BANCA D'ITALIA
EUROSISTEMA

Temi di discussione

(Working Papers)

Corporate leverage and monetary policy effectiveness in the Euro area

by Simone Auer, Marco Bernardini and Martina Cecioni

December 2019

Number 1258

BANCA D'ITALIA
EUROSISTEMA

Temi di discussione

(Working Papers)

Corporate leverage and monetary policy effectiveness in the Euro area

by Simone Auer, Marco Bernardini and Martina Cecioni

Number 1258 - December 2019

The papers published in the Temi di discussione *series describe preliminary results and are made available to the public to encourage discussion and elicit comments.*

The views expressed in the articles are those of the authors and do not involve the responsibility of the Bank.

ISSN 1594-7939 (print)
ISSN 2281-3950 (online)

Printed by the Printing and Publishing Division of the Bank of Italy

CORPORATE LEVERAGE AND MONETARY POLICY EFFECTIVENESS IN THE EURO AREA

by Simone Auer*, Marco Bernardini* and Martina Cecioni*

Abstract

We study the relationship between corporate leverage and the sensitivity of industrial production to monetary policy shocks within the euro-area manufacturing sector. Using *polynomial state-dependent* local projections, we document a non-linear association. When leverage is low, more indebted industries adjust their production more strongly in response to a monetary policy shock, consistently with a financial accelerator framework. At higher leverage ratios, this positive relationship weakens until it reaches a point where additional leverage is associated with a decrease in sensitivity to monetary policy. We show that this weakening effect is particularly intense within the short-term horizon and in recessions. Our results are consistent with recent studies analyzing the role of default risk in dampening the financial accelerator mechanism.

JEL Classification: C23, E32, E52, G32.
Keywords: financial heterogeneity, monetary policy, polynomial state-dependent local projections, high-frequency shocks, panel data.
DOI: 10.32057/0.TD.2019.1258

Contents

* Bank of Italy, Directorate General for Economics, Statistics and Research.

1 Introduction[1]

Corporate balance sheet positions play a key role in the transmission of monetary policy to the real economy. The financial accelerator literature finds that the aggregate response of investment and production to monetary policy is amplified by the fluctuations in corporate leverage driven by changes in asset prices and cash flows (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997).

When considering the heterogeneity in leverage across firms, which are the most responsive to monetary policy shocks is theoretically more ambiguous. On one hand, highly leveraged firms are expected to be more financially constrained. Borrowing an additional unit of funds is more costly, unfeasible, or even not profitable for them. All other things being equal, these firms are likely to adjust less their production in response to exogenous disturbances. On the other hand, they are supposed to be more exposed to the financial accelerator mechanism. With a larger share of debt financing, their net worth is proportionally more sensitive to shocks, amplifying the response of their production.

Which of these effects prevails is ultimately a quantitative matter. According to the conventional view based on the work of Bernanke, Gertler, and Gilchrist (1999), a higher leverage ratio should generally imply a stronger sensitivity to monetary policy shocks. Recently, Ottonello and Winberry (2018) have shown that this prediction could not necessarily hold true for highly leveraged – risky – firms, suggesting the possible presence of a non-linear relationship between corporate

[1]The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy or the Eurosystem. We are grateful to Peter Karadi and Marek Jarociński for providing their series of high-frequency monetary policy shocks. We thank Giuseppe Ferrero, Angus Foulis, Andrea Gazzani, Priit Jeenas, Stefano Neri, Marco Taboga and an anonymous referee for useful comments and suggestions. We also thank conference participants at the 2019 SED meeting in St. Louis and the 3rd ESCB Workshop on Monetary Economics in London. All remaining errors are ours.

leverage and the effectiveness of monetary policy. We empirically investigate this relation by exploiting the heterogeneity in industrial production and corporate leverage across twenty-two manufacturing industries in seven euro-area countries over the period 2001-18.

Recent studies address similar questions using firm-level data on US and UK listed firms (Ottonello and Winberry, 2018; Jeenas, 2019; Cloyne, Ferreira, and Surico, 2018; Anderson and Cesa-Bianchi, 2019). Our data differ from those used in these studies on two crucial and related dimensions. First, our industry-level data include information from both listed and non-listed firms. The latter group commonly accounts for a very large fraction of the non-financial corporate sector and includes those firms that are more likely to be subject to severe financial constraints. Second, our data refer to euro-area economy. They can provide useful insights on the role of financial heterogeneity in the monetary policy transmission since non-listed small and medium enterprises in the euro area account for a larger share of value added and employment than in the United States.[2] For the purpose of our analysis, both the country-industry dimension and the use of euro-area data strike the right balance between the need of having sufficient heterogeneity in corporate financial positions and that of capturing meaningful variation in production.

In the baseline we estimate the cumulative response of industrial production to a high-frequency monetary policy shock by means of what we call *polynominal state-dependent* panel local projections.[3] In particular, we introduce a polynomial

[2]Moreover, evidence for the euro-area economy is scanter than for the United States and dates back to the years prior to the adoption of the euro (Dedola and Lippi, 2005; Peersman and Smets, 2005).

[3]While the theory mainly deals with capital accumulation, in our empirical exercise we focus on an output measure such as industrial production, which is a broader economic indicator for assessing the overall effectiveness of monetary policy.

form of state-dependency within the local projection framework pioneered by Jordá (2005) in order to account for potential non-linearities in the relationship between corporate leverage and the effectiveness of monetary policy. The main advantage of this approach is its flexibility and parsimony to address, within the context of a macroeconomic dynamic model, non-linear forms of state-dependency that until recently were confined to applied microeconometric research.

The monetary policy shocks are constructed from high-frequency changes in relevant interest rates around the monetary policy meetings of the Governing Council of the European Central Bank (ECB). This state-of-the-art identification strategy has the benefit to impose a minimal set of restrictions with respect to other methods commonly used in the literature. To take into account the possibility that market participants react to the Governing Council assessment of the economic outlook rather than the policy announcements, we control for information shocks.

We find evidence of a non-linear relation between corporate leverage and the sensitivity of industrial production to a monetary policy shock. We show that at low leverage ratios, more indebted industries adjust their production more strongly in response to a monetary policy shock, consistently with a financial accelerator framework. As the corporate financial structure relies less on equity, this positive relation weakens until it reaches a point where additional leverage is associated with a decrease in the sensitivity to monetary policy. Quantitatively, we find that industries with liabilities to assets ratio close to 65-70% are those for which the effects of monetary policy on production are the strongest. Above such levels, higher leverage ratios are associated with a lower responsiveness to monetary policy shocks. An industry with a leverage ratio of 75%, for example, despite reacting more strongly than an industry with a ratio of 45%, adjusts its production less aggressively than industries with a 65% leverage ratio.

While the presence of a concave relation is found to be long-lasting, its inversion is more likely to emerge during the first months after the shock. Our estimates indeed suggest that the degree of non-monotonicity becomes less significant over the analyzed horizon, a result that is consistent with the finding that over the medium-term highly leveraged firms unambiguously benefit from the increase in net worth connected with a decrease in policy rates and expand their activity more than other firms (Jeenas, 2019).

We explore the sensitivity of our findings to several alternative specification choices and find that they are not specific to the analyzed sample or to the employed definition of corporate leverage. The results continue to hold when considering additional balance sheet indicators, when taking into account the presence of group-specific sensitivities, or when defining different forms of state-dependency. Moreover, the existence of a concave relationship is robust to the adoption of an alternative two-step approach in which we first estimate the dynamic response of industrial production to a monetary policy shock in each country-industry pair and then analyze how these responses are associated with leverage ratios in each pair.

Financial constraints could be stronger during recessions as highly leveraged companies are likely to be perceived as more risky and to feel a stronger need to repair their balance sheets. In this regard, an additional interesting question to explore within our setup is the extent to which the relation between corporate leverage and monetary policy varies with the phases of the industrial business cycle. To investigate this possibility, we take advantage of the flexibility of local projections and further allow the response of industrial production to be different if the shock occurs in good or in bad times. We find that the documented non-monotonicity that emerges at high leverage ratios is particularly intense during a negative phase of the industrial cycle.

The rest of the paper is organized as follows. The next section offers a brief review of the literature, focusing on the theoretical channels through which corporate leverage can alter the effectiveness of monetary policy. Section 3 describes the series of monetary policy shocks, the data, and the econometric methodology. Section 4 presents the empirical results on the relation between corporate leverage and monetary policy effectiveness in the euro area. Section 5 discusses the robustness of our findings. Section 6 further explores the analyzed relation differentiating between good and bad times. Finally, section 7 concludes.

2 A selected review of the literature

The financial accelerator literature unambiguously predicts that fluctuations in corporate leverage amplify the aggregate response of investment and production to monetary policy. An unexpected cut in the policy rate activates a number of indirect effects which magnify the direct effect due to the upward shift in the demand curve of capital. In particular, higher collateral values and expected cash flows, increase net worth and bring down firms' leverage. Under the presence of financial frictions, this induces a downward shift and a flattening in their supply curve of capital.[4] These indirect effects embedded in the balance sheet channel of monetary policy allow a further expansion of their activity over that ensured by the direct effect.

