan recovery rate conditional on firm default. Our calibration leverages exact, real-world data on the cross-section of loan recovery rates from the European Banking Authority. Every region is populated by a frictional representative firm, a representative household, and a standard New Keynesian block.

Cross-country differences in loan recovery rates are priced competitively into the distribution of external finance premia. Access to external finance varies persistency across space and induces differential responses to the same aggregate interest rate shock. We formalize this difference analytically through the *marginal propensity to invest* (MPI) — a sufficient statistic that captures firm investment responses to sudden changes in the interest rate. We show that regions that are less financially constrained exhibit higher MPIs. In other words, low-constraint regions are more responsive to interest rate shocks, at least in partial equilibrium.

We proceed by showing that the heterogeneous response logic is also obtained in general equilibrium along the full transition path following sudden monetary policy disturbances. Our model generates differential responses of investment between regions with high and low levels of financial frictions that are quantitatively similar to their empirical counterparts. We also show that monetary expansions facilitate rising regional inequality as cross-country differences in quantities, prices, and leverage all widen.

Finally, we quantitatively study a "financial integration" experiment. A key challenge for the euro area is absence of a money markets union and of a banking union. We consider a variant of our model economy where all 26 countries converge to the highest common denominator in terms of the level of financial frictions. When the central bank expands money supply in this counterfactual, financially integrated economy, we find that the aggregate response of both prices and quantities is greater. Interestingly, the impact of the monetary shock on firm leverage is also considerably higher. Thus, the increased potency of monetary policy as a result of financial convergence may come at the cost of financial instability.

Literature. Our paper contributes to the literature on the canonical financial accelerator mechanism (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Bernanke et al., 1999). Several papers have built on this literature and studied heterogeneity in financial frictions. Ottonello and Winberry (2020) put forth the investment channel of monetary policy in a model with firms that differ in risk and distance to default. Manea (2020) develops a New Keynesian model with unconstrained and constrained non-financial firms. Jeenas (2024) builds a model of heterogeneous firms and the liquidity channel of monetary policy. Baqaee et al. (2024) study the supply side of monetary policy in a model with

heterogeneous firms and endogenous product market power. González et al. (2023) study optimal policy in a NK model with heterogeneous firms and financial frictions. The first contribution of our paper relative to this strand is to shift the level of aggregation from an individual firm or establishment to a region (country). Second, our quantifiable NK framework with 26 asymmetric regions is calibrated with the full distribution of measured loan recovery rates across European nation states.

Our paper also contributes to the burgeoning Heterogeneous-Agent New Keynesian (HANK) literature that studies demand-side frictions and heterogeneity in the household sector (McKay and Reis, 2016; Kaplan et al., 2018; Auclert et al., 2024). Bayer et al. (2024) develop a HANK model of a monetary union with two countries and study both within- and cross-region income and wealth inequality. Aggarwal et al. (2023) study fiscal policy in a many-country model of large open economies. Bellifemine et al. (2023) build a monetary union model of the United States with 3,000+ counties that differ in local marginal propensities to consume and the share of non-tradable goods. Our aim is to focus on cross-country differences in financial frictions faced by *firms* in a multi-country model of the euro area.

Empirically, we contribute to the literature that studies the external finance premium and heterogeneous effects of ECB monetary policy shocks. Burriel and Galesi (2018) find that countries with more fragile banking systems benefit the least from unconventional monetary policy measures. Altavilla et al. (2024) decompose the external finance premium in the euro area into country-level, bank-level, and firm-level contributions. Almgren et al. (2022) show that the cross-country difference in the share of hand-to-mouth households is a systematic predictor of the local response to monetary shocks. One of our key empirical contributions is to show that our results are robust to the presence of regional variation in the share of rule-of-thumb consumers. Bellifemine et al. (2025) find that eurozone countries with high levels of legacy public debt are more responsive to monetary shocks. Boehnert et al. (2025) document that euro area countries with a higher expenditure share on non-tradable consumption exhibit weaker output responses to monetary policy shocks.[1] Our paper focuses on a relatively under-researched channel of financial frictions. In particular, we leverage novel and granular data from the SAFE survey of the ECB to measure the distribution of financially constrained firms across space.

[1] See also Petersen and Rajan (2002); Nguyen (2019); Greenstone et al. (2020) for more evidence on the existence of regional factors that affect firm access to finance. See Wasmer and Weil (2004) for a discussion of theoretical implications.

2 Empirical Analysis

2.1 The European Central Bank's SAFE Survey

To study the geography of financial constraints in Europe, we use granular data from the European Central Bank's (ECB) Survey on the Access of Finance of Enterprises (SAFE).

The ECB has been conducting SAFE since 2009. The survey is conducted twice a year (around April and October; quarterly since 2024) and while it was initially limited in scope to a number of euro-area countries, since 2013 one round per year is run in cooperation with the European Commission (the 'Common Round') covering all European Union member states plus some neighboring countries.

In each round, around 11.000 firms are surveyed by an external provider through either telephone or online interviews with the interviewee described as a 'top-level executive' in each firm. Firms are selected randomly and the sample is stratified by country, enterprise size class, and economic activity. Publicly available survey results are broken down by firm size, sector, country, firm age, financial autonomy and ownership. In addition, for the purposes of this project, we have access to a more granular SAFE micro dataset containing data from all surveys conducted between 2014 and 2023 along with several additional variables as well as identification at the regional (NUTS 1) level.[2, 3]

A Measure of Regional Financial Constraints. Crucially for our purposes, the survey asks detailed questions regarding enterprises' financial situation and the availability of external finance. We use this information, as captured in our granular SAFE micro dataset, to construct a novel measure of regional financial constraints.

Specifically, for all regions and survey rounds, we compute the degree of financial constraints as the ratio of enterprises (as a fraction of all surveyed enterprises) encountering obstacles in receiving external finance in the form of a bank loan in the current or previous quarter. In doing so, consider answers to two sequential questions in the survey: Namely, *'Have you applied for a bank loan (excluding overdraft and credit lines) during the previous or current quarter?'*(Q7a) and *'If you applied and tried to negotiate for this type of financing over the past six months, what was the outcome?* (Q7b).

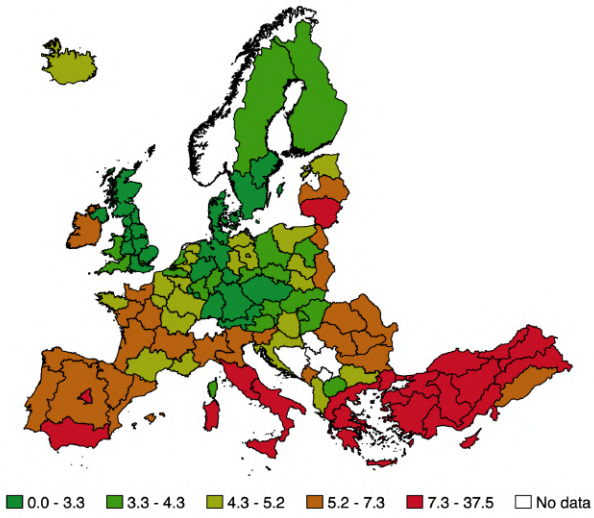
The four mutually exclusive answers we consider to be a sign of financing obstacles for the questioned enterprise are (i) *'Did not apply because of possible rejection'*, (ii) *'[applied, but]*

[2] Nomenclature of Territorial Units for Statistics (NUTS) is the European Union's geocode standard for referencing administrative divisions in countries. NUTS0 refers to the country level, NUTS1 typically to a regional administrative unit (between 3 and 7 million people according to NUTS regulation).

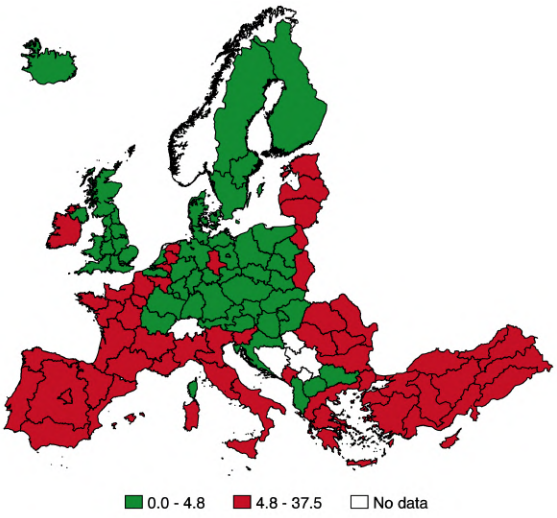
[3] Further information on data and methodology can be found in the ECB's SAFE handbook: https://www.ecb.europa.eu/stats/pdf/surveys/sme/ecb.safemi.en.pdf.

Figure 1: The Geography of the Financial Accelerator in Europe

(a) Five Groups



(b) Core and Periphery



Notes: Geographic distribution of average region-specific levels of financial constraints.

only received a limited part of it', (iii) *'[applied, but] refused because the cost was too high'*, and (iv) *'[applied, but] was rejected'*. If either of these answers is reported by an enterprise, we count the firm as financially constrained. Our measure of financial constraints in a given region j at time t, FC_{jt}, is then defined as the number of enterprises reporting financing obstacles over the total number enterprises surveyed in region j at time t.

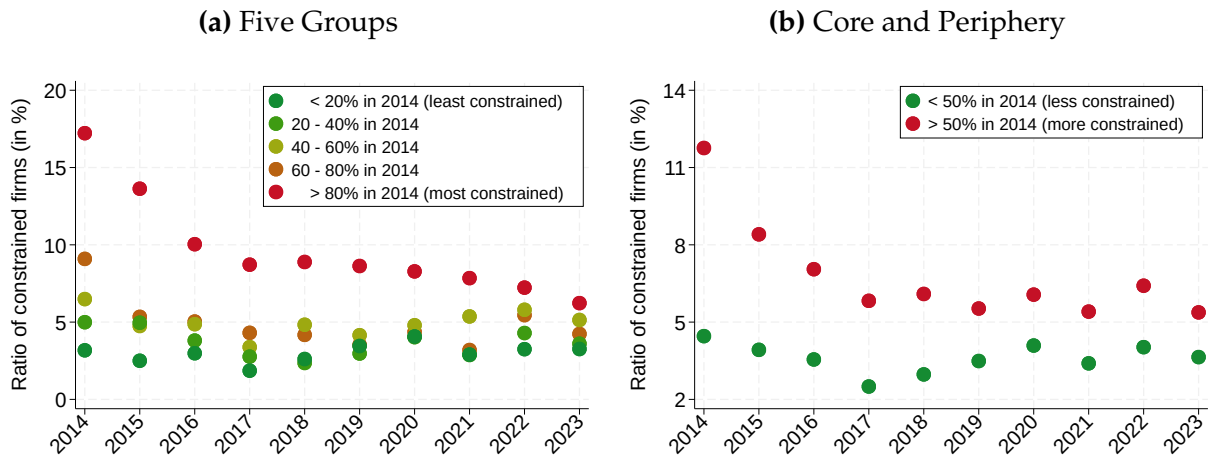
2.2 The Geography of the Financial Accelerator

Figure 1 shows the degree of regional heterogeneity in financial constraints across Europe. It depicts two maps of our regional measure of financial constraints, FC_{jt}, averaged over the years 2014 to 2023. Panel 1a sorts regions in five groups (quintiles) based on the degree of financial constraints, from least (green) to most constrained (red). Panel 1b reduces the dimensionality sorting regions in just two groups (above and below median).

There is substantial cross-regional heterogeneity in the access to external finance. This cross-regional heterogeneity can be well approximated by a 'core-periphery' view.[4] Firms in central and northern Europe (BeNeLux, Czech Republic, Germany, parts of Poland, Scandinavia) face significantly smaller obstacles to external finance than their counterparts in Cyprus, Greece, Italy, Spain, and Turkey. This is our first new stylized fact.

[4] Appendix A shows that this is also true for a more granular sorting by deciles (ten groups).

Figure 2: Heterogeneity in the Financial Accelerator over Time



Notes: Time series evolution of group average levels based on a 2014 quintile / median split.

2.3 Time-Series Variation

Figure 2 shows that the observed cross-regional heterogeneity in the access to external finance is persistent across time. Sorting regions by quintiles or median, respectively, based on the degree of financial constraints in 2014 (year 1 of our sample), it plots the evolution of group averages over time, keeping the sorting fixed at their 2014 level.