Whether more leveraged firms provide a larger contribution to this aggregate response is however theoretically ambiguous. The supply curve of these firms is

[4]The microeconomic friction behind the financial accelerator is the presence of an information asymmetry between the borrower and the lender. The resolution of this asymmetry, which is carried-out either by paying an agency cost (Bernanke and Gertler, 1989) or by conditioning the granting of credit to the value of the available collateral (Kiyotaki and Moore, 1997), leads to an upward-sloping or even vertical supply curve of capital and sub-optimal economic outcomes.

steeper, but also shifts more after the shock. For a given shift in the demand curve, the first feature reduces the real effectiveness of the shock, while the second amplifies it. Which of these two forces prevails is ultimately a quantitative matter. In a two-sector version of their representative firm model, Bernanke, Gertler, and Gilchrist (1999) bring evidence in favor of the existence of a positive relationship between corporate leverage and the effectiveness of a monetary policy shock by documenting an "excess sensitivity" of the more constrained firms.

Ottonello and Winberry (2018) build on this framework to include heterogeneous firms subject to default risk and show that the sensitivity to a monetary policy shock is a non-linear function of firms' leverage. Financially constrained firms are significantly more responsive than unconstrained firms, which finance themselves mostly with equity and thus operate with low leverage. Among constrained firms, however, more leveraged firms are more risky and face a steeper marginal cost of capital curve. In their calibration the direct effect of monetary policy dominates over the indirect ones, implying that the most leveraged firms do not necessarily display the highest sensitivity to shocks. Using a similar theoretical framework, Jeenas (2019) claims that the dominance of the direct effect is likely to appear only in the short-run. In the medium-run, the most leveraged firms unambiguously benefit from the increase in their net worth induced by a cut in the policy rate, expanding more their production.

The sensitivity of highly indebted firms could also be dampened through a debt overhang distortion (Myers, 1977; Occhino and Pescatori, 2015). This financial friction arises because firms are aware that during periods of financial distress the return from investment tends to be reaped by the firms' creditors.[5] For a given

[5] As discussed in Tirole (2010) the concept of debt overhang is however elusive. This term has also been used to identify credit rationing scenarios.

marginal cost, the possibility that the firm may experience such a distress, or even default on its outstanding debt obligations, lowers the marginal benefit that it expects to receive from capital accumulation and other discretionary decisions aimed at maintaining or increasing its production. This causes the firm to invest and produce less than optimal. After an exogenous reduction in the policy rate, highly indebted firms may even decide to take the opportunity to deleverage and reduce their debt burden. A preference towards balance sheet repair can therefore dampen the expansionary effect of monetary policy for highly leveraged firms.

Despite a growing body of empirical research studying the role of household debt in conditioning the strength of the monetary policy transmission, the literature on the role of corporate debt is instead scanter.[6] A series of recent papers study the heterogeneity across firms and investigate how this is important for monetary policy. In addition to Ottonello and Winberry (2018) and Jeenas (2019), Anderson and Cesa-Bianchi (2019), using daily data on credit spreads and volume of bond issued by US firms, investigate the quantitative relevance of the balance sheet channel, finding that it is stronger the higher the leverage. Cloyne et al. (2019) document that in the United States and in the United Kingdom younger firms with relatively lower leverage or more liquidity are those which have a significantly higher sensitivity to monetary policy shocks.

Our paper contributes to this recent strand of the literature by documenting the existence of a non-linear relation between corporate leverage and monetary policy effectiveness. In particular, we document that the responsiveness of industrial

[6]With regard to household debt, the literature has reached mixed results. Some authors find that the effectiveness of monetary policy in stimulating output is weakened during periods of high household indebtedness (e.g. Alpanda and Zubairy, 2019; Alpanda, Granziera, and Zubairy, 2019), while other contributions challenge the view that debt is the prevailing factor lowering the reactivity of households to monetary policy shocks (e.g. Gelos et al., 2019). Cloyne et al. (2019) instead document that the aggregate response of consumption to interest rate changes is driven by households with a mortgage.

production to a monetary policy shock is concave in leverage. This indicates that, at high leverage ratios, more leverage does not necessarily imply a greater sensitivity to monetary policy. We also show that this concave relation tends to invert, generating non-monotonic effects. This inversion is more likely to emerge in recessions and slowly fades away in the medium-term horizon. These results suggest that the most leveraged firms are not necessarily the most sensitive to monetary policy.

3 Data and methodology

The baseline analysis estimates the sensitivity of industrial production (the response variable) to monetary policy shocks, conditional on the degree of corporate leverage (the state variable). In this section we describe the main elements underlying our empirical analysis: (i) a series of monetary policy shocks; (ii) the disaggregated panel data used to define the response variable and the state variable; and (iii) the Jordá's (2005) local projection methods employed to compute impulse responses.

3.1 High-frequency identification of monetary policy shocks

The ECB monetary policy shocks are constructed using a high-frequency identification approach in the spirit of Gürkaynak, Sack, and Swanson (2005), Gertler and Karadi (2015), and Jarociński and Karadi (2018). The identification is carried-out in three steps. In the first step, a series of policy announcement surprises is obtained by extracting information from the changes in Euro Overnight Index Average (EONIA) swap rates within a fixed time window around monetary policy meetings. The identifying assumptions are that, in the specified time window, (i) no other relevant news affects the EONIA swap rates and (ii) markets fully incorporate the news released by the ECB. In a second step, the so-collected surprises are used to identify a series of monetary policy shocks, as opposed to information shocks. During the press conference that follows the monetary policy meeting, market participants may indeed react to the Governing Council assessment of the economic outlook for the euro area rather than to the release of unexpected monetary news (Nakamura and Steinsson, 2018a). To control for information shocks, we adopt the "poor-man" identification strategy proposed by Jarociński and Karadi (2018) and consider a policy announcement surprise as a pure monetary policy shock only when there is a negative co-movement with the surprise in the equity price index.[7] In the third and final step, high-frequency monetary policy shocks are aggregated at the monthly frequency to match with that of the dependent variable.

In this paper we consider two alternative measures of ECB monetary policy shocks. We borrow the first from Jarociński and Karadi (2018) and derive the second in the spirit of Cecioni (2018). The main difference between the two measures of shocks is the size of the time window: the latter is based on daily intervals, while the measure in Jarociński and Karadi (2018) only reflects intraday movements.[8] The choice of the time window should trade-off identification accuracy and statistical power. On one hand, a narrower window maximizes the

[7]They show that the proportion of "wrong-signed" responses is quite relevant in both the Unites States and the euro area (respectively, 35% and 45%) and that ignoring the information shocks strongly biases the results of the standard high-frequency monetary policy identification.

[8]The authors consider as monetary policy events the release of press statements as well as 60-minute press conferences. In both cases the specified window starts 10 minutes before the event and ends 20 minute afterwards. Whenever there is a press conference after the Governing Council meeting, they sum the changes in the two windows. The two measures also differ on the dimension over which the communication about future monetary policy is captured. The daily-frequency shocks are computed using the first principal component of daily changes of the EONIA swap rates spanning the first year of the term structure, while the intraday-frequency shocks exploit 3-months contracts.

Figure 1. High-frequency ECB monetary policy shocks

Note. Time-series of the monetary policy shocks identified using daily (blue) and intraday (red) time windows. The series are shown over the actual time interval used in the estimations and are normalized so that a positive unit value corresponds to a one-standard deviation expansionary shock.

chances that the identified shocks are truly exogenous. On the other hand, it is more likely to limit the statistical power to assess their medium-run effects on real variables, such as industrial production, which tend to respond with "long and variable lags" and are affected by many other shocks over the analyzed horizon (Nakamura and Steinsson, 2018b).

Figure 1 plots the two series over the actual time interval used in the estimations. Both shocks are normalized so that a positive unit value corresponds to a one-standard deviation expansionary impulse. Despite capturing roughly the same major unexpected policy announcements, the correlation between the two time-series is only moderately positive ($\rho = 0.55$). In this respect, we report the results based on both intraday and daily measures, providing robustness to the empirical findings presented in the paper.

3.2 Disaggregated panel data at country-industry level

Both the response and the state variables vary over time, across countries and across NACE two-digit manufacturing industries. Exploiting the wide cross-sectional variation in industry-level panel data can be particularly useful in understanding the effectiveness of monetary policy in the euro area. In particular, the industry-level of aggregation strikes the right balance between country-level and firm-level data. Using aggregate data, we would not be able to properly uncover the relationship between corporate leverage and the strength of the monetary policy transmission as the former tends to vary more across industries than countries (Dedola and Lippi, 2005). On the other hand, the use of highly disaggregated data has some limitation as well. First, with firm-level data the response variable would be at most quarterly. Moving to a lower frequency would entail a loss of information arising from the temporal aggregation of the high-frequency monetary policy shocks. Second, the firm-level databases generally used in the literature (i.e. Worldscope and COMPUSTAT) only cover publicly listed firms. While they make up a relevant share in the US, they constitute just a minority in the euro area.[9] This is a relevant issue for our analysis since publicly listed firms are less likely to be subject to severe financial constraints.