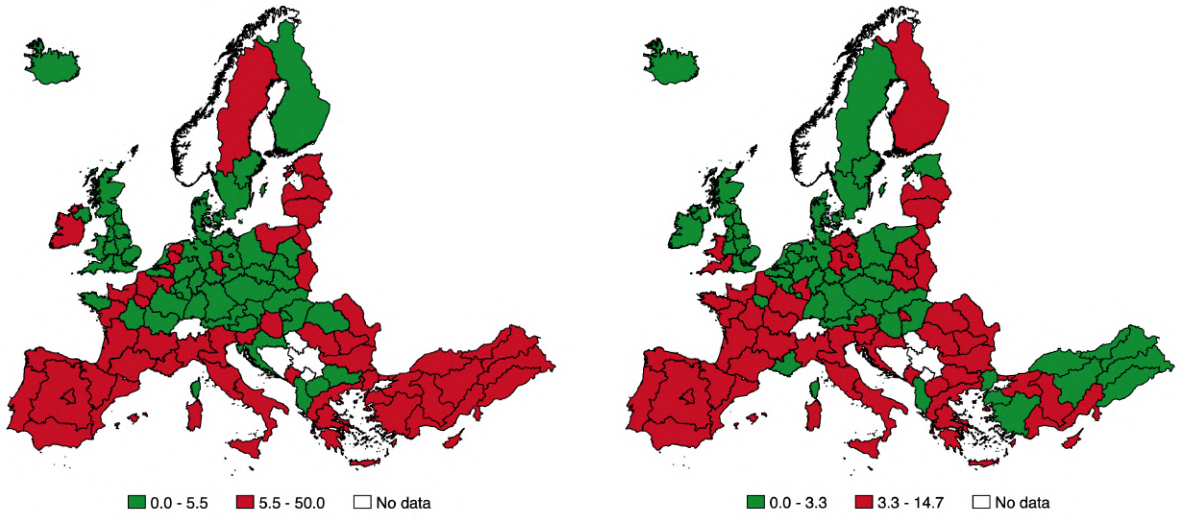
Consider the following case study. The region of *Centre (ITI)* in Italy (containing the provinces of Lazio, Marche, Tuscany, Umbria) was classified as most constrained in 2014 but not in the latter part of our sample as obstacles to external finance declined relative to other regions. For the purposes of Figure 2, we keep *Centre (ITI)* in its 2014 group (red dot, highly constrained) and let it contribute to that group average over time. With a lot of time-series variation in regional financial constraints, one would expect group averages based on the 2014 classification to converge and, ultimately, intersect (switch positions) as time passes. This is not what we observe.

While there is some initial convergence driven by an easing of financial conditions in the most constrained regions in 2015 and 2016, the group averages broadly co-move from 2017 onward. Panel 2a suggests at least some transitions of regions between groups (*Centre (ITI)* is an example of this) but the sorting of group averages remains fairly stable over a horizon of ten years. For the case of a median split, Panel 2b presents clear evidence for the strong persistence of regional heterogeneity in financial constraints across time.

Figure 3: Heterogeneity by Firm Size

(a) Small Firms

(b) Large Firms



Notes: Geographic distribution of average region-specific levels of financial constrains. Split by firm size.

2.4 Firm Size and Sectoral Dimensions

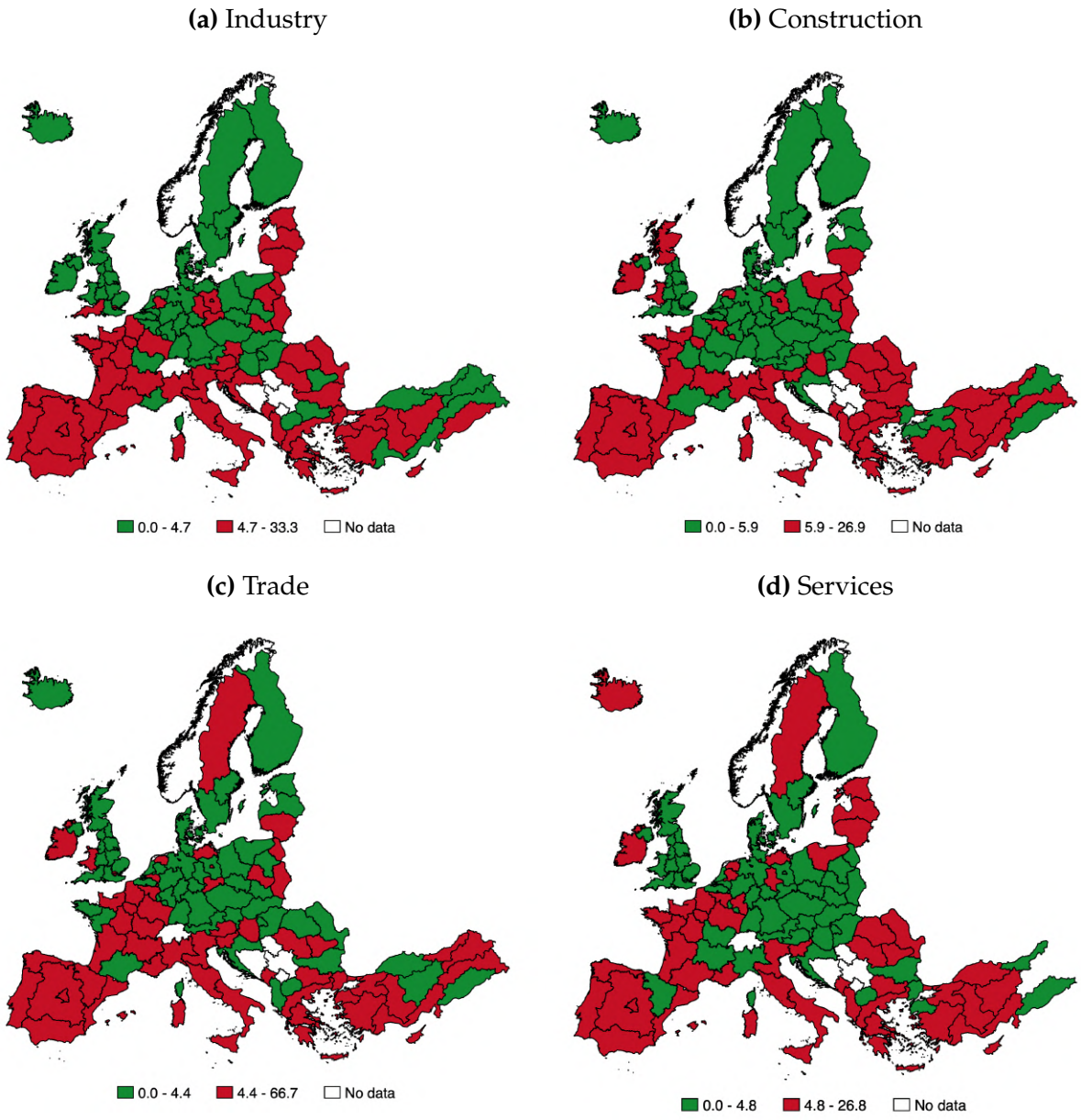
So far we have shown that there is cross-country heterogeneity in the share of financially constrained firms across Europe. This heterogeneity is very sticky across time, suggesting the presence of persistent, permanent region-specific characteristics that drive spatial differences in financial frictions. It can also not be readily explained by differences in firm size or sectoral composition. This is our second new stylized fact.

Figure 3, once again, depicts our regional measure of financial constraints, averaged over the years 2014 to 2023. This time, regions are sorted and heterogeneity is plotted separately for small and large firms (less and more than fifty employees, respectively).

The composition of spatial heterogeneity is fairly robust to a split along the firm size dimension. While obstacles to external finance are generally larger in size for small firms, the 'core-periphery' view holds up. In cases where there are substantial differences between Panels 3a and 3b as well as our baseline in Figure 1 (several regions in Turkey, for example) these can usually be explained by data coverage (the sample of surveyed large firms in Eastern Turkish provinces is small and fluctuates across waves).

Figure 4 extends this result to sectoral heterogeneity. Panels 4a to 4d depict the sorting of surveyed enterprises into four sectors — industry, construction, trade, and services — and present a consistent 'core-periphery' narrative. While there are differences in the average degree of obstacles to external finance by firm size and sector, neither of these

Figure 4: Heterogeneity by Firm Sector



Notes: Geographic distribution of average region-specific levels of financial constrains. Split by firm sector.

dimensions can readily explain the cross-regional heterogeneity observed.

Our empirical results are robust to the sorting and/or taking snapshots of cross-regional heterogeneity at different points in time, the introduction of additional groups (and a more granular sorting), and changes to the definition of 'small' versus 'large' firms.

3 Heterogeneous Responses to Monetary Policy

Having documented substantial and persistent cross-regional heterogeneity in the access to external finance in Europe, in this section we turn to an empirical investigation of the implications for monetary policy. We find that countries that are less financially constrained are more responsive to identified ECB monetary policy shocks. This result is robust to us controlling for the country-level share of hand-to-mouth households as constructed by Almgren et al. (2022). This points to important differences in the heterogeneous transmission of monetary policy of firms and households. This is our third stylized fact. Finally, Section 4 will formalize all three facts in a structural model.

3.1 Monetary Policy Responses by Country

We estimate country-level output and price responses to ECB monetary policy shocks with lag-augmented local projections (Jordà, 2005; Montiel Olea and Plagborg-Møller, 2021; Jordà and Taylor, 2025). Our dependent variables are h-month ahead log changes in industrial production (IP) and the harmonized index of consumer prices (HICP). Both are available at monthly frequency. In our baseline specification, we include 32 countries with data from 1999M1 to 2020M2.

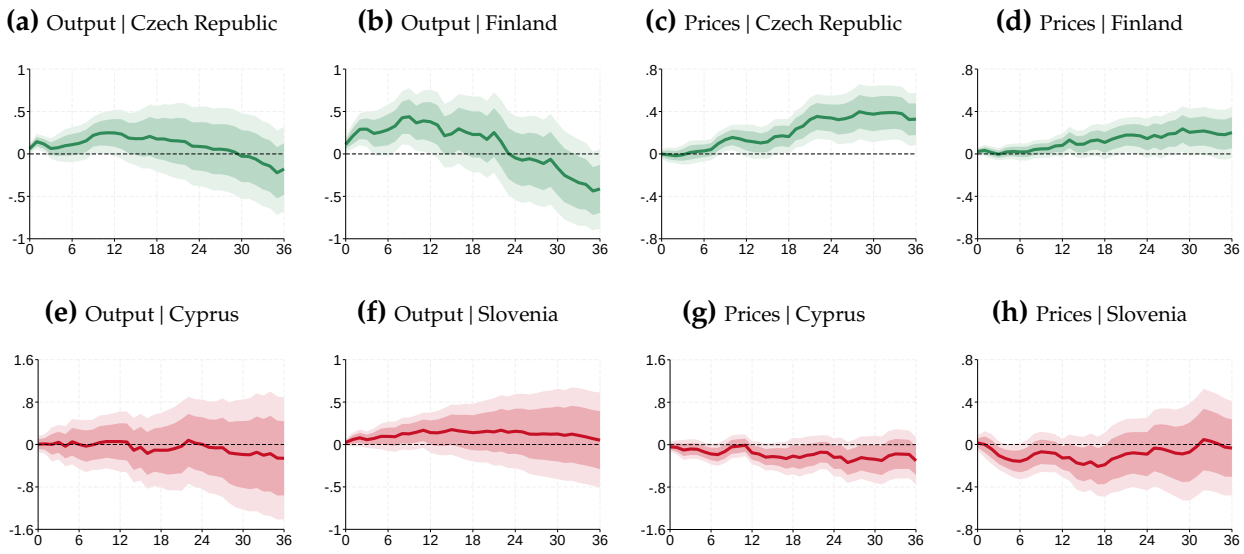
Monetary policy shocks are taken from Jarocinski and Karadi (2020). More specifically, the identified monetary shock is the first principal component of monetary event window changes in overnight index swaps (OIS) with maturities 1-, 3-, 6-months and 1-year. The shock series is cleaned from central bank information effects using a median rotation that imposes the relevant sign restrictions.[5] For each country j and horizon $h = [0, 36]$, we run

$$\Delta \ln(y_{j,t+h}) = \beta_{jh} \times \varepsilon_t + \sum_{\ell=1}^{6} \gamma_{h\ell} \Delta \ln(X_{j,t-\ell}) + u_{jht}, \tag{1}$$

where $\Delta \ln(y_{j,t+h}) = \ln(y_{j,t+h}) - \ln(y_{j,t-1})$ is the h-month ahead ('long difference') change in the dependent variable, ϵ_t is the identified monetary policy shock, and $\Delta \ln(X_{jt-\ell}) = \ln(X_{j,t-1}) - \ln(X_{j,t-\ell-1})$ is a vector of first differences of three control variables that includes the monetary policy shock and the two dependent variables. In line with the literature, in our baseline specification we control for lagged controls up to $\ell = 6$ (half a year).