The response variable is the seasonally and working-day adjusted index of industrial production, observed at monthly frequency in the period 2001m1–2018m12 and sourced from EUROSTAT. The state variable is the ratio of

[9] When compared with the US, the euro-area economy is characterized by a higher share of small and medium-sized enterprises (SMEs) in the manufacturing sector, with a limited access to market-based financing and largely reliant on bank lending.

total liabilities to total assets, both measured at book values. An industry with a leverage ratio equal to 0% (100%) should therefore be considered as being fully (not) capitalized, i.e. financed only with equity (debt).[10] Data on balance sheets and income statements are available as an end-of-year figure between 2001 and 2015 and sourced from the BACH database.[11] Overall, our dataset covers a sizable cross-section of 7 euro-area countries (i.e. Austria, Belgium, Germany, Spain, France, Italy, and Portugal) and 22 manufacturing industries.[12]

The BACH database offers key advantages to investigate our research question. First, it can be reliably used to make cross-country comparisons of industries' leverage ratios across several euro-area economies.[13] Second, differently from other databases generally used in the literature, the BACH database covers listed as well as non-listed firms, providing a broad and comprehensive assessment of the degree of financial heterogeneity in the euro area.

There are however some caveats in using the BACH database. First, data are observed as end-of-year values. In order to work with monthly series, we set the first eleven months of a specific year equal to the last month of the previous year (e.g. we set the 2006m1-2006m11 figures equal to the 2005m12 figure). Second, national entities provide coverage ratios of the total population of non-financial corporations that can vary over time. As a result the time variation in the leverage

[10]Notice that the leverage ratio can also be greater than 100% when equity is negative.

[11]The BACH database is constructed by the European Committee of Central Balance Sheet Data Offices (ECCBSO). Balance sheets and income statements of a large number of European non-financial corporations, which are collected at individual level by central banks and government statistical agencies, are aggregated for each unit of observation at annual frequency. The aggregation is based on NACE Revision 2, the same adopted for industrial production.

[12]We exclude "C12 - Manufacture of tobacco products" and "C19 - Manufacture of coke and refined petroleum products" due to lack of data in the BACH and EUROSTAT databases. The missing information is likely to be associated with the limited number of existing firms in these industries.

[13]The database is the result of a substantial effort to ensure that a large number of firms are used in the aggregation and that the resulting indicators are harmonized across countries notwithstanding differences in national accounting practices (BACH Working Group, 2015).

ratio of a particular manufacturing industry in a given country could partly incorporate changes in the sample selection of firms in addition to changes in the demography of their population. Notwithstanding these limitations, it should be noted that our book-value measure of leverage tends to evolve very slowly over time and that the bulk of the variation comes from the cross-section. Nonetheless, to assess their relevance, in section 5 we discuss the use of an alternative – more structural – definition of leverage, i.e. an indicator that exclusively varies across countries and industries.

3.3 Methodology and heterogeneous effects of monetary policy

This paper addresses the following questions: is the heterogeneity in the effects of a common monetary policy shock across countries and industries linked to different leverage positions? And if so, how? Before we proceed further, we ask a preliminary question: how different are the responses of industrial production to a common monetary policy shock across statistical units? To this end, in this section we summarize the degree of such heterogeneity by means of Jordá's (2005) local projections (LPs). This method allows to directly compute impulse responses without specifying an underlying multivariate dynamic system, as it is the case in Vector AutoRegressions, making it a very flexible tool to accommodate panel structures and non-linearities (as we do in the next section).[14]

In particular, we estimate the cumulative response of industrial production for each country-industry pair, for a total of 154 statistical units, by means of the

[14]Other advantages are that LPs do not impose implicit dynamic restrictions on the shape of the impulse response and allow for parsimonious specifications. A disadvantage, however, is that they tend to lose efficiency as the analyzed horizon from the initial impulse increases.

following model:

$$\sum_{l=0}^{h} \Delta_{l+1} \ln y_{c,s,t+l} = \alpha_{c,s}^{h} + \beta^{csh} \varepsilon_t + \sum_{p=1}^{12} \theta^{hp} \Delta \ln y_{c,s,t-p} + u_{c,s,t+h}^{h} \tag{1}$$

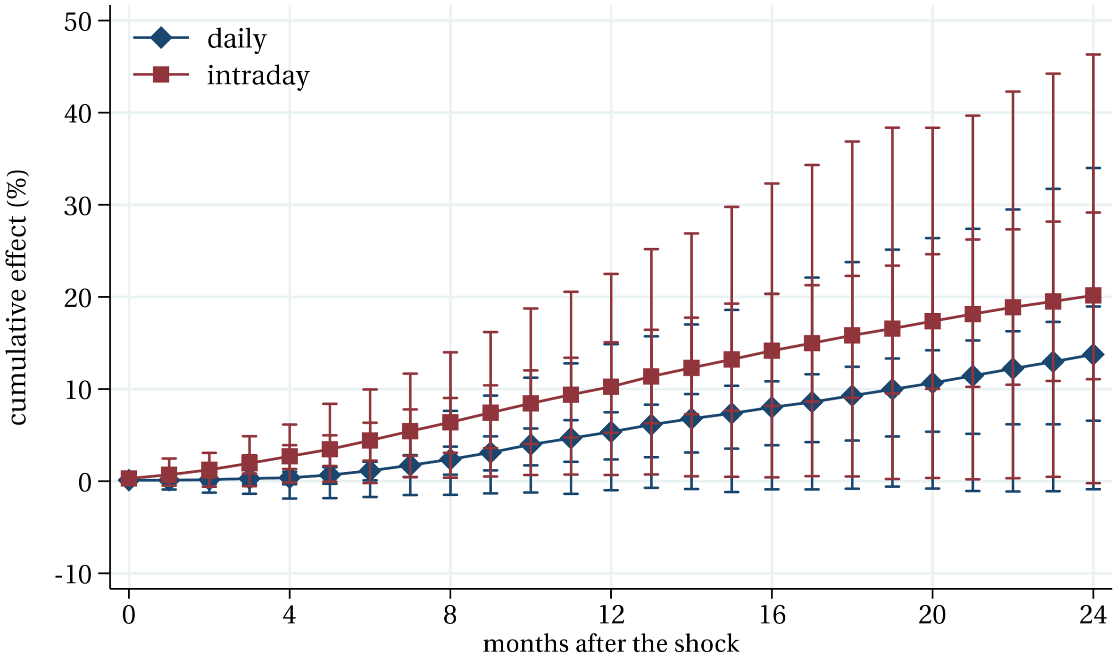
for $h = 0, \ldots, H$, where $y_{c,s,t}$ is the industrial production index of the sector s in the country c at time t and ε_t is the high-frequency monetary policy surprise, normalized so that a positive unit value corresponds to a one-standard deviation expansionary shock.[15] The operator Δ_{l+1} denotes the difference between a variable at a given point in time and its $l+1$ period lag.[16] Following Ramey (2016), the left-hand-side variable is specified so that the main coefficient of interest β^{csh} measures the cumulative response of industrial production (i.e. the area underneath the impulse response) at the horizon h to an expansionary policy shock in each country-industry bin. We focus on the total production gain because it provides a synthetic measure of the effects of monetary policy on real industrial activity during a given period. Moreover, it also yields a simple and implicit way to smooth-out the noisy pattern of the impulse response that is linked to the non-parametric nature of the LP estimator. The model includes twelve lags of the monthly growth rate in the industrial production index.[17] Finally, to compare the

[15] As discussed in Stock and Watson (2018), an alternative option is to treat ε_t as an instrumental variable. Instead of measuring the impulse response in terms of the variation in ε_t (the commonly used "unit standard deviation normalization"), the IV approach re-scales it in terms of the units of a specified instrumented variable ("unit effect normalization"). For the purpose of policy analysis, the former provides an advantage in settings where ε_t may not have direct economic interpretation (e.g. as in models where shocks are obtained resorting to non-economic instruments such as the magnitude of natural disasters or the number of terrorist attacks). A disadvantage, however, is that it comes at the cost of a reduction in the precision of the estimates due to the additional uncertainty related to the first-stage regression. Since our series ε_t has an intuitive economic interpretation, in this study we treat ε_t as a direct measure of monetary policy shocks.

[16] That is $\Delta_{l+1} \ln y_{c,s,t+l} = \ln y_{c,s,t+l} - \ln y_{c,s,t-1}$. In case of a one period difference we use the standard notation Δ without the subscript ($\Delta_1 = \Delta$).

[17] Notice that, differently from a model in which the identification of the monetary policy shocks is carried-out "internally", the use of externally identified exogenous shocks implies that lagged controls should not play any major role in the estimation of the impulse response. However, as pointed-out in Stock and Watson (2018), their inclusion can improve estimator efficiency.

Figure 2. Heterogeneous effects of an expansionary monetary policy shock



Note. Cross-sectional dispersion in the cumulative dynamic effect of a one-standard deviation expansionary monetary policy shock on industrial production at the country-industry level using model (1). Blue lines refer to monetary policy shocks identified at daily-frequency, while red lines are related to monetary policy shocks identified at intraday-frequency. Solid lines with markers show the mean of the distribution, while vertical bars show different percentile intervals for daily-frequency and intraday-frequency shocks, respectively: 25th-75th (50%) and 5th-95th (90%).

estimates across horizons h, we hold the sample constant by using the one implied by the longest horizon, which is two years in our analysis ($H = 24$).[18]

Figure 2 summarizes the cross-sectional heterogeneity in the cumulative response of the two-digit level industrial production index $\hat{\beta}^h_{c,s} = \left\{\hat{\beta}^{11h}, ..., \hat{\beta}^{CSh}\right\}$ for $h = 0, \ldots, H$ using both daily and intraday shocks. A one-standard deviation expansionary monetary policy shock has a positive and persistent effect on industrial activity. After two years, the cumulative production gain generated in response to a one-standard deviation expansionary monetary policy shock is

[18] Due to the presence of leads and lags in model (1), the actual time interval used in the estimations is 2002m2–2016m12.

around 20 percentage points, which corresponds to an average effect of 0.8 percentage points on a monthly basis. By looking at the different percentiles, however, the size of this effect is considerably heterogeneous across country-industry pairs, as some industries in some countries strongly increase their production, while others barely react to it.