[5] Our results are robust to using the shock that is not adjusted for the information effect as well as the simpler "poor man's" approach.

Figure 5: Heterogeneous Responses to an Expansionary Monetary Policy Shock



Notes: Country specific impulse responses to a 1 standard deviation expansionary monetary shock. Shaded areas represent 90% and 68% confidence bands, respectively, constructed using Newey-West standard errors. The y-axes depict the h-step ahead percentage change. The x-axes depict months.

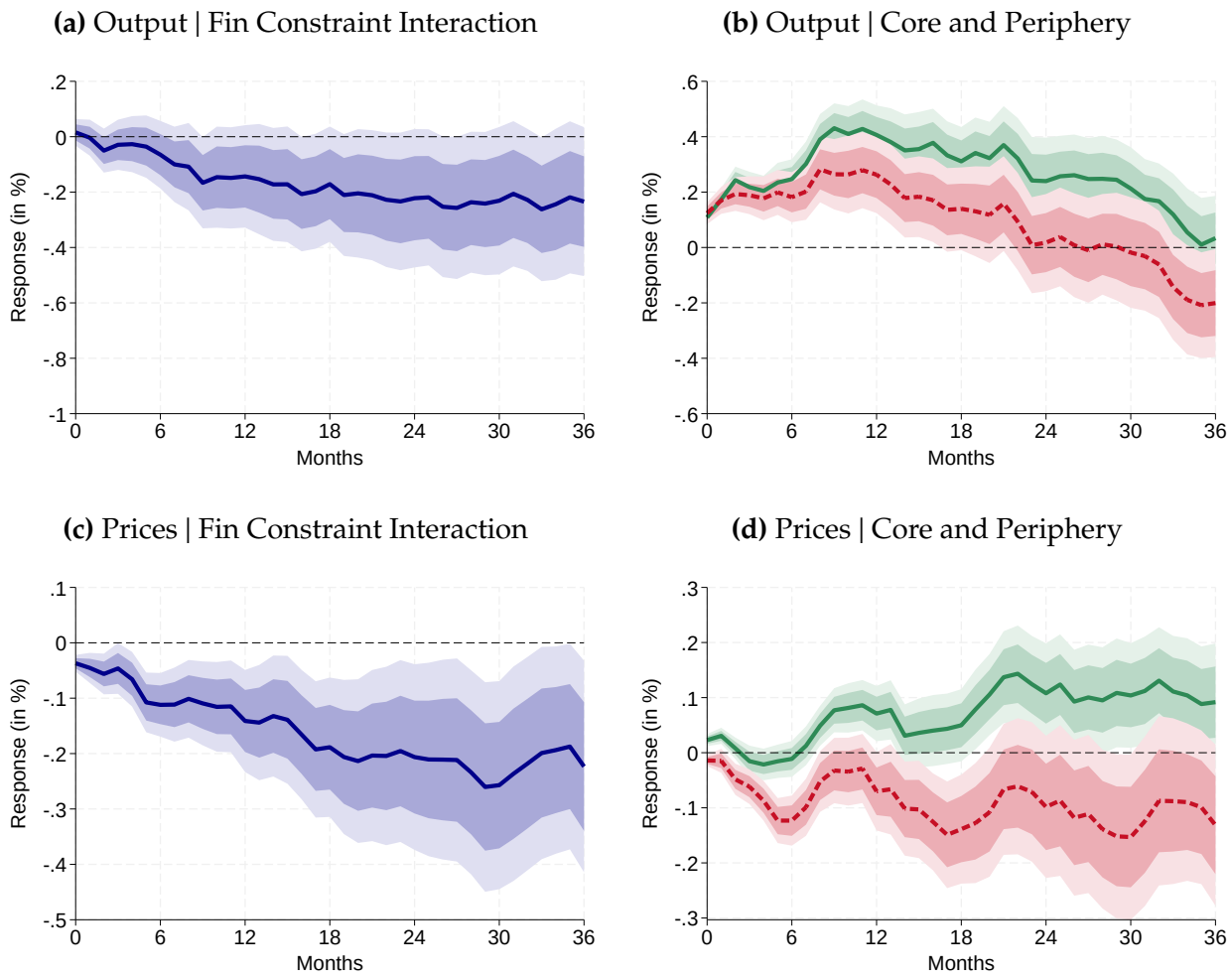
Results. Figure 5 presents estimated impulse responses for four European countries to a 1 standard deviation expansionary monetary policy shock (β_{jh}). The selection of countries is meant to be suggestive as two of them, Czech Republic and Finland (in green), were part of the group of least constrained countries in 2014 (bottom quintile), while the other two, Cyprus and Slovenia (in red), were in the most constrained group (top quintile). Confidence bands around point estimates are constructed using Newey-West estimators. Appendix A shows the collection of impulse responses for all 32 countries in our data set.

What we can see when we look at Figure 5 is the first indication of the least financially constrained countries reacting more to an expansionary monetary policy shock than the most constrained ones. This is true for the responses of both output and prices. It is also reminiscent of Ottonello and Winberry (2020), who show that in the United States financially constrained firms are less responsive to monetary shocks. We continue to investigate this finding in the following two subsections.

3.2 Monetary Policy Responses by Degree of Financial Constraint

In order to corroborate our hypothesis that larger obstacles to external finance attenuate the transmission of monetary policy, we switch to estimating lag-augmented panel local projections rather than country-specific ones (Montiel Olea and Plagborg-Møller, 2021).

Figure 6: Heterogeneous Responses by Degree of Financial Constraint



Notes: Panel impulse responses to a 1 standard deviation expansionary monetary shock. Panels (a) and (c) depict the estimated interaction coefficient $\hat{\beta}_h^{FC}$ (blue). Panels (b) and (d) depict the impulse response for the group of countries with more (red-dash) and less financially constrained firms (green-solid). Shaded areas represent 90% and 68% confidence bands, respectively, constructed using standard errors clustered at the country level. The y-axes depict the h-step ahead percentage change. The x-axes depict months.

With standard errors clustered at the country level, for each horizon $h = [0, 36]$ we run

$$\Delta \ln(y_{j,t+h}) = \alpha_{jh} + \beta_h \times \varepsilon_t + \beta_h^{FC} \times D_j^{FC} \times \varepsilon_t + \sum_{\ell=1}^{6} \gamma_{h\ell} \Delta \ln(X_{j,t-\ell}) + u_{jht}, \tag{2}$$

where our choice of dependent variables, controls, and the monetary policy shock remains unchanged relative to equation (1); α_{jh} is a country fixed effect; and D_j^{FC} is an indicator variable that equals one for all countries j which are more financially constrained than the

median country based on our 2014 classification.[6] This approach allows us to estimate two coefficients of interest: β_h denotes the estimated impulse response to a 1 standard deviation expansionary monetary policy shock for the set of less constrained countries (below the median, baseline); β_h^{FC} is an interaction coefficient that is activated for more constrained countries (above the median). It directly pins down the differential response based on the degree of financial constraints in the data.

Results. Figure 6 presents our main evidence for a statistically significant and economically meaningful effect of financial constraints on the transmission of monetary policy. Panels 6a and 6c plot the estimated interaction term $\hat{\beta}_h^{FC}$ for output and prices in response to an expansionary 1 standard deviation monetary policy shock. The estimated coefficient is downward sloping and (generally) significantly different from zero. Greater obstacles to external finance in a given country translate into attenuated responses of output and inflation. Panels 6b and 6d illustrate this further by plotting the responses of output and prices of the more and less constrained country groups *in levels*. It is clear that the more financial constrained regions are less reactive to monetary shocks.

3.3 Financial Constraints and the Hand-to-Mouth Shares

A natural question in the context of this empirical analysis is to ask how our measure of financial constraints (for firms) relates to alternative measures (particularly for households). In recent work, Almgren et al. (2022) find strong accelerator effects in the transmission of monetary policy shocks based on the ratio of hand-to-mouth (HtM) households in a country. Are our results confounded by the presence of regional differences in the mass of HtM households?

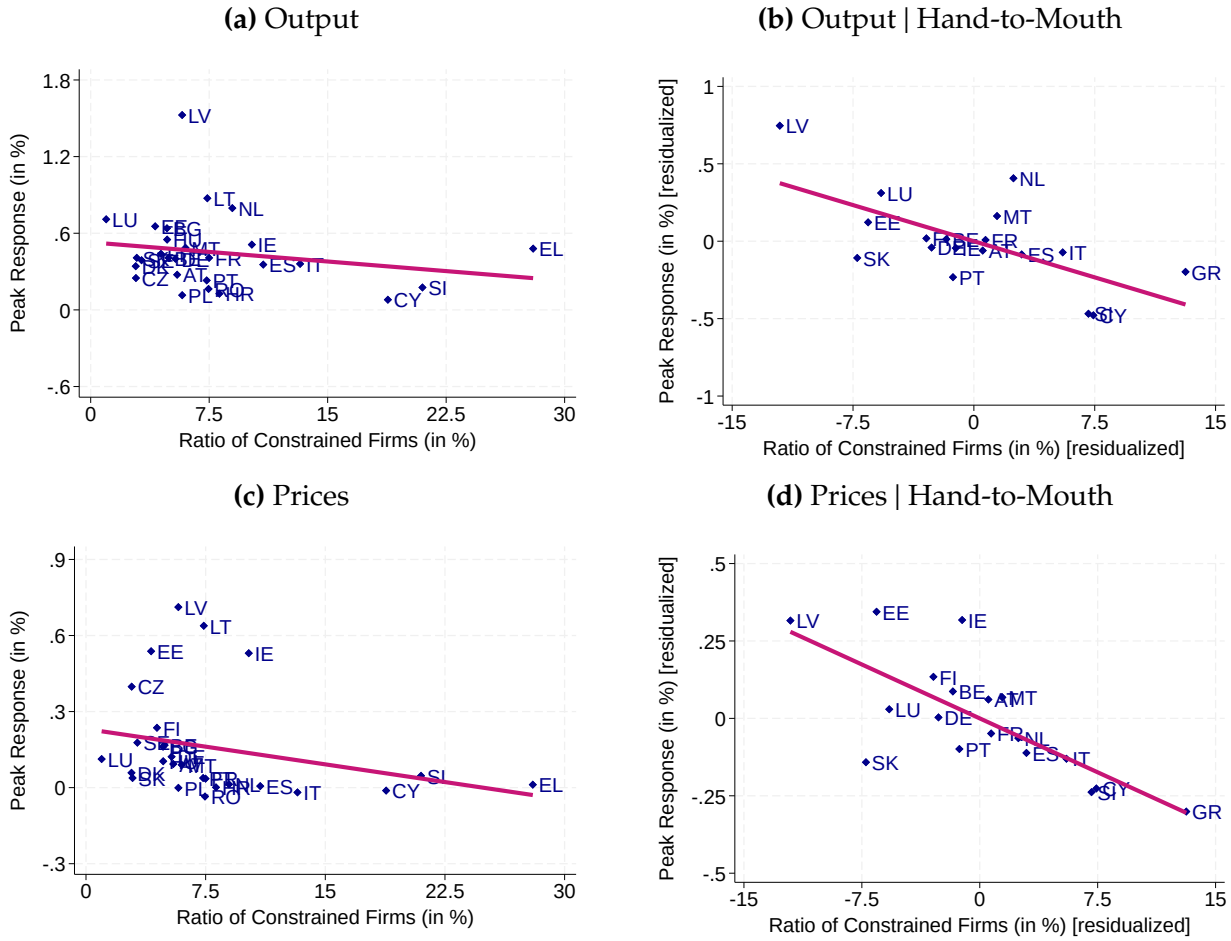
Figure 7 provides a first-pass answer to this question. It presents scatter plots with peak output and price responses to an expansionary 1 standard deviation monetary policy shock on the y-axis, and our measure of financial constraints on the x-axis. Focusing on the left hand side for now, Panels 7a and 7c, we see once again that countries with a higher ratio of constrained firms react less to expansionary monetary policy shocks. The fitted line is downward sloping.

Turning to the right-hand side now, Panels 7b and 7d, we observe the effect of controlling for the share of HtM households in these regressions. In order to do so, we merge our dataset with HtM data from Almgren et al. (2022). Given their coverage of countries is more limited, we lose some cross-country variation. The results, plotted over the now

[6] Recall that the dynamic of financial constraints is highly persistent over time. Our results are qualitatively robust to alternative classifications, including those based on averages over time.

residualized axes, are striking. As the fitted line (in purple) becomes steeper, correlation coefficients turn more negative, and p-values rapidly decline. Ultimately, the explanatory power of our measure of financial constraints *increases* when one controls for HtM shares. This suggests that the firm's financial risk channel of monetary policy is separate from the canonical marginal propensity to consume mechanism that is relevant for understanding household behavior (Kaplan et al., 2018).