4 Corporate leverage and monetary policy effectiveness

In this section we take advantage of the documented heterogeneity in the response of industrial production to a monetary policy shock to verify the presence of a relation between corporate leverage and monetary policy effectiveness across country-industry pairs in the euro area. As discussed before, from a theoretical standpoint the sensitivity of output to a monetary policy shock does not necessarily increase linearly with the degree of corporate leverage. According to the conventional view, a higher leverage ratio should generally imply a stronger sensitivity. However, the effects embedded in the balance sheet channel may not necessarily prevail for highly indebted industries. In this case, the presence of dampening effects connected with a steeper marginal cost of borrowing curve and a debt overhang distortion could be particularly strong to weaken the positive relation between corporate leverage and monetary policy effectiveness.

In order to account for potential non-linearities in the analyzed relation, we estimate the following *polynomial state-dependent* panel LPs:

$$\begin{aligned}\sum_{l=0}^{h}\Delta_{l+1}\ln y_{c,s,t+l} = & \alpha^{h}+\beta^{h}\varepsilon_{t}+\sum_{p=1}^{12}\theta^{hp}\Delta\ln y_{c,s,t-p}+\\ & +\ell_{c,s,t-1}\left[\alpha^{Lh}+\beta^{Lh}\varepsilon_{t}+\sum_{p=1}^{12}\theta^{Lhp}\Delta\ln y_{c,s,t-p}\right]+\\ & +\ell_{c,s,t-1}^{2}\left[\alpha^{Qh}+\beta^{Qh}\varepsilon_{t}+\sum_{p=1}^{12}\theta^{Qhp}\Delta\ln y_{c,s,t-p}\right]+\\ & +\alpha_{c}^{h}+\alpha_{s}^{h}+\alpha_{t}^{h}+u_{c,s,t+h}^{h}\end{aligned} \tag{2}$$

for horizon $h = 0, \ldots, H$, where $\ell_{c,s,t-1}$ is the predetermined leverage ratio of the industry s in the country c at time $t-1$, and α_c^h, α_s^h, and α_t^h are a set of fixed effects specific to countries, industries, and time periods.[19] The model in equation (2) is a state-dependent panel version of the LP model (1) presented in section 3. In particular, we now add a linear interaction term to test whether the response of industrial production is increasing with leverage and a quadratic interaction term to check whether this relation amplifies, attenuates or remains broadly constant as the corporate financial structure relies more on debt. More precisely, the parameters β^h, β^{Lh}, and β^{Qh} define a relation $\psi^h[\ell]$ expressing the cumulative response of industrial production to a common expansionary monetary policy shock at horizon h as a function of corporate leverage ℓ:

$$\psi^h[\ell] = \beta^h + \beta^{Lh}\ell + \beta^{Qh}\ell^2 \tag{3}$$

The modeling of the state-dependency as a polynomial function is an agnostic and parsimonious way to test the relevance of the analyzed theoretical mechanisms. It is agnostic because it does not rely on the *ex-ante* imposition of any threshold. The

[19] We specify a predetermined leverage ratio $\ell_{c,s,t-1}$ to avoid the possible contemporaneous influence of the shock ε_t on the state variable itself.

presence of possible non-linearities is detected taking advantage of all the available information in the data. It is parsimonious because it accounts for complex forms of state-dependency also in settings where the size of the data, especially in the cross-sectional dimension, is not large enough to split the sample into multiple – threshold-defined – narrow bins of equal width. This is typically the case with panel datasets at the industry-level, bank-level or country-level. To the best of our knowledge this paper is the first study to adopt this approach in the context of a macroeconomic dynamic model.

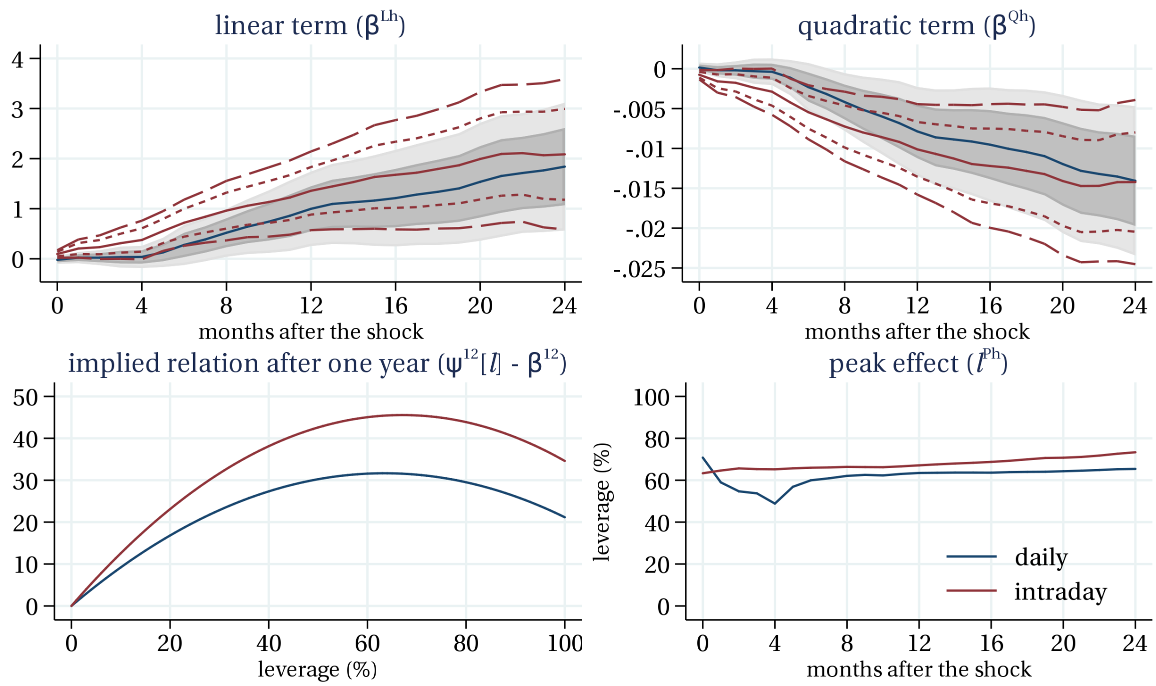
Notice that the intercept α^h and the parameter β^h in equation (2) are absorbed by the fixed effects, implying that $\psi^h[\ell]$ can only be estimated up to an unidentified constant β^h. This suggests that the quantification of $\psi^h[\ell]$ must be carried-out in differential terms rather than in levels, i.e. calculating the rate of change in the effectiveness of a monetary policy shock associated with a difference ξ in the leverage ratio:

$$\tilde{\psi}^h[\ell,\xi] = \psi^h[\ell+\xi] - \psi^h[\ell] = \beta^{Lh}\xi + \beta^{Qh}\left(\xi^2 + 2\ell\xi\right) \tag{4}$$

Figure 3 shows the main coefficients of interest from the model in equation (2).[20] The upper-left panel reports the coefficient β^{Lh}, which is positive and similarly estimated using the two alternative definitions of shocks. This indicates that, consistently with the balance sheet channel, a higher leverage ratio is generally associated with a greater responsiveness of industrial production to a common monetary policy impulse. The upper-right panel shows the coefficient related to the

[20] The estimation is carried-out using an unbalanced macro panel consisting of 27,279 observations, which account for approximately 99 per cent of the total number of possible combinations of countries (7), sectors (22), and time periods (179). Table A1 in the data appendix reports the summary statistics for the all the variables used in this study. In all the estimations we specify Driscoll and Kraay (1998) standard errors, which take into account potential residual cross-sectional correlation, as well as serial correlation and heteroskedasticity among the residuals over time.

Figure 3. Quadratic relation between corporate leverage and monetary policy

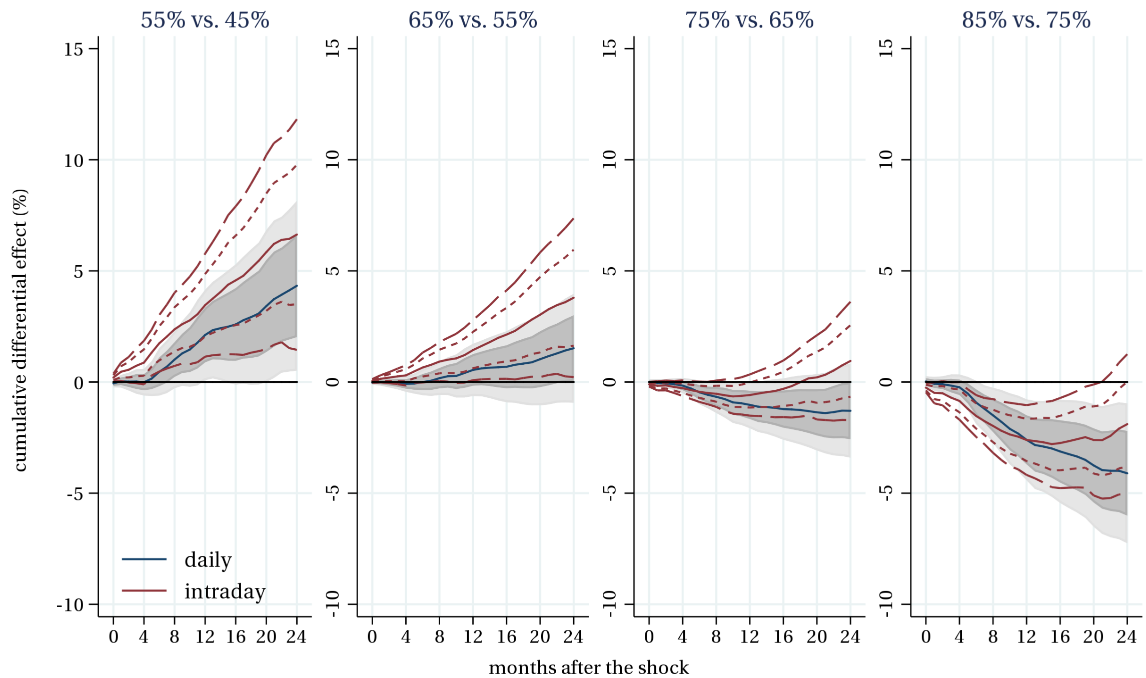


Note. Estimates of the parameters underlying the quadratic relation between leverage and monetary policy. The implied relation between corporate leverage and the effectiveness of monetary policy in the lower-left panel is identified up to the constant β^{12}. Blue lines are estimates of equation (2) using monetary policy shocks identified at daily-frequency, while red lines are obtained using monetary policy shocks identified at intraday-frequency. Dark (light) area and dotted (dashed) line show 68% (90%) confidence intervals for daily and intraday frequency, respectively.

quadratic term β^{Qh}, which is negative and, also in this case, robust to different measures of monetary policy shocks. This suggests that the positive association between corporate leverage and monetary policy tends to weaken as the corporate financial structure becomes more skewed towards debt. The implied hump-shaped relation at the one-year horizon ($h = 12$) is shown in the lower-left panel. The lower-right panel shows the leverage level associated with the maximum effect of monetary policy at different horizons, $\ell^{Ph} = -1/2\left(\beta^{Lh}/\beta^{Qh}\right)$, which is relatively stable and close to 65%-70%.

To offer useful benchmarks for theorists and policymakers, Figure 4 quantifies

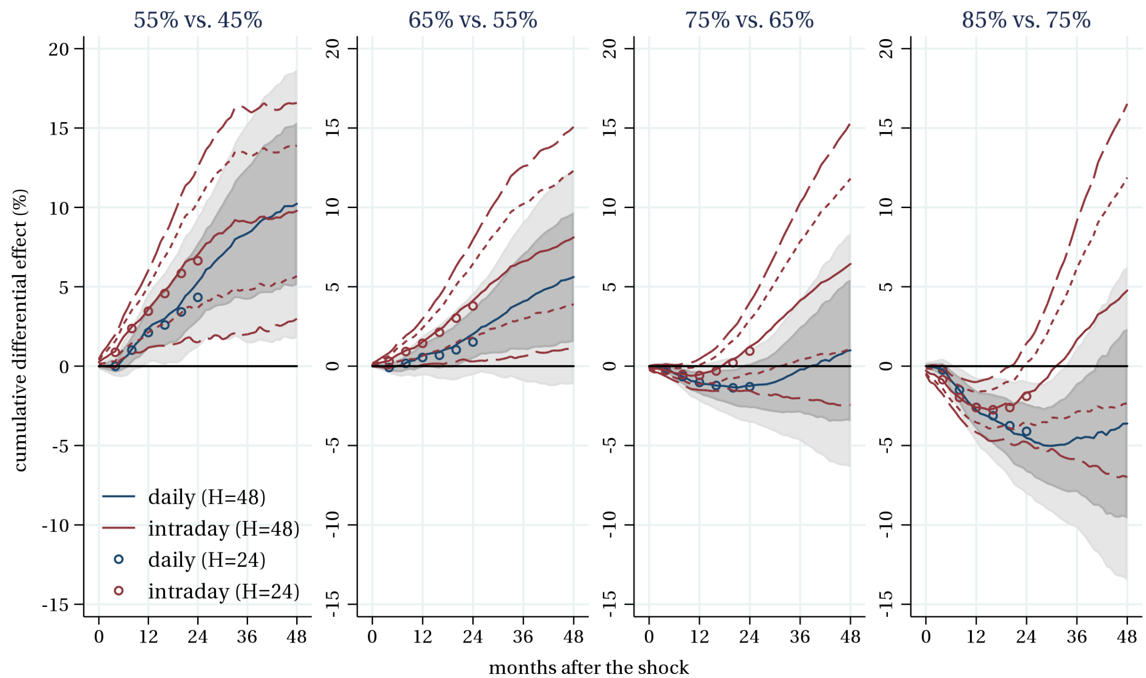
Figure 4. Differences in sensitivity to monetary policy along the leverage dimension



Note. Differences in the cumulative response to a one-standard deviation expansionary monetary policy shock associated with a difference in leverage of 10 percentage points at several leverage ratios. Blue lines are estimates of equation (2) using monetary policy shocks identified at daily-frequency, while red lines are obtained using monetary policy shocks identified at intraday-frequency. Dark (light) area and dotted (dashed) line show 68% (90%) confidence intervals for daily and intraday frequency, respectively.

the differential effect in equation (4) specifying a difference in leverage of 10 percentage points ($\xi = 10$) and several reference values ($\ell = \{45\%, \ldots, 75\%\}$). The first panel on the left shows that an industry with a leverage ratio of 55% reacts more strongly to an expansionary monetary policy shock than an industry with a ratio of 45%. After two years, the cumulative production gain generated in response to a one-standard deviation expansionary monetary policy shock is around 4.5–6.5 percentage points, which corresponds to an average differential effect of about 0.2 percentage points on a monthly basis. The differential response of production across country-industry pairs is not short-lived and lasts for up to two years for both measures of shocks. As the corporate financial structure relies

Figure 5. Differences in sensitivity along the leverage dimension at longer horizons



Note. Differences in the cumulative response to a one-standard deviation expansionary monetary policy shock associated with a difference in leverage of 10 percentage points at several leverage ratios. Lines are the estimates obtained specifying $H = 48$ in equation (2), while circles denote the baseline estimates for $H = 24$ shown in Figure 4. Blue lines and circles are estimates obtained using monetary policy shocks identified at daily-frequency, while red lines and circles are obtained using monetary policy shocks identified at intraday-frequency. Dark (light) area and dotted (dashed) line show 68% (90%) confidence intervals for daily and intraday frequency, respectively.

less on equity, however, the size of this positive differential effect weakens up to a point where we find evidence of a negative (i.e. non-monotonic) effect. For instance, our estimates suggest than an industry with a liability to asset ratio of 75% (i.e. an equity ratio of 25%), despite reacting more strongly than an industry with a ratio of 45%, adjusts its production less aggressively than an industry with a ratio of 65%.

While these results strongly point to the presence of a concave relation between corporate leverage and monetary policy effectiveness, its inversion is more likely to appear in the short-run. Figure 5 shows that the degree of non-monotonicity in the analyzed relation becomes less pronounced over the medium-term horizon, with the negative cumulative differential effect that emerges at high leverage ratios starting to fade between one and three years after the shock (right-hand side panel).[21] Although the estimates based on daily shocks point to a delayed dynamics, possibly reflecting the higher persistence of the underlying monetary surprises, overall the results suggest that the relation between corporate leverage and monetary policy effectiveness is likely to be still concave but monotonic in the longer horizon. These findings are consistent with Jeenas (2019) which argues that the presence of a negative relation between leverage and monetary policy is more likely to appear only within the short-term horizon. In the medium-term horizon, highly leveraged firms unambiguously benefit from the increase in net worth connected with a decrease in policy rates and expand their activity more than other firms.

5 Robustness

5.1 Alternative specification choices

In this section we explore the sensitivity of our findings to several alternative specification choices.[22] We argue that the results are not specific to the analyzed sample or to the employed definition of corporate leverage. Similarly, they hold when augmenting the baseline model with additional balance sheet indicators, when taking into account the presence of group-specific sensitivities, or when defining alternative forms of state-dependency.

[21] We re-estimate the model in equation (2) specifying $H = 48$. This reduces the actual sample size, implying that point estimates and confidence bands do not necessarily overlap with those obtained in the baseline.

[22] An appendix with the full set of robustness checks is available upon request from the authors.

Sample Our findings could be specific to the analyzed sample. For example, they could reflect a selection bias induced by the use of an unbalanced panel or be driven by the inclusion of specific countries, industries, or time periods. To address these concerns we consider a fully-balanced sample, shorter samples (ending in 2014 or even 2011), as well as samples in which we remove one country or one manufacturing industry at a time.[23] This set of alternative specifications produces results that are qualitatively similar to that of the baseline estimation.