Figure 7: Scatterplot of Responses by Degree of Financial Constraint



Notes: Effectiveness of monetary policy as measured by the peak effect on output and prices, calculated using country-level local projections versus the ratio of financially constrained firms in 2014. The purple lines are fitted. Axes in Panels b. and d. are residualized after controlling for HtM shares.

This concludes our empirical analysis. The results in this section — in particular our third stylized fact — are robust to modifications of our measure of financial constraints, seasonally adjusted output and price data, and alternative monetary policy shock series.

4 Model

This section describes our multi-country New Keynesian model of a monetary union with cross-country asymmetry in financial frictions. The economy is populated by a discrete number $\mathcal{N}$ of regions, indexed by j. We normalize the total population of the union to unity and allow regions to vary in relative size λ_j. In each region, there are representative firms, households, financial intermediaries, as well as producers of a capital good, a differentiated intermediate good, and a final good. Firms can default with a common probability ϕ. Conditional on default, only a fraction of firm assets get recovered. This fraction, ω_j, is *region-specific*. Thus, our monetary union structure features regions that are asymmetric in the degree of financial frictions — captured by ω_j — and country size, λ_j.

Our multi-country framework builds on Corsetti et al. (2010), Aggarwal et al. (2023), and Bayer et al. (2024). The production side of our economy follows closely Bernanke et al. (1999) and Ottonello and Winberry (2020). The demand side of the economy and the New Keynesian block are kept standard. Time is discrete and infinite. Markets are complete. There is no aggregate uncertainty, and we study perfect-foresight transitions following unexpected, "MIT" shocks.[7]

4.1 Firms

In each region j, a representative firm sells its output to the local retailer in a competitive market at a relative price $p_{j,t}$, expressed in final good terms. The final good is the numeraire. The firm lives for two periods and can finance investment through internal funds or by obtaining external funds from an intermediary. In the latter case, the firm issues new nominal debt with real face value $b_{j,t+1} = \frac{B_{j,t+1}}{\Pi_{j,t}}$, with $B_{j,t+1}$ the nominal face value and $\Pi_{j,t}$ the inflation rate. Local lenders price debt competitively at $Q_{j,t}$. No new equity issuance is allowed, and there is a non-negativity constraint on divided payments: $d_{j,t} \geq 0$.

The firm enters period t with pre-existing capital $k_{j,t}$ and net worth $n_{j,t}$. Without loss of generality, we normalize $k_{j,t}$ to unity. The firm chooses a *scale ratio*:

$$s_{j,t} > 0, \qquad k_{j,t+1} = s_{j,t} k_{j,t} = s_{j,t}, \tag{3}$$

which is financed by internal net worth $n_{j,t}$ and debt $b_{j,t}$. The unit price of capital is $q_{j,t}$ and the real wage is $w_{j,t}$. Firms produce an undifferentiated good with a technology that

[7] As shown by Boppart et al. (2018) and Auclert et al. (2021), as long as the MIT shocks are not too large, this approach is equivalent to computing impulse responses by first-order perturbation in the model with aggregate uncertainty.

is decreasing returns to scale:

$$y_{j,t} = A_{j,t} k_{j,t}^{\alpha} \ell_{j,t}^{\nu}, \qquad \alpha, \nu \in (0,1), \quad \alpha + \nu < 1. \tag{4}$$

Labor demand. Profit maximization in period t implies optimal labor demand schedule:

$$\ell_{j,t} = \left(\nu A_{j,t} p_{j,t} / w_{j,t}\right)^{\frac{1}{1-\nu}} k_{j,t}^{\frac{\alpha}{1-\nu}}, \tag{5}$$

yielding period-t operating cash flow per unit of *old* capital

$$\pi_{j,t} = \max_{\ell} p_{j,t} A_{j,t} \ell_{j,t}^{\nu-1} s_{j,t}^{\alpha+\nu-1} \; - \; w_{j,t} \ell_{j,t} s_{j,t}^{\alpha+\nu-1} \; + \; q_{j,t}(1-\delta) s_{j,t}, \tag{6}$$

where δ is the depreciation rate.

Financial structure and dividends. Dividends are constrained to be non-negative,

$$d_{j,t} = n_{j,t} - q_{j,t} s_{j,t} + Q_{j,t} b_{j,t} \; \geq 0, \qquad b_{j,t} = \max\left\{(q_{j,t} s_{j,t} - n_{j,t})/Q_{j,t},\, 0\right\}. \tag{7}$$

Next-period net worth. With fixed operating cost ξ, that firms are required to pay every period, and gross inflation $\Pi_{j,t+1}$, the law of motion of net worth is given by

$$n_{j,t+1} = s_{j,t}\left(\pi_{j,t} - b_{j,t}/\Pi_{j,t+1}\right) - \xi. \tag{8}$$

Default and loan recovery. At $t+1$ the firm is solvent with a probability $\phi \in (0,1)$; otherwise it liquidates and creditors recover the *region-specific* fraction $\omega_j \in (0,1)$ of non-depreciated assets $(1-\delta) q_{j,t} s_{j,t}$. The stochastic discount factor between t and $t+1$ is denoted by $m_{j,t+1} \equiv \beta \frac{\Lambda_{j,t+1}}{\Lambda_{j,t}}$ with Λ the marginal rate of substitution of the household. Since the firm, conditional on $\omega_j < 1$, is financially constrained, it will always pay no dividends (Khan et al., 2020).

Firm value. The ex-ante real equity value v, in recursive notation, solves the following Bellman equation:

$$\begin{aligned} v = \max_{s} \mathbb{E}_t \Big\{ m_{t+1} \Big[& p_t \left(\tfrac{\beta p_t}{w_t}\right)^{\beta/(1-\beta)} s^{\alpha+\beta-1} - w_t \left(\tfrac{\beta p_t}{w_t}\right)^{1/(1-\beta)} s^{\alpha+\beta-1} \\ & + \phi \left((1-\delta) q_{t+1}\, s - \frac{q_{t+1} s - n}{Q_{t+1} \Pi_{t+1}} \right) + (1-\phi)\, \omega (1-\delta) q_{t+1}\, s \Big] \Big\}. \end{aligned}$$

Using (7)–(8) and the labor block (5)–(6), we can collect terms and simplify the problem into

$$v_t = m_{t+1}\Big[\mathcal{A}_t\, s^{\alpha+\nu-1} - q_t \mathcal{B}_t\, s\Big], \tag{9}$$

where

$$\begin{aligned} \mathcal{A}_t &= p_t\Big(\frac{\nu p_t}{w_t}\Big)^{\frac{\nu}{1-\nu}} - w_t\Big(\frac{\nu p_t}{w_t}\Big)^{\frac{1}{1-\nu}}, \\ \mathcal{B}_t &= \phi\Big[(1-\delta) - \frac{1}{Q_{t+1}\Pi_{t+1}}\Big] + (1-\phi)\,\omega(1-\delta). \end{aligned} \tag{10}$$

Optimal firm scale. Let $e \equiv \alpha+\nu-1 \neq 0$, an assumption that is guaranteed by decreasing returns to scale production. Maximizing (9) yields the following first-order condition:

$$\mathcal{A}_t\, e\, s^{e-1} - q_t \mathcal{B}_t = 0. \tag{11}$$

When $e < 0$ and $\mathcal{B}_t < 0$, the interior solution exists and is unique:

$$s^\star = \Big[q_t \mathcal{B}_t/(\mathcal{A}_t e)\Big]^{\frac{1}{e-1}} \tag{12}$$

Marginal propensity to invest. Of primary purpose for us is the response of the investment block to changes in the policy rate, the determination of which we detail further below. For now, we exploit the perfect pass-through from the policy rate onto the borrowing rate, the inverse of $Q_{j,t}$. Differentiating (12) with respect to Q we obtain an object that we will refer to as the *marginal propensity to lend* (MPI):

$$\text{MPI}_{j,t} = \frac{C\phi\,(1-\delta)}{Q_{j,t+1}\,\Pi_{j,t+1}\,\mathcal{B}_t} \tag{13}$$

with $C = 1/(\alpha+\beta-2)$. The MPI is a region-specific elasticity of firm scale with respect to a positive change in the regions price of debt, i.e. a decline in the interest rate. Absent general equilibrium forces, it summarizes the pass-through of monetary policy changes to firm investment decisions.

4.2 Financial Intermediary

In each region, the representative intermediary lends to firms at a region-specific price level $Q_{j,t}$. As mentioned before, if the firm defaults in a particular region, the bank recovers only a fraction $0 \leq \omega_j \leq 1$ of its loans. The intermediary prices in firm insolvency risk and

liquidation costs competitively:

$$Q_{j,t} = \mathbb{E}_t\Big[\Lambda_{j,t+1}\frac{1}{\Pi_{j,t+1}}\Big(1-\phi+\phi\omega_j r_{j,t+1}\Big)\Big] \tag{14}$$

where $r_{j,t+1} \equiv \min\Big(1, \alpha(1-\delta)q_{j,t+1}\frac{s_{j,t}}{b_{j,t+1}}\Big)$ is realized asset recovery.

4.3 Representative Household

The problem of the representative national household consists of choosing consumption of the final good, $C_{j,t}$, and hours worked, $L_{j,t}$. The household supplies total labor hours, which then satisfies local labor demand of regional firms. The household discounts the future with a discount factor $\beta \in (0,1)$. Preferences are defined by:

$$\mathbb{E}_t \sum_{s=0}^{\infty} \beta^s \mathcal{U}\Big(C_{j,t+s}, L_{j,t+s}\Big) \tag{15}$$

Period utility function is given by

$$\mathcal{U}(C_{j,t}, L_{j,t}) = \log\Big(C_{j,t}\Big) - \chi L_{j,t}, \tag{16}$$

where χ controls the dis-utility of work. The household problem yields the Euler equation that links the nominal interest rate and the stochastic discount factor: $\Lambda_{j,t+1} = \frac{1}{R_t^N/\Pi_{j,t+1}}$. The expectation operator is omitted because deviations from steady state are studied under the assumption of perfect-foresight transitions following MIT shocks.

4.4 New Keynesian Block

Our New Keynesian block follows the textbook approach (Woodford, 2003; Galí, 2015). There is a unit-mass continuum of retailers, indexed by $i \in [0,1]$. These retailers are region-specific. Retailers produce differentiated intermediate goods $\tilde{y}_{i,j,t}$ using the firms' aggregate output, $y_{i,j,t}$, as inputs: $\tilde{y}_{i,j,t} = y_{i,j,t}$. Retailers set a price for their variety but must incur an adjustment cost á la Rotemberg (1982): $\frac{\theta}{2}\left(\frac{\tilde{p}_{i,j,t}}{\tilde{p}_{i,j,t-1}} - 1\right)^2 Y_{j,t}$. Varieties get aggregated into the regional final good via the following CES aggregator:

$$Y_{i,j,t} = \left(\int_0^1 \tilde{y}_{i,j,t}^{\frac{\gamma-1}{\gamma}} di\right)^{\frac{\gamma}{\gamma-1}} \tag{17}$$

where $\gamma > 1$ is the elasticity of substitution between differentiated varieties that is common to all regions.

The above problem is symmetric across all retailers and yields the familiar New Keynesian Phillips Curve relation. It links current regional inflation with the future expected inflation and current deviations of the real marginal cost from its desired steady-state value:

$$\log \Pi_{j,t} = \frac{\gamma - 1}{\theta}(\log MC_{j,t} - \log MC^*) + E_t\left[\Lambda_{j,t+1} \log \Pi_{j,t+1}\right] \tag{18}$$

where x^* denotes variables in the steady state. The marginal cost for the retailer is simply the price of the firms' output, $p_{j,t}$. The steady-state price is $p^* = \frac{\gamma-1}{\gamma}$.

4.5 Capital Good Producer

There is a representative, region-specific capital goods producer that creates new capital using a technology $\psi\left(\frac{I_{j,t}}{K_{j,t}}\right)K_{j,t}$ with $\psi' > 0$ and $\psi' \leq 0$ and $\psi'(\delta) = 1$, $\psi(\delta) = \delta$. Let the slope of this function be η. The evolution of the regional aggregate capital stock is as follows:

$$K_{j,t+1} = (1 - \delta) + \psi\left(\frac{I_{j,t}}{K_{j,t}}\right)K_{j,t} \tag{19}$$

The regional real shadow value of capital, i.e. the Tobin's $q_{j,t}$, is given by the profit-maximization problem of the capital good producer and yields: $q_{j,t} = \frac{1}{\psi'\left(\frac{I_{j,t}}{K_{j,t}}\right)}$.