Measure of leverage Our preferred measure of leverage is the ratio of total liabilities to total assets. An advantage of this definition is that it can be interpreted either as an indication of the degree of indebtedness as well as a measure of the degree of capitalization, the latter being a key variable in the theoretical literature on financial frictions (it measures to what extent a borrower has "skin in the game"). It can be argued, however, that a narrower definition of leverage provides a more appropriate measure of the degree of indebtedness (Rajan and Zingales, 1995). We find that the baseline result does not materially change when total liabilities are replaced with the sum of loans and debt securities and total assets are netted with trade payables and deferred liabilities. Using this alternative measure, the maximum effect of monetary policy is reached at leverage ratios ℓ^{Ph} close to 40%.

Another possible criticism concerning our state variable, based on end-of-year book values, is that it displays a staggered dynamics, mechanically varying over time only every twelve months. As an alternative, we consider a more structural measure that exclusively varies across countries and industries, i.e. stays constant

[23] A fully-balanced panel is obtained by excluding the sector "C15 - Manufacture of leather and related products", due to missing data for Germany in the BACH database, and dropping the sectors "C30 - Manufacture of other transport equipment" and "C33 - Repair and installation of machinery and equipment", due to missing observations in the first years of the sample for Spain and Portugal in the EUROSTAT database. The fully-balanced macro panel consists of 23,807 observations.

over time. In particular, we employ an alternative state variable $\bar{\ell}_{c,s}$ which is defined as the median leverage ratio over time in a given country-industry bin. The use of the median value is intended to minimize the incidence of the time variation. Also in this case we find very similar patterns. If anything, the concavity of the analyzed relation becomes even more pronounced for both measures of shocks.

Use of a single indicator as a state-dependent variable We focus on leverage since it is theoretically and empirically linked to the costs of external finance and the literature on financial frictions. However, other relevant corporate balance sheet indicators correlated with leverage could as well explain the documented relation with the effectiveness of monetary policy. Putting it differently, the variation in the state variable is predetermined but not exogenous, as it is often the case in many empirical papers analyzing other forms of state-dependency, such as the effects of macroeconomic shocks in expansions and recessions. Although we do not aim to establish a causal link, but rather to verify the prediction of a reduced-form relation, from an empirical point of view it is interesting to understand to what extent the main findings survive the inclusion of additional balance sheet indicators that could as well influence the transmission of the monetary policy impulse. To do so, we consider an augmented version of model (2), where we add additional state variables one at a time.[24] We find that controlling for the ratios of liquid assets, current debt, and bank credit, as well as for measures of profitability, working capital, debt service does not significantly affect our main findings.

[24]Practically we add two additional rows to the model in equation (2), respectively multiplied by an alternative state variable $\tilde{\kappa}_{c,s,t-1}$ and its square. We analyze the additional state variables one by one to prevent the model from becoming too large.

Presence of country and industry effects The heterogeneous responsiveness of industrial production to monetary policy might also be driven by group-specific factors unrelated to financial frictions, such as the presence of different fiscal reaction functions across countries or distinct demand elasticities across industries. To the extent that such group characteristics are correlated with corporate leverage, they might drive the results. To address these concerns we estimate a modified version of model (2), where we interact the monetary policy shock with a set of country and industry dummies. Despite effectively controlling for both observed and unobserved group-specific confounders, a major drawback of this approach is that it might also absorb valuable information – genuinely linked to the presence of financial frictions – making the identification of the relation under scrutiny more difficult. Nonetheless, we observe that the analyzed relation does not change meaningfully when accounting for the presence of country-specific and industry-specific factors influencing the response to monetary policy.

Use of a second-order polynomial We use of a second-order polynomial to account for potential non-linearities in the relation between corporate leverage and monetary policy effectiveness. Nonetheless, a second-order polynomial could still not be flexible enough to detect more complex forms of state-dependency. To address this concern, we re-estimate the baseline model considering either third-order or fourth-order polynomials and find that the results are very similar to the ones shown in Figure 4.

As an alternative approach, a discrete dummy indicator that takes value one if corporate leverage is above a certain threshold could be used. As stated before, we prefer our specification because it is more agnostic and parsimonious: it does not require the *ex-ante* imposition of any threshold and it can be used in settings where the cross-sectional dimension is not too large. Nonetheless, we estimate an alternative model where we consider a first-order polynomial, instead of a second-order one, and interact it with a dummy indicator $T_{c,s,t-1}$, and its complement $(1 - T_{c,s,t-1})$, that takes value one when $\ell_{c,s,t-1}$ is at or above 65%, i.e. a value close to the estimated peak ℓ^{Ph}.[25] The results confirm that below the specified threshold more leverage is associated with a greater sensitivity of industrial production to a monetary policy impulse; above that threshold, however, this positive differential effect is weakened and, in this specific range, it changes sign.[26]

5.2 A two-step approach

We further check the robustness of our results using an alternative *two-step* approach in the spirit of Dedola and Lippi (2005) and Peersman and Smets (2005). In a first step we estimate the cumulative response of industrial production to a monetary policy shock for each country-industry pair, obtaining the cross-sectional distribution of elasticities $\hat{\beta}^h_{c,s}$ shown in Figure 2. In a second step we employ two alternative strategies to verify the presence of a relation between $\hat{\beta}^h_{c,s}$ and a cross-sectional – time invariant – measure of leverage. In particular, we employ the median leverage ratio $\bar{\ell}_{c,s}$ introduced in the previous section.

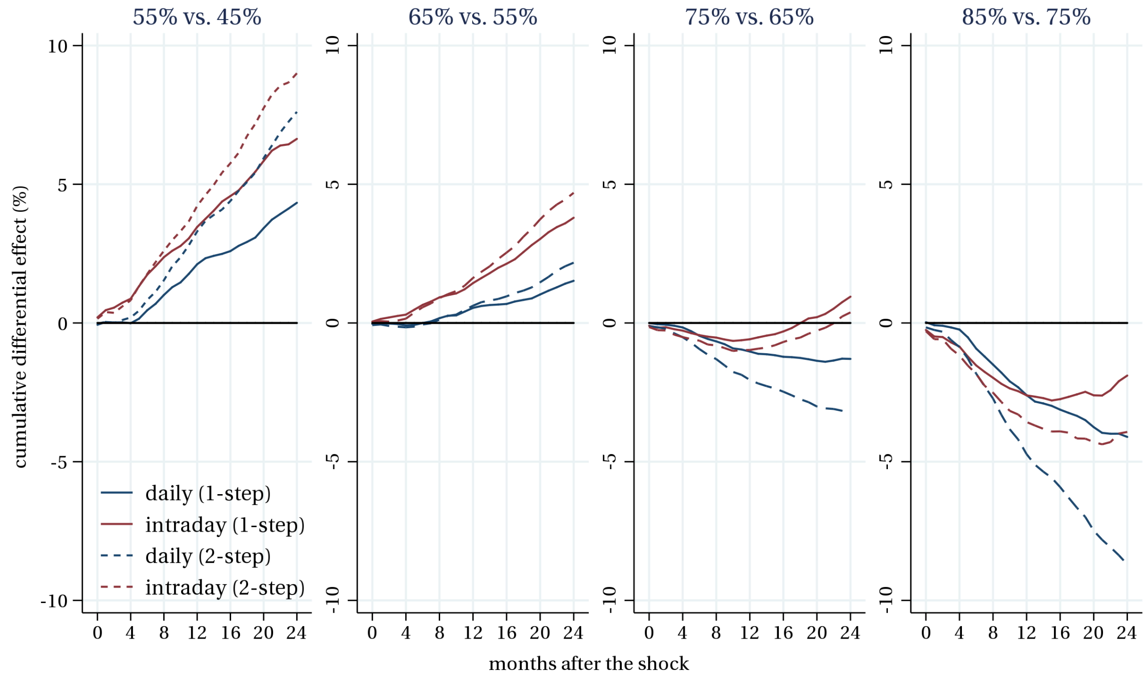
In a first exercise, we fit a quadratic relation between $\hat{\beta}^h_{c,s}$ and $\bar{\ell}_{c,s}$:

$$\hat{\beta}^h_{c,s} = \gamma^h + \gamma^{Lh}\bar{\ell}_{c,s} + \gamma^{Qh}\bar{\ell}^2_{c,s} + \varepsilon^h_{c,s} \tag{5}$$

[25]More precisely, compared to the model in equation (2), we drop the third row and we interact each of the first two rows with the two dummy indicators mentioned above. This specification is very similar to the one shown later in equation (6), section 6, where we further allow the second-order polynomial $\psi^h[\ell]$ to differ between periods of expansion and recession.

[26]Adopting a similar approach based on quintiles of the leverage distribution, Jeenas (2018) documents an analogous lack of monotonicity in the relationship between leverage and the firm-level response of capital accumulation to US monetary policy shocks.