4.6 Monetary Policy

The pan-continental monetary authority controls the nominal interest rate that all regions take as given. The central bank targets the size-weighted average union-wide gross inflation rate Π_t:

$$\Pi_t = \sum_j^N \lambda_j \Pi_{j,t} \tag{20}$$

The central bank follows a rule in the spirit of Taylor (1993):

$$\log(R_t^N) = \log\frac{1}{\beta} + \varphi_\Pi \pi_t + e_t, \quad e_t \sim N(0, \sigma_e) \tag{21}$$

where R_t^N is the nominal rate, $e_t \sim \mathcal{N}(0, \sigma_e^2)$ is the monetary shock, and $\varphi_\pi > 1$ is the weight on inflation. In the steady state, $e_t = 0$. The real interest rate is determined by the Fisher equation: $r_t = i_t - \pi_t$, where r_t and π_t are both net rates, respectively.

4.7 Market Clearing

An equilibrium is a set of regional prices $q_{j,t}, p_{j,t}, \Pi_{j,t}, \Lambda_{j,t}, w_{j,t}$, union-wide prices Π_t, firm value functions $v_{j,t}$, and the associated optimal scale decision rule $s^*_{j,t}$, such that (a) all agents in all regions optimize, (b) the regional financial intermediaries price firm insolvency risk competitively, and (c) all markets in all $\mathcal{N}$ regions clear.

5 Quantitative Analysis

This section discusses are two-step calibration strategy and presents the main quantitative results.

5.1 Calibration

Model frequency is one quarter. Our economy consists of $\mathcal{N} = 26$ countries — members of the monetary union. Our calibration approach consists of two steps. First, we assign values to parameters that are country-specific. These constitute the loan recovery rates ω_j and size λ_j. Second, we assign values to parameters that are common to all countries.

Region-specific parameters. We start with loan recovery rates. Our primary source is Demirgüç-Kunt and Huizinga (2023) whose underlying data is from the 2020 European Banking Authority's report on national loan enforcement (European Banking Authority, 2020). The report provides survey-based information on (i) the gross recovery rate of loans conditional on firm insolvency and (ii) time to recovery (in years) for 26 European countries. We leverage both variables and construct the *net* recovery rate, which is the gross recovery rate adjusted by recovery duration.[8] It is the net recovery rate which corresponds one-to-one to ω_j in the model.

Table 1 provides the statistics on the recovery rates and years to recovery for 26 European countries. The average recovery rate is around 40%, the value in the ballpark of what is commonly used in the literature (Bernanke et al., 1999; Ottonello and Winberry, 2020). However, the average masks rich heterogeneity in ω_j, which varies from as low as 5% for Greece and as high as 75% for Luxembourg. Recovery rates are also negatively correlated with the share of constrained firms, as computed from our SAFE survey data.

Next, Table 1 also reports our empirical equivalent for λ_j. We use real GDP (in USD) as of 2014 and compute relative size weights. The correlation coefficient between net

[8] Assume $\tilde{\omega}_j$ is the country-specific gross recovery rate and the time recovery is τ_j. Then, the net recovery rate is $\omega_j = \tilde{\omega}_j \times \beta_j^{\tau}$.

Table 1: Region-Specific Parameters

Country	Gross Recovery Rate	Years to Recovery	Net Recovery Rate	Size Weight
EL	0.05	6.00	0.05	0.01
IE	0.07	24.40	0.06	0.02
PL	0.11	14.00	0.10	0.03
HR	0.21	1.20	0.21	0.00
HU	0.21	7.20	0.21	0.02
CY	0.26	16.40	0.24	0.01
IT	0.26	25.60	0.23	0.02
RO	0.26	15.20	0.24	0.06
CZ	0.28	17.20	0.26	0.00
EE	0.30	8.00	0.28	0.01
MT	0.34	21.20	0.31	0.00
FR	0.34	14.80	0.32	0.18
BG	0.39	15.60	0.36	0.03
FI	0.40	5.60	0.39	0.00
PT	0.43	13.20	0.40	0.09
DK	0.47	12.00	0.45	0.00
DE	0.49	6.80	0.48	0.14
SK	0.50	10.00	0.48	0.00
AT	0.53	9.20	0.51	0.02
LV	0.53	8.80	0.51	0.03
LT	0.55	12.80	0.52	0.25
BE	0.55	11.60	0.52	0.02
NL	0.64	7.20	0.62	0.00
ES	0.66	16.00	0.62	0.00
SE	0.69	2.40	0.68	0.04
LU	0.75	7.60	0.72	0.01

Notes: Calibration of model parameters that are region-specific.

recovery rates and size weights is a weak 10%, suggesting that market size does not absorb cross-country variation in financial frictions.

Union-wide parameters. The second step of our calibration steps consists of union-wide, i.e. region-invariant, parameters. These are summarized in Table 2 and partitioned into four blocks. We start with the parameters that are fitted to hit certain targets. The fixed operational cost, ξ, is calibrated such that its ratio to total output is 4%, following Ottonello and Winberry (2020). Initial capital, k_o, is calibrated to hit the union-wide size-weighted average investment to output ratio of 0.2. The dis-utility of work, χ, is calibrated to hit steady-state labor hours of 0.3. Finally, initial net worth, n_0, is chosen to achieve to a union-wide size-weighted average debt to assets ratio of 0.3. This number is obtained from a 2023 scientific report of the European Systemic Risk Board (Beck et al., 2023). It corresponds to corporate debt as a share of total corporate assets (gross leverage).

Table 2: Union-Specific Parameters

Parameter	Description	Value	Target/source
		Fitted	
ξ	Operating cost	0.022	4% of output, Ottonello and Winberry (2020)
k_0	Initial capital	18.4	Average investment/output = 0.2
n_0	Initial net worth	3.71	Average debt/assets = 0.3, EU average
χ	Dis-utility of work	3.06	Steady-state hours = 0.3
		Fixed - Household	
σ	Risk aversion	1	Standard
β	Discount factor	0.99	Standard
		Fixed - Firm	
α	Capital share	0.23	Jeenas (2024)
ν	Labor share	0.64	Karabarbounis and Neiman (2013)
ϕ	Firm default probability	0.03	EU average
δ	Depreciation rate	0.025	Standard
		Fixed - NK Block	
γ	Demand Elasticity	10	Markup = 11%
φ	Price adjustment cost	90	Phillips curve slope = 0.1 (Kaplan et al., 2018)
η	Capital adjustment cost	2	Standard
φ_π	Taylor rule coefficient	1.5	Standard

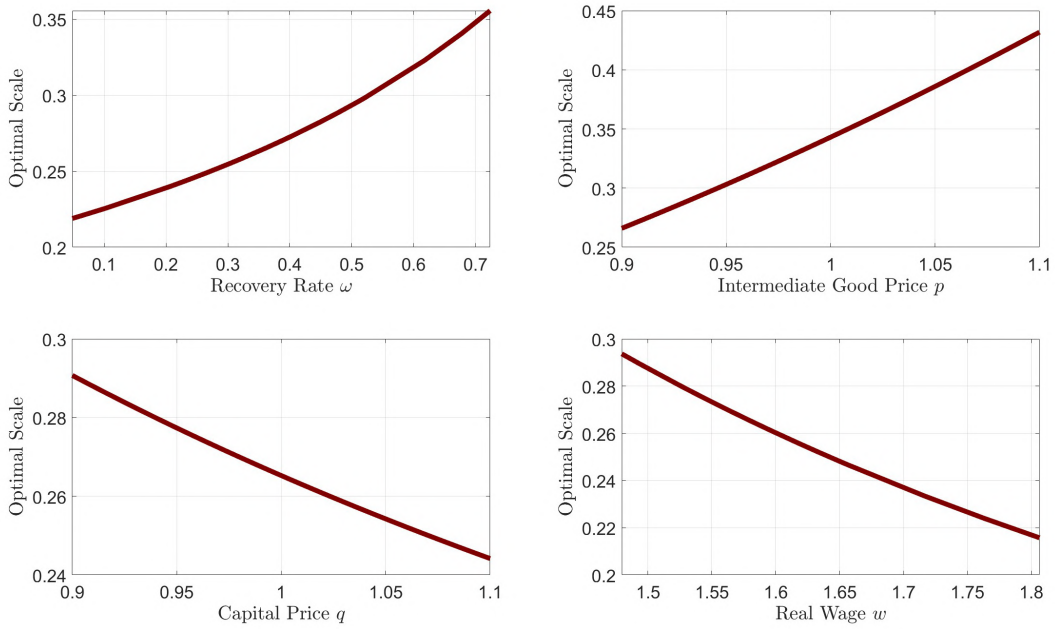
Notes: Calibration of model parameters that are not region-specific.

We proceed with three sets of fixed parameters. First, the household block consists of risk aversion, σ, and the discount factor, β. The former is already implicitly set to unity since we work with log-utility. The latter is set to a standard value of 0.99.

Second, for the firms block we set the capital share, α, to 0.23 following Jeenas (2024). The labor share, ν, is set to 0.64 as in Karabarbounis and Neiman (2013). It delivers decreasing returns to scale of 0.87. The quarterly depreciation rate of 0.025 is standard. Finally, the probability of firm default, ϕ, is region-invariant and equates 3%. This decision is dictated by three reasons. First, we want to limit the dimensions of cross-country heterogeneity and focus exclusively on the loan recovery rate, following the main mechanism in Bernanke et al. (1999). Second, this value corresponds to the average in the euro area (Constâncio, 2016). Third and finally, the average corporate mean default rate for the United States is also around 3% (Ottonello and Winberry, 2020).

Third and finally, parameters that belong to the New Keynesian block are all standard. The demand elasticity, γ, is set to 10 to imply a steady-state mark-up of 11%. The price adjustment cost, φ, is set to 90, implying a Phillips curve slope of 0.1 (Kaplan et al., 2018). The curvature of the capital adjustment function, η, is set to 2, giving the elasticity of

Figure 8: Comparative Statics of Optimal Firm Scale



Notes: comparative statics of optimal firm scale, s^*, with respect to different values for the loan recovery rate, the price of intermediate goods, the price of capital, and the real wage rate.

capital price changes to investment of around 0.5. Finally, the Taylor rule coefficient is set to a standard value of 1.5.[9]

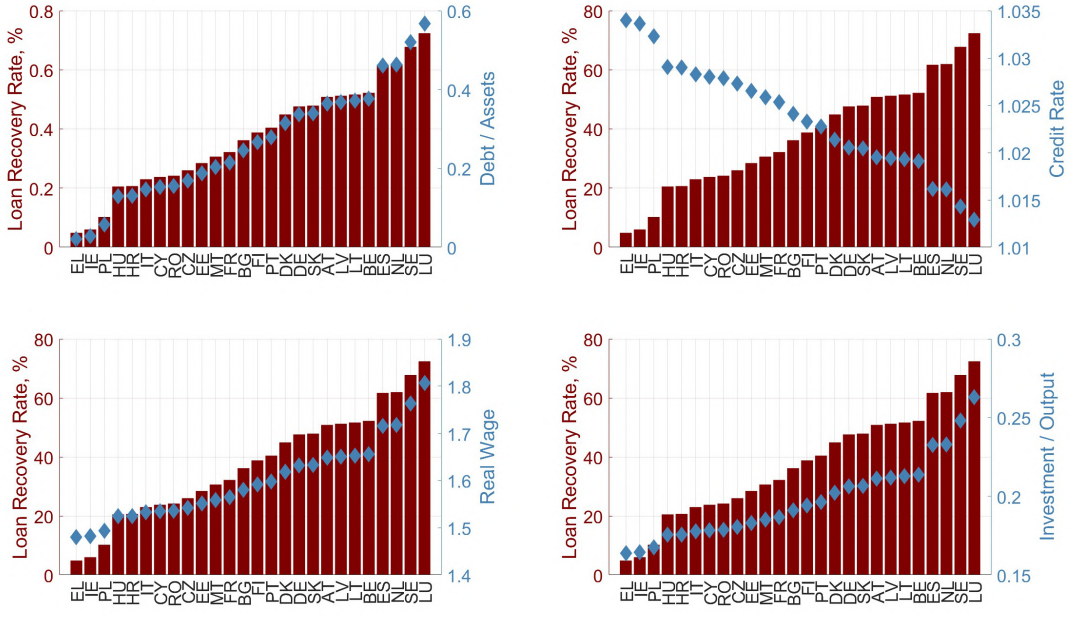
5.2 Steady-State Properties

We begin the quantitative analysis of our calibrated model with an inspection of steady-state properties. Figure 8 presents comparative statics of optimal firm scale, $s^\star$, with respect to changes in the recovery rate ω, and relative prices p, q, and w. Optimal scale is monotonically increasing in both ω and p, since both raise the discounted real equity value of the firm. On the other hand, optimal scale is decreasing in q and w, since these reduce the franchise value of the firm by increasing its operating costs. These relationships are intuitively consistent with outcomes of the firm optimization problem.