Figure 6. Differences in sensitivity: one-step *versus* two-step approach

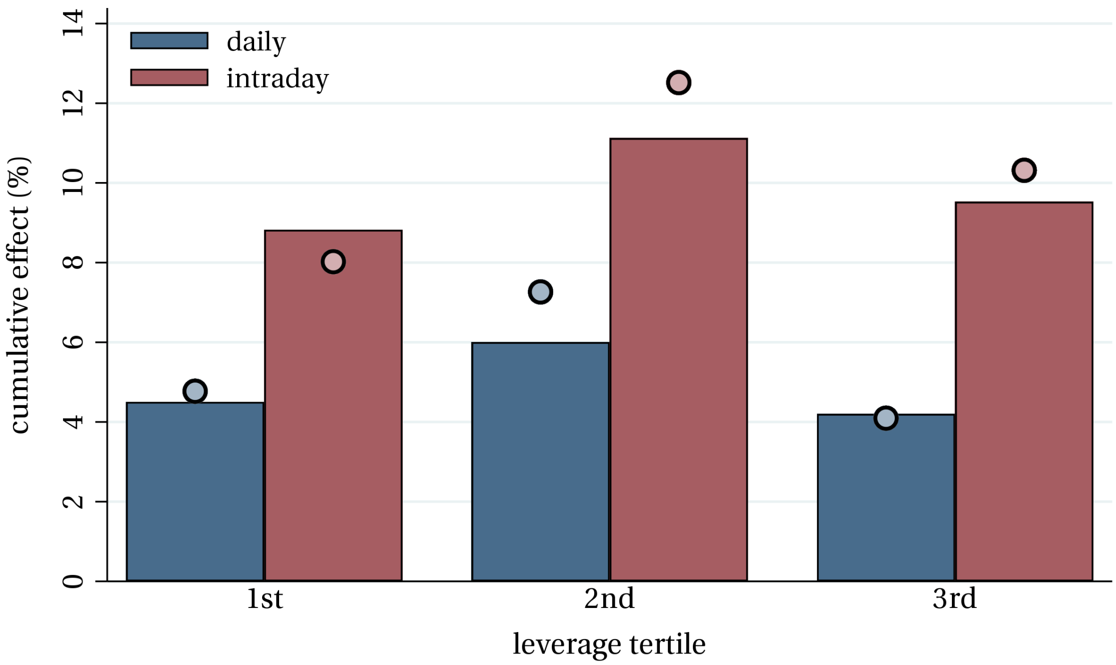


Note. Differences in the cumulative response to a one-standard deviation expansionary monetary policy shock associated with a difference in leverage of 10 percentage points at several leverage ratios, using the baseline model (2) and a two-step approach (5). Blue lines refer to monetary policy shocks identified at daily-frequency, while red lines are related to monetary policy shocks identified at intraday-frequency. Solid lines refer to the one-step approach, while dashed lines are related to two-step approach.

and compare the resulting rate of change in the effectiveness of a monetary policy shock, $\tilde{\psi}^h_{2step}[\ell, \xi] = \gamma^{Lh}\xi + \gamma^{Qh}(\xi^2 + 2\ell\xi)$, to the one obtained in the one-step approach. Figure 6 shows that the estimates obtained with this alternative approach are broadly in line with those of the baseline. Similarly to the robustness check in the previous section where we replace $\ell_{c,s,t}$ with $\bar{\ell}_{c,s}$, the only major difference is that the concavity of the relation is slightly more pronounced. Hence, this is more likely to be related to the use of an alternative measure of leverage and not to the methodology.

In the second exercise, we compute the average of $\hat{\beta}^h_{c,s}$ in each tertile of the

Figure 7. Cross-sectional average effect of monetary policy by leverage tertile



Note. Average cumulative response after one year to a one-standard deviation expansionary monetary policy shock on industrial production by leverage tertile. Bars denote cross-sectional medians while circles indicate cross-sectional means. Blue bars and circles are based on the estimates of equation (1) using monetary policy shocks identified at daily-frequency, while red bars and circles are obtained using monetary policy shocks identified at intraday-frequency.

distribution of $\bar{\ell}_{c,s}$, specifying $h = 12$. A concave and non-monotonic pattern, similar to the one identified using the one-step approach, tends to emerge for both daily and intraday monetary policy shocks (Figure 7). If we compare the second tertile of the leverage distribution with the first, the responsiveness of industrial production to a common monetary policy shock is on average stronger. However, moving from the second to the third tertile does not result in a larger sensitivity to a monetary policy shock.

Notice that these exercises are based on a limited number of observations, i.e. a hundred impulse responses at a given horizon h, and a measure of leverage $\bar{\ell}_{c,s}$ that is less informative than the state variable $\ell_{c,s,t}$ used in the one-step approach.

Notwithstanding these limitations, the results from the two-step approach are broadly in line with the ones identified using model (2).

6 Good and bad times

In the baseline model (2), the state variable $\ell_{c,s,t}$ tends to capture mostly structural differences in leverage within the euro-area manufacturing sector. However, the evidence in Ottonello and Winberry (2018) suggests a potentially important source of time-variation in monetary policy transmission, being less powerful in periods when firms have a higher risk of default. In this regard, financial frictions as well as debt overhang distortions are supposed to be particularly strong in bad times as highly leveraged companies are likely to be perceived more risky and may feel a stronger need to repair their balance sheets.

In this section we try to uncover some of the "missing" time variation in our state variable using an indirect approach. In particular, we explore whether the documented relation between corporate leverage and monetary policy effectiveness changes with the phase of the industrial business cycle. Even if by construction our end-of-year book-value measure of leverage does not fluctuate much over time, in periods of contraction in economic activity its underlying perceived riskiness should increase, giving rise to (unobserved) time variation in the tightness of the financial constraints.

We take advantage of the flexibility of the baseline model in equation (2) and further allow the response of industrial production to be different conditional on whether the monetary policy shock occurs in expansions or in recessions.[27] We first

[27] Notice that this exercise could not be easily implemented in the two-step approach, as in the first step, when we compute the impulse responses at a given horizon h in each country-industry bin, we

define as an industry-recession a period in which a negative year-on-year growth in the industrial production index $y_{c,s,t}$ is recorded for at least six consecutive months. We then construct a discrete indicator $I_{c,s,t}$ that takes value one when such condition occurs in a manufacturing industry of a specific country and zero otherwise.[28] Finally, this dummy indicator and its complement to one are interacted with all the terms considered in model (2), with the exception of the country, sector and time fixed effects.

The estimated model thus becomes:

$$\begin{aligned}\sum_{l=0}^{h} \Delta_{l+1} \ln y_{c,s,t+l} =& (1 - I_{c,s,t-1}) \left[\alpha^{Eh} + \beta^{Eh} \varepsilon_t + \sum_{p=1}^{12} \theta^{Ehp} \Delta \ln y_{c,s,t-p} \right] + \\ & + (1 - I_{c,s,t-1}) \ell_{c,s,t-1} \left[\alpha^{LEh} + \beta^{LEh} \varepsilon_t + \sum_{p=1}^{12} \theta^{LEhp} \Delta \ln y_{c,s,t-p} \right] + \\ & + (1 - I_{c,s,t-1}) \ell^2_{c,s,t-1} \left[\alpha^{QEh} + \beta^{QEh} \varepsilon_t + \sum_{p=1}^{12} \theta^{QEhp} \Delta \ln y_{c,s,t-p} \right] + \\ & + I_{c,s,t-1} \left[\alpha^{Rh} + \beta^{Rh} \varepsilon_t + \sum_{p=1}^{12} \theta^{Rhp} \Delta \ln y_{c,s,t-p} \right] + \\ & + I_{c,s,t-1} \ell_{c,s,t-1} \left[\alpha^{LRh} + \beta^{LRh} \varepsilon_t + \sum_{p=1}^{12} \theta^{LRhp} \Delta \ln y_{c,s,t-p} \right] + \\ & + I_{c,s,t-1} \ell^2_{c,s,t-1} \left[\alpha^{QRh} + \beta^{QRh} \varepsilon_t + \sum_{p=1}^{12} \theta^{QRhp} \Delta \ln y_{c,s,t-p} \right] + \\ & + \alpha_c^h + \alpha_s^h + \alpha_t^h + u^h_{c,s,t+h} \end{aligned} \tag{6}$$