Figure 9 presents select model-implied steady-state properties. We show how four key statistics vary with country-level loan recovery rates, ω_j, which is always shown on the left y-axis. First, the debt/assets ratio is monotonically increasing in ω_j. Intuitively, firms

[9]Employing more sophisticated interest rate rules, such as those with loadings on an output gap, is straightforward to implement and does not influence any of our results.

Figure 9: Model Steady-State Properties



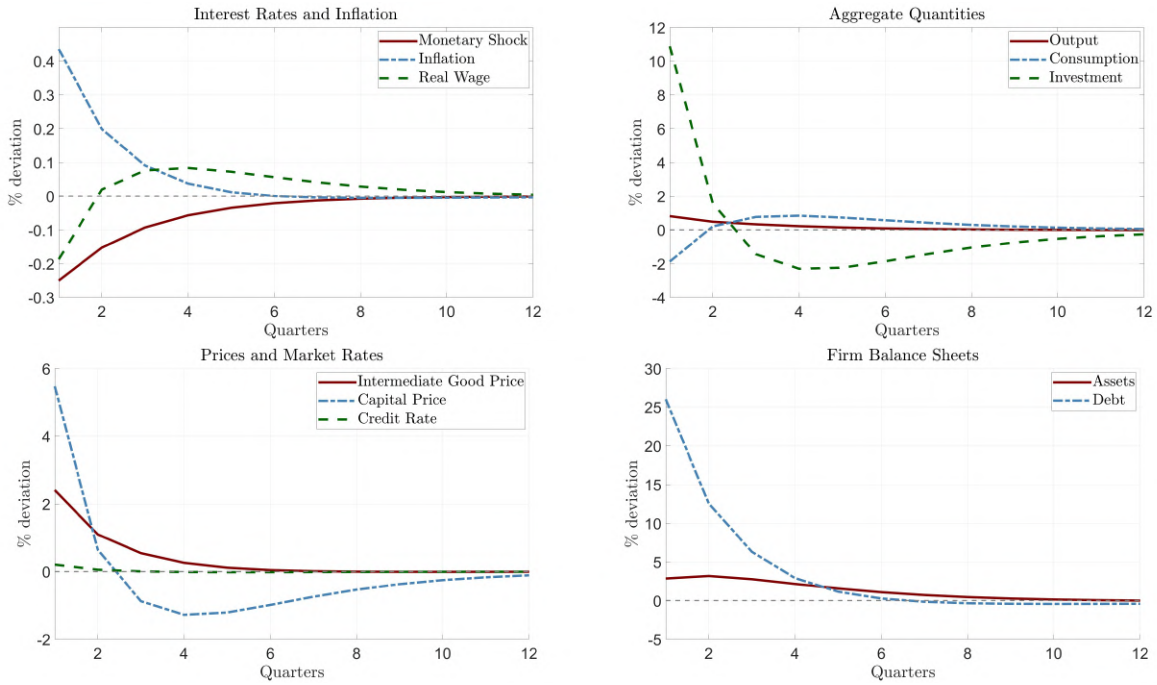
Notes: Equilibrium relations between select model-implied country-level aggregates and loan recovery rates in the steady state.

that operate in countries where the legal and financial structure is such that loan recovery conditional on insolvency is higher, are able to obtain more external financing from local financial intermediaries. In other words, debt is more obtainable in those regions where financial frictions are low.

Second, as seen from Figure 9, high-ω_j countries exhibit lower credit rates (inverse Q_j). This takes place because — conditional on a fixed and common insolvency probability ϕ — competitive financial intermediaries price in heterogeneity in recovery rates directly into credit rates. Thus, debt is cheaper in higher-recovery regions, everything else equal.

Third, the partial-equilibrium pass-through from ω_j to higher Q_j also affects general-equilibrium outcomes, as can be seen from the two bottom plots of Figure 9. Because firms in high-ω_j regions are more levered, they are able to achieve greater equilibrium scale. Growth comes with a higher demand for inputs, which puts upward pressure on the wage rate, w_j. In addition, firm balance sheet growth is also reflected in a higher investment to output ratio.

Figure 10: Aggregate Response to Monetary Policy



Notes: Aggregate response to a monetary policy shock that lowers the nominal rate by 1% p.a. and reverts back to zero at the rate 0.61.

5.3 Aggregate Response to Monetary Policy

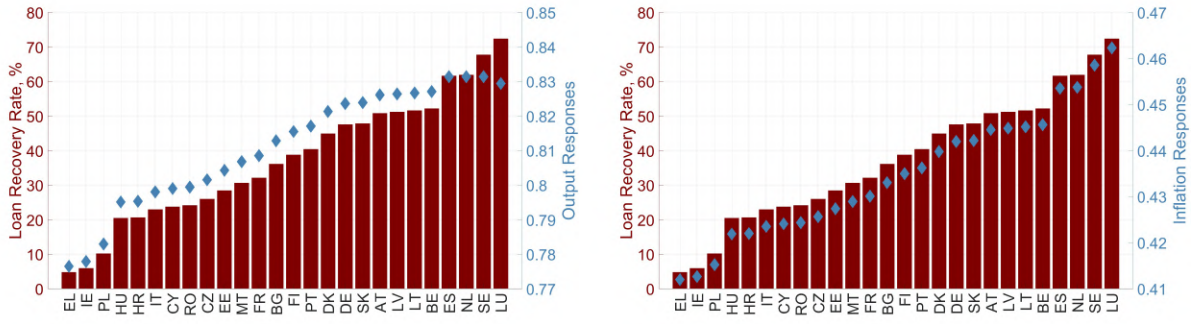
In this section, we consider the effects of exogenous shocks to the interest rate rule, e_t. We study perfect-foresight transition paths that originate from and return to the steady state. The size of the shock is 1% annualized, i.e. $e_t = -0.0025$. The shock is expansionary. It reverts back to zero according to $e_{t+1} = \rho_e e_t$ with $\rho_e = 0.61$.

Figure 10 presents the results from this exercise. We start with aggregate, union-wide responses. These are obtained, as before, as size-weighted averages of regional responses. Following a monetary expansion, cheaper external financing stimulates firm balance sheet growth. This growth, as can be seen clearly from the bottom-right panel, is leverage-driven as firms accumulate more debt on their balance sheets.

At the macro level, firm growth puts upward pressure on labor demand and the real wage rate, which rises from the second quarter onward. All aggregate quantities — including investment, consumption, and output — rise. Positive consumption growth is priced — via the stochastic discount factor — into the credit rate which rises, albeit mildly. In addition, higher aggregate demand also raises the price of capital, as the average Tobin's Q is now greater than unity, and intermediate goods' relative prices.

Finally, observe that investment rises by the most, especially on impact, followed by

Figure 11: Heterogeneous Impact Responses to Monetary Policy



Notes: Country-level on-impact responses to a monetary policy shock that lowers the nominal rate by 1% p.a. and reverts back to zero at the rate 0.61.

output and consumption. This ordering and the observed magnitudes are consistent with the standard evidence from macro VARs (Lawrence et al., 2005). Unlike Lawrence et al. (2005), our model generates only mildly hump-shaped aggregate responses, which can be achieved with, for example, external or internal habit formation.

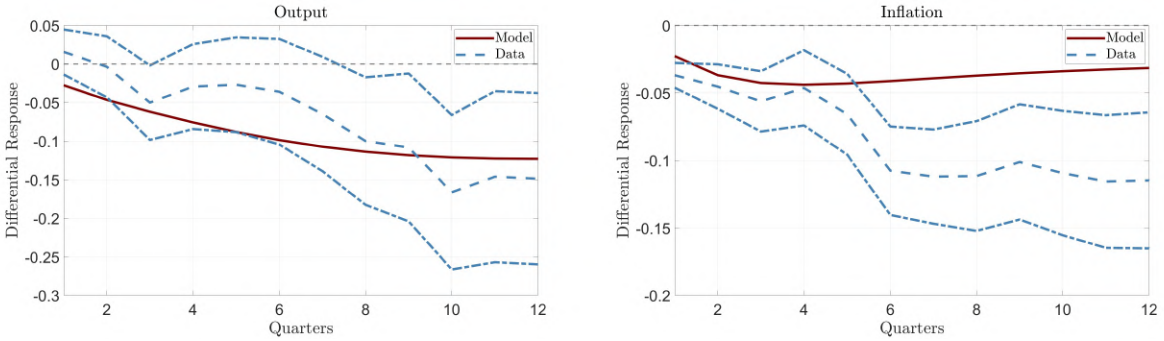
5.4 Heterogeneous Responses to Monetary Policy

One of our key quantitative interests is to study heterogeneous, country-specific responses to monetary policy shocks. We now present the full geography of responses as implied by the transition path following an expansionary shock. We start with on-impact responses for simplicity. Figure 11 presents the distribution of country-specific output and inflation responses, with the net loan recovery rate ω_j, as usual, on the left y-axes. We observe that countries that are *less* financially constrained are *more* responsive to the monetary expansion — both in terms of quantities and prices.

This result is reminiscent of the influential finding in Ottonello and Winberry (2020), who document the same pattern — both empirically and theoretically — for the case of U.S. firms. Thus, the conclusion that less financially constrained firms — whether measured at the level of an individual establishment or a country — are more reactive to interest rate shocks appears to be ubiquitous.

Next, we present the full paths of differential impulse responses of output and inflation. In order to maintain a close link to our empirical analysis, we compute average responses for countries that are either above or below the median level of the net recovery rate. Then, we subtract high-constraint responses from the low-constraint responses and present the differential response paths. We also plot the estimated empirical interaction coefficients from Figure 6, alongside 90% confidence bands. Qualitatively, the model and data are

Figure 12: Heterogeneous Responses to Monetary Policy



Notes: Country-level impulse responses to a monetary policy shock that lowers the nominal rate by 1% p.a. and reverts back to zero at the rate 0.61.

matched very well. Quantitatively, the model's differences are perfectly aligned with the data for the case of aggregate output. For inflation, the empirical differences are more propagated and persistent, and the match is less precise for quarters 6 through 12.

5.5 Regional Inequality

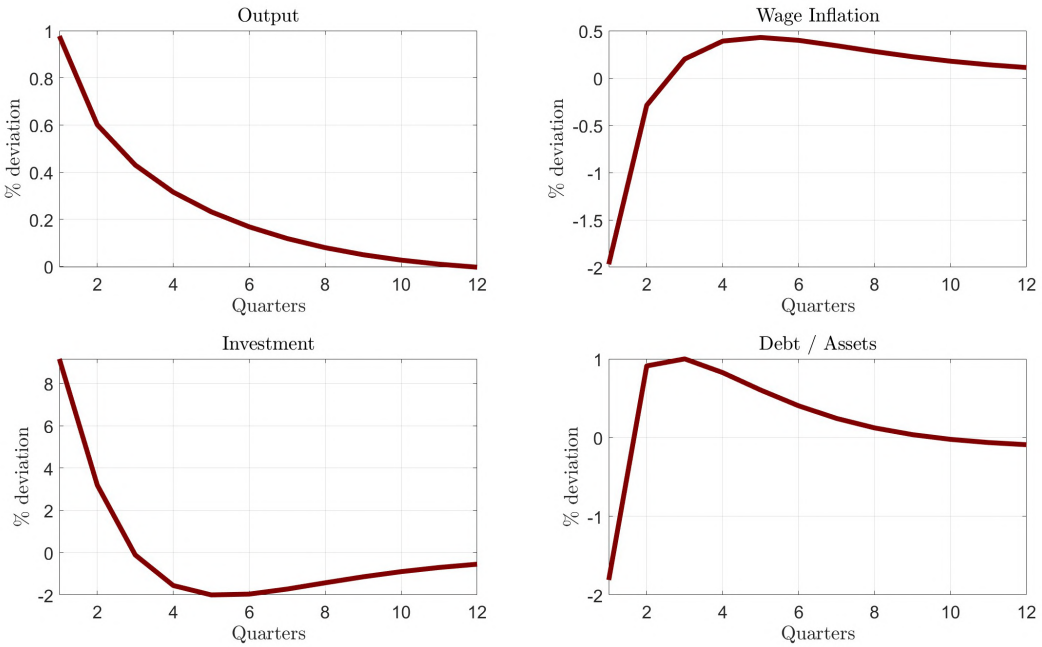
We have shown that a common interest rate shock induces very different responses across individual member states of the monetary union. What are the implications of monetary policy for formal metrics of regional inequality?

Figure 13 presents the responses of time-varying cross-regional dispersions of various aggregates. We proxy the second moment with the standard deviation. We observe that following a monetary policy expansion, regional inequality unambiguously increases for output and investment. Leverage inequality falls on impact but then rises in a persistent manner. Since steady-state price inflation is zero, we report wage inflation as a proxy of price behavior. Wage inequality also falls on impact but rises after the second quarter and remains elevated for around three years. Overall, our results point to expansionary monetary policy having an increasing effect on cross-regional inequality in our monetary union.[10]

The above result is related to Bellifemine et al. (2025) who document that persistent regional differences across the euro area systematically lead to heterogeneous responses to common aggregate demand shocks. While Bellifemine et al. (2025) focus on household heterogeneity and national fiscal space as a primary sorting characteristic, our emphasis is on the geography of financial frictions faced by firms and the production side of the

[10]Our result echoes the finding in Andersen et al. (2023) who show that softer monetary policy increases inequality among households.

Figure 13: Cross-Country Inequality



Notes: Changes in the time-varying standard deviations of cross-country aggregates to a monetary policy shock that lowers the nominal rate by 1% p.a. and reverts back to zero at the rate 0.61.

economy in the eurozone.

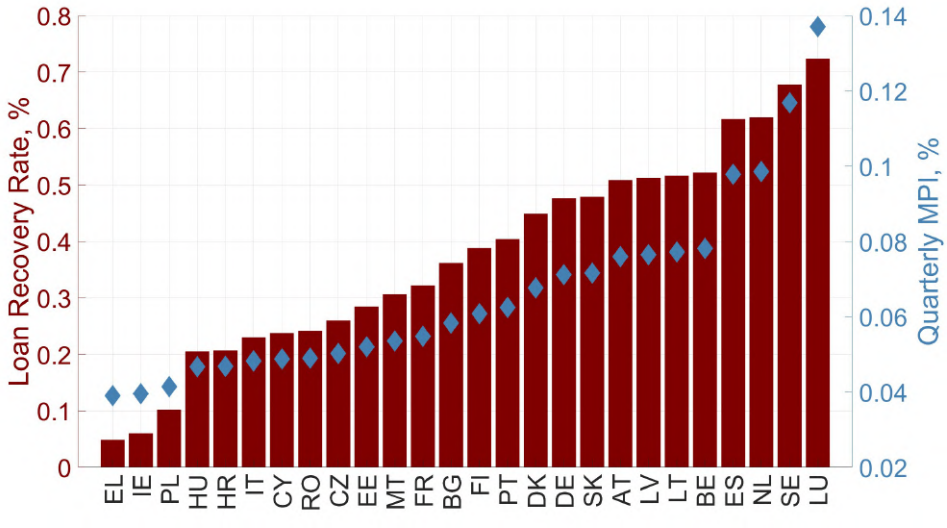
5.6 Inspecting the Mechanism — Marginal Propensity to Invest

To understand the mechanism behind our results so far, we now turn to our key sufficient statistic — the marginal propensity to invest (MPI). Recall that the MPI summarizes the partial-equilibrium response of firm scale to unexpected changes in interest rates. To the extent that general-equilibrium forces in this class of models are relatively mild (Khan and Thomas, 2013; Ottonello and Winberry, 2020), the regional distribution of MPIs is very useful for understanding the whole monetary transmission process.

Figure 14 reports the model's country-level quarterly MPIs, in percent, as a function of the loan recovery rate. The MPIs are clearly increasing in ω_j. Thus, in partial equilibrium, firms that are domiciled in regions with *low* financial frictions are *more* responsive to changes in the cost of external financing.

What is the economic intuition behind this finding? To first order, cross-regional heterogeneity in ω_j effectively captures spatial differences in the degree of steepness of firms' marginal cost curves. Countries that feature high loan recovery rates have flatter

Figure 14: Marginal Propensity to Invest



Notes: Quarterly marginal propensities to invest as implied by Equation 13.

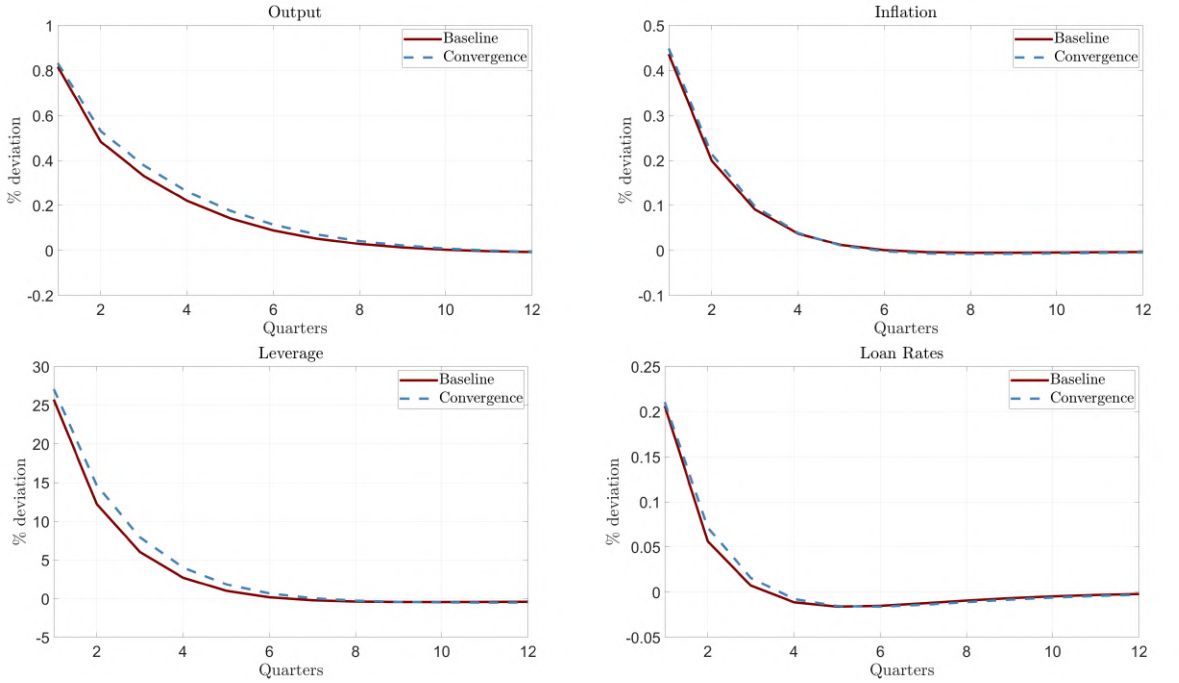
marginal cost curves. Non-financial firms that operate in such regions can afford to access more external finance following a relaxation of borrowing conditions. In contrast, firms that operate in low-loan-recovery countries face steeper upward-sloping marginal cost curves. Everything else equal, these firms do not benefit from monetary expansionary episodes.

Importantly, the above logic is exactly orthogonal to the economic intuition behind the behavior of constrained *households*. The classic result of the literature on heterogeneous households is that a greater share of hand-to-mouth or rule-of-thumb consumers generally increases the responsiveness to aggregate demand shocks (Campbell and Mankiw, 1989; Galí et al., 2007). In contrast, a higher share of constrained firms — both in models and in data, and both in Europe and the United States — appears to *dampen* aggregate responsiveness and fluctuations.

5.7 Convergence and Financial Integration in Europe

Our final quantitative exercise is a convergence experiment. One of the critical challenges for Europe in general and for the euro area in particular is absence of a money market union and of a banking union (Véron, 2012; Martinez et al., 2022). Country-specific borrowing rates are not invariant to country-specific factors, as was clearly seen already in Table 1. As a result, persistent regional obstacles in access to finance exist, and these

Figure 15: Financial Convergence and Aggregate Responses



Notes: Aggregate responses to a monetary policy shock that lowers the nominal rate by 1% p.a. and reverts back to zero at the rate 0.61 under two alternative initial steady states. The first is the baseline economy with heterogeneous loan recovery rates. The second is the convergence counterfactual with a homogeneous loan recovery rate.

obstacles may interfere with the conduct of monetary policy.

We consider a variant of our monetary union with two changes to the net recovery rate — the fundamental source of cross-country heterogeneity in our setup. First, ω_j is now *common* to all countries. Second, ω is now set to the highest value in our sample, i.e. 0.72, corresponding to that of Luxembourg. Our experiment therefore considers a situation where all European countries converge to the highest common denominator in terms of financial frictions.

Figure 15 reports impulse response functions of select macroeconomic aggregates for the baseline economy and the "convergence" case with a common and high loan recovery rate. We observe that financial integration has a strengthening impact on the effects of monetary policy. Output, inflation, and credit rates all react to the interest rate shock by more. Observe that firm leverage is also more responsive, albeit in the situation where the loan recovery rate is high. This result is reminiscent of the trade-off between macroeconomic and financial stability (Coimbra and Rey, 2023).

Quantitatively, the magnitude of the impact effects may appear small. In the Appendix, Figure A4 also reports *cumulative* impulse response functions for the two model economies. After three years following the expansionary shock, the financially integrated economy

features a macroeconomic response that is stronger by around 25 basis points for output, 5 basis points for price inflation, and 4 basis points for credit rates.

Observe that the difference for the cumulative responses of leverage is higher by as much as 10 percentage points, three years into the shock. It therefore appears the financial integration is a dual-edged sword and while it empowers the macroeconomic stabilization arm of the central bank it can also lead to financial de-stabilization. Intuitively, the latter result is expected because the financially integrated economy features a much higher average loan recovery rate and, as a result, a higher average marginal propensity to invest. The average firm is much more financially-constrained and its ability to obtain external financing leads to rapid leveraging.

6 Conclusion

Geographical disparities in the access to external finance in Europe have a first-order impact on the conduct of monetary policy. Firms that operate in less-constrained regions exhibit greater marginal propensities to invest out of changes in the cost of funds. The geography of MPIs translates into differential general-equilibrium responses to the same aggregate demand shock. The spatial distribution of financial frictions varies over time. Prospected convergence of European countries towards a low and homogeneous level of loan recovery rates raises the aggregate effectiveness of monetary policy, but at a potential cost to rising firm leverage and financial instability.

Our theoretical and quantitative results are based on a multi-region New Keynesian model of a monetary union with 26 countries that are asymmetric in size and the loan recovery rate conditional on firm default. We calibrate the model using the full distribution of observed recovery rates. The tractability of our model allows us to obtain many partial-equilibrium results — such as optimal firm scale choice and the MPI — in closed form.

To provide empirical support for our theory, we leverage proprietary, granular data from the ECB's SAFE survey. We document new stylized facts on the geography of financial frictions faced by firms in the euro area. In particular, we show that eurozone countries in which firms face larger obstacles to obtaining external finance are *less* responsive to union-wide monetary policy shocks. This moment is consistent with a model where low-risk regions feature flatter marginal cost curves and lower MPIs.

Our paper aims to alter the conventional wisdom that financial frictions amplify the effects of monetary policy. We show — both empirically and theoretically — that European regions that are most likely to benefit from expansionary monetary policy are, in fact, the *less* constrained ones.

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— Appendix —

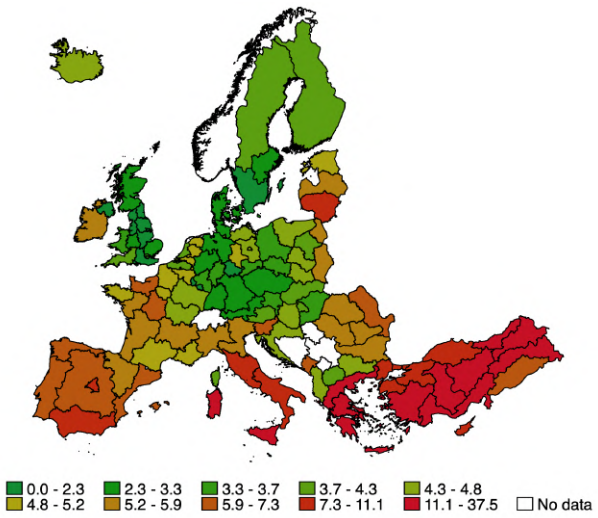
The Geography of the Financial Accelerator

Alexander Haas and Rustam Jamilov

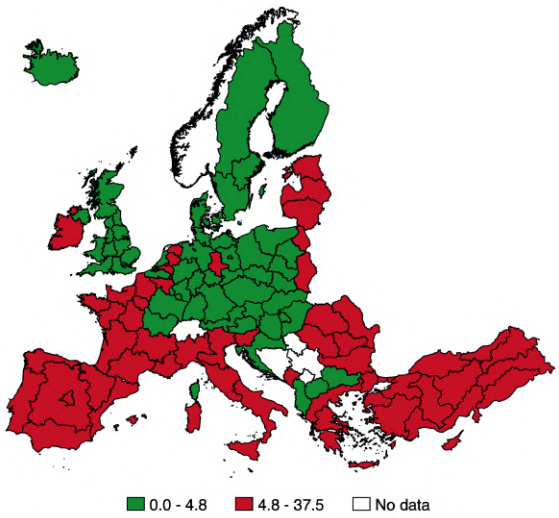
A Empirical Appendix

Figure A1: The Geography of the Financial Accelerator in Europe

(a) Ten Groups

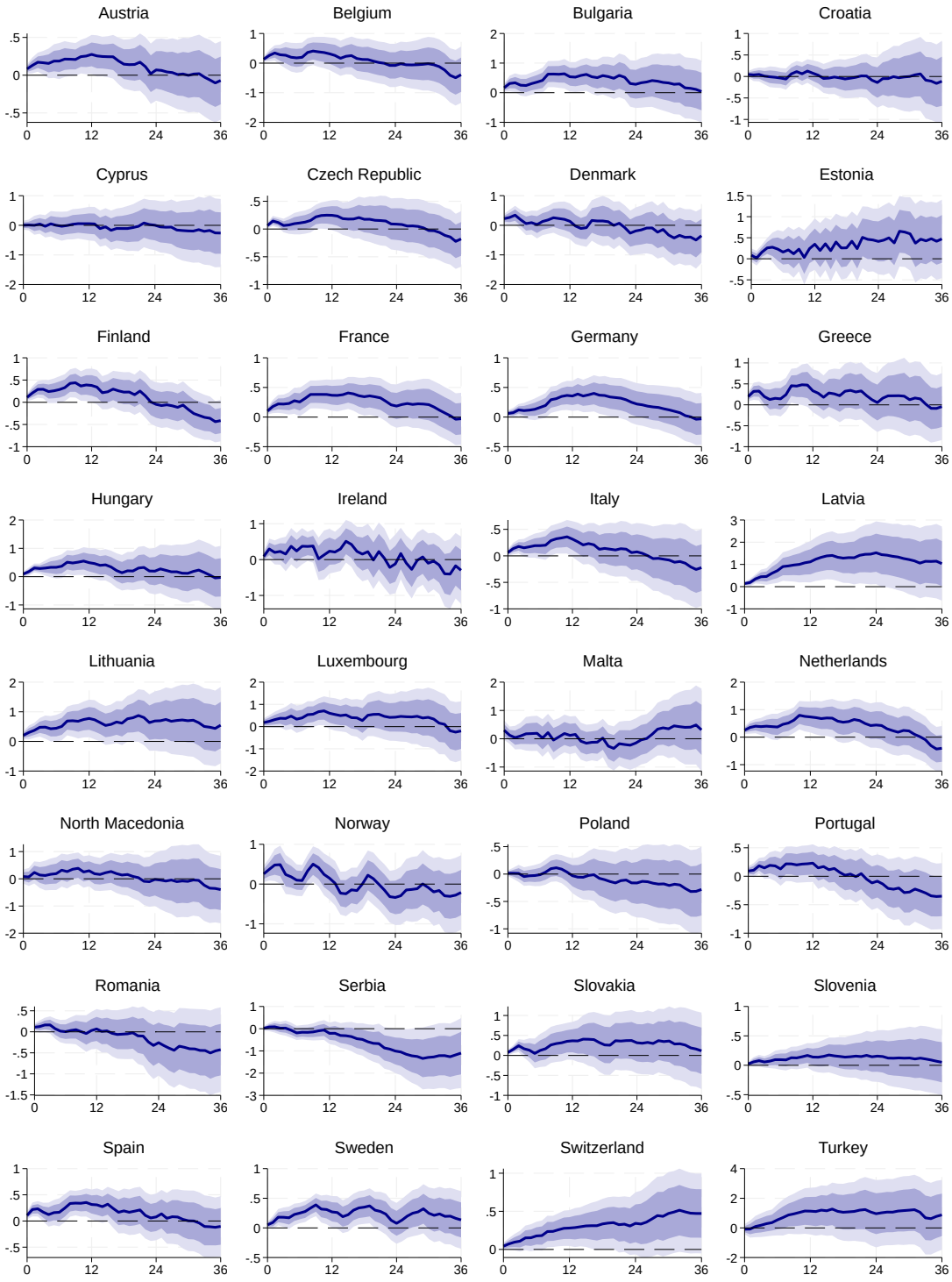


(b) Core and Periphery



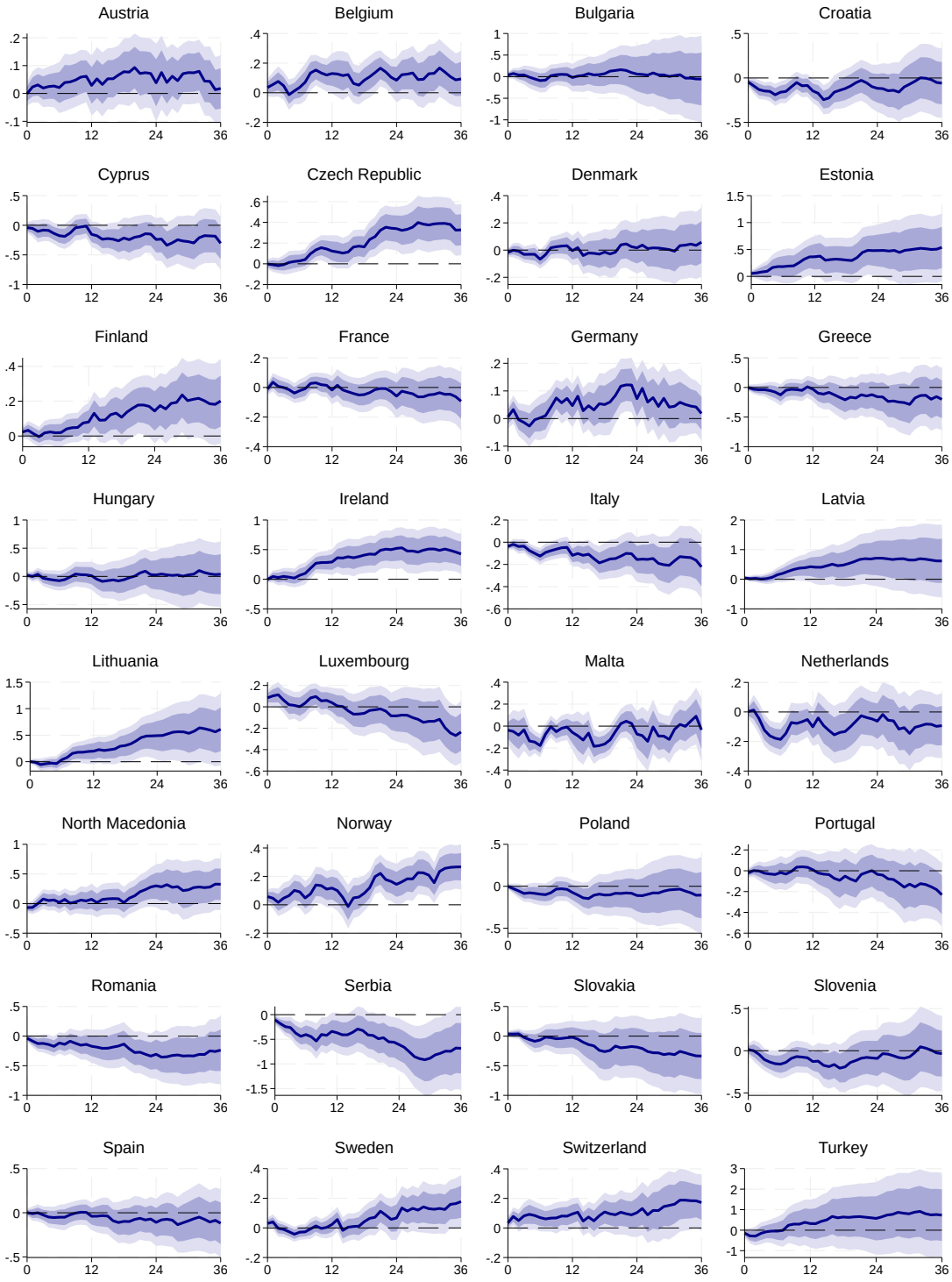
Notes: Geographic distribution of average region-specific levels of financial constraints.

Figure A2: Impulse Responses for Output by Country



Notes: Country specific impulse responses to a 1 standard deviation expansionary monetary shock. Shaded areas represent 90% and 68% confidence bands, respectively, constructed using Newey-West standard errors. The y-axes depict the h-step ahead percentage change. The x-axes depict months.

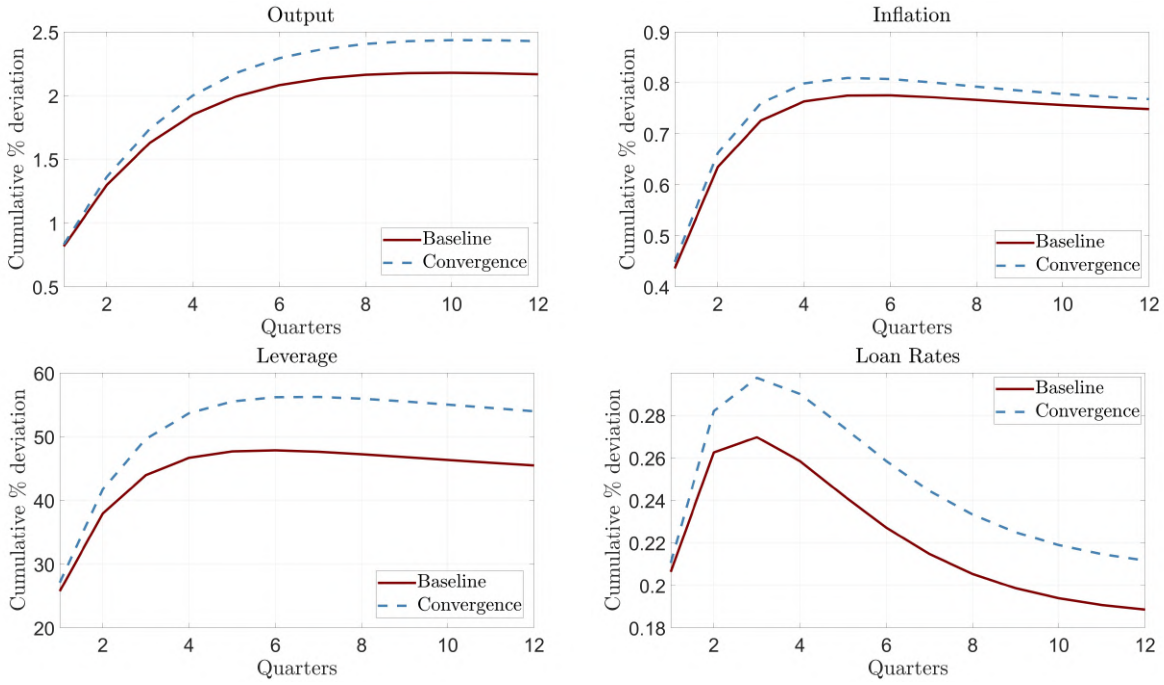
Figure A3: Impulse Responses for Prices by Country



Notes: Country specific impulse responses to a 1 standard deviation expansionary monetary shock. Shaded areas represent 90% and 68% confidence bands, respectively, constructed using Newey-West standard errors. The y-axes depict the h-step ahead percentage change. The x-axes depict months.

A.1 Model Appendix

Figure A4: Financial Convergence and Cumulative Aggregate Responses



Notes: Cumulative aggregate responses to a monetary policy shock that lowers the nominal rate by 1% p.a. and reverts back to zero at the rate 0.61 under two alternative initial steady states. The first is the baseline economy with heterogeneous loan recovery rates. The second is the convergence counterfactual with a homogeneous loan recovery rate.