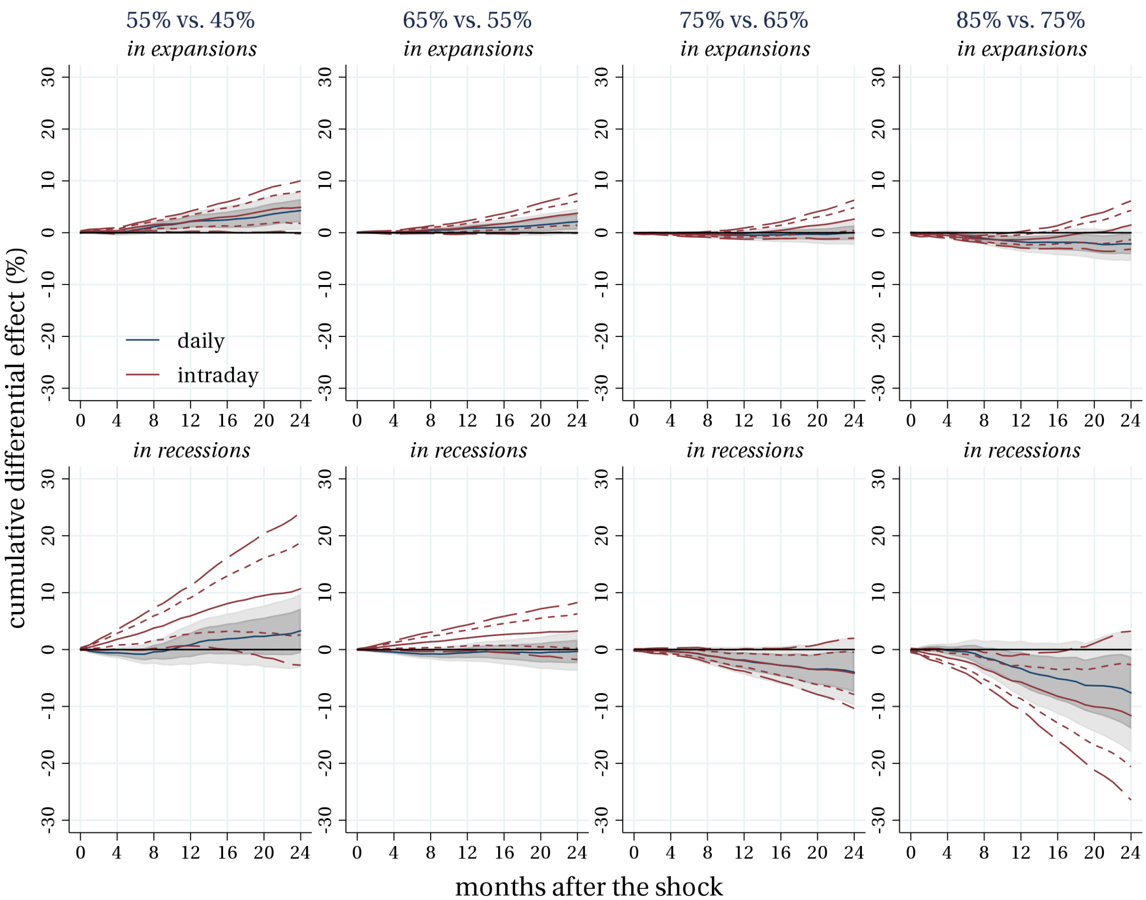
for $h = 0, \dots, H$.[29] The rate of change in the effectiveness of a monetary policy shock associated with a difference ξ in the leverage ratio, defined in equation (4), now

lose the time dimension.

[28]Using this definition, the frequency of a recession in the sample is about 30%, on average (see Table A1 in the data appendix). We also checked alternative filtering procedures like the Bry-Boschan algorithm for locating business cycle turning points and the results are broadly similar.

[29]Similarly to the baseline model in equation (2), notice that the intercept α^{Eh} and the parameter β^{Eh} in equation (6) are absorbed by the fixed effects and therefore not estimated.

Figure 8. Leverage and monetary policy effectiveness in good times and bad



Note. Differences in the cumulative response to a one-standard deviation expansionary monetary policy shock associated with a difference in leverage of 10 percentage points at several leverage ratios. The top panels refer to periods of expansion, while the bottom panels to periods of recession. Blue lines are estimates of equation (6) using monetary policy shocks identified at daily-frequency, while red lines are obtained using monetary policy shocks identified at intraday-frequency. Dark (light) area and dotted (dashed) line show 68% (90%) confidence intervals for daily and intraday frequency, respectively.

depends also on the state S of the industrial production cycle and becomes:

$$\tilde{\psi}^{Sh}\left[\ell,\xi\right] = \beta^{LSh}\xi + \beta^{QSh}\left(\xi^2 + 2\ell\xi\right) \qquad \text{with } S = \{E, R\} \tag{7}$$

where E and R denote, respectively, periods of expansion and recession.

Figure 8 quantifies the differential effects in model (7) specifying the same parameters ℓ and ξ used in the baseline exercise. The estimates show that in both expansions and recessions the association between corporate leverage and monetary policy effectiveness is concave in leverage. However, while in expansions this relation is found to be largely monotonic, in recessions the concavity of the analyzed relation increases significantly, leading to persistently negative differential effects at high leverage ratios. This finding is consistent with the view that, during a negative phase of the industrial cycle, firms with higher leverage ratios are likely to be perceived as more risky. In bad times, when risk tolerance is generally lower, they are therefore exposed to more severe financial constraints than in good times. Alternatively, in bad times the opportunities to invest are lower and the highly indebted firms may take advantage of the expansionary shock to deleverage and reduce the debt overhang distortions. All other conditions being equal, these could further limit their capacity to adjust their investment and production plans following a monetary policy shock.

7 Conclusions

We investigate the relationship between corporate leverage and monetary policy effectiveness within the euro-area manufacturing sector. Using *polynomial state-dependent* local projections, we document the presence of a non-linear relation. When leverage is low, more indebted industries adjust their production more strongly in response to high-frequency monetary policy shocks. At higher leverage ratios, we find that this positive relation tends to weaken until it eventually inverts its sign, especially within the short-term horizon. Therefore, more leverage does not always imply a greater sensitivity of industrial production to a monetary policy shock, as the amplification effect generally associated with the balance sheet channel is somehow attenuated. We also document that this last phenomenon is particularly intense in recessions, when low capitalized companies, being perceived as more risky, are likely to be exposed to tighter financial constraints and feel a stronger need to repair their balance sheet.

These results bring additional interesting questions which are left for future research. A relevant one is whether the attenuation effect is more evident after an expansionary monetary policy shock, as borrowing constraints might bind asymmetrically depending on the sign of the shock. Since ECB monetary policy surprises are by their nature common across euro-area countries and manufacturing industries, this exercise would require the availability of a considerably longer time series. Another interesting extension is to analyze the response of financial variables, such as leverage, debt service, and cash flows, with a view to providing a more detailed understanding of the transmission mechanism. Since we observe balance sheets and income statements only at relatively low frequencies, in this analysis we are bound to use these measures exclusively as state variables.

These results also have important policy implications. The overall impact of a monetary policy shock on economic activity may depend on the average level of indebtedness as well as its distribution within the economy. Moreover, high leverage ratios in some segments of the non-financial corporate sector could be associated with an attenuation of the overall effects of an expansionary monetary policy impulse, especially in recessions. The results of our analysis also suggest that the exceptionally expansive monetary policies adopted over the recent years in the euro area have exerted their strongest effects on industries for which the financial structures were relatively more solid and the exposure to the default risk was limited.

References

Alpanda, Sami, Eleonora Granziera, and Sarah Zubairy. 2019. "State Dependence of Monetary Policy Across Business, Credit and Interest Rate Cycles." Bank of Finland Research Discussion Paper No. 16/2019, Bank of Finland.

Alpanda, Sami and Sarah Zubairy. 2019. "Household Debt Overhang and Transmission of Monetary Policy." *Journal of Money, Credit and Banking* 51 (5):1265–1307.

Anderson, Gareth and Ambrogio Cesa-Bianchi. 2019. "Firm Heterogeneity, Credit Spreads, and Monetary Policy." Mimeo.

BACH Working Group. 2015. "The Bank for the Accounts of Companies Harmonized (BACH) database." ECB Statistics Paper No. 11, European Central Bank.

Bernanke, Ben S. and Mark Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review* 79 (1):14–31.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." In *Handbook of Macroeconomics*, vol. 1C, edited by John B. Taylor and Mark Woodford, chap. 21. North Holland, 1341–1393.

Cecioni, Martina. 2018. "ECB Monetary Policy and the Euro Exchange Rate." Bank of Italy Working Paper No. 1172, Bank of Italy.

Cloyne, James, Clodomiro Ferreira, Maren Froemel, and Paolo Surico. 2019. "Monetary Policy, Corporate Finance and Investment." Banco de España Working Paper No. 1911, Banco de España.

Cloyne, James, Clodomiro Ferreira, and Paolo Surico. 2018. "Monetary Policy when Households have Debt: New Evidence on the Transmission Mechanism." *The Review of Economic Studies* forthcoming.

Dedola, Luca and Francesco Lippi. 2005. "The Monetary Transmission Mechanism: Evidence from the Industries of Five OECD Countries." *European Economic Review* 49 (6):1543–1569.

Driscoll, John C. and Aart C. Kraay. 1998. "Covariance Matrix Estimation with Spatially Dependent Panel Data." *Review of Economics and Statistics* 80 (4):549–560.

Gelos, Gaston, Tommaso Mancini Griffoli, Machiko Narita, Federico Grinberg, Umang Rawat, and Shujaat Khan. 2019. "Has Higher Household Indebtedness Weakened Monetary Policy Transmission?" IMF Working Paper No. 19/11, International Monetary Fund.

Gertler, Mark and Peter Karadi. 2015. "Monetary Policy Surprises, Credit Costs, and Economic Activity." *American Economic Journal: Macroeconomics* 7 (1):44–76.

Gürkaynak, Refet S., Brian Sack, and Eric Swanson. 2005. "Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements." *International Journal of Central Banking* 1 (1).

Jarociński, Marek and Peter Karadi. 2018. "Deconstructing Monetary Policy Surprises: the Role of Information Shocks." ECB Working Paper No. 2133, European Central Bank.

Jeenas, Priit. 2018. "Monetary Policy Shocks, Financial Structure, and Firm Activity: A Panel Approach." Mimeo.

———. 2019. "Firm Balance Sheet Liquidity, Monetary Policy Shocks, and Investment Dynamics." Mimeo.

Jordá, Óscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95 (1):161–182.

Kiyotaki, Nobuhiro and John Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105 (2):211–48.

Myers, Stewart C. 1977. "Determinants of Corporate Borrowing." *Journal of Financial Economics* 5 (2):147–175.

Nakamura, Emi and Jón Steinsson. 2018a. "High-frequency Identification of Monetary Non-neutrality: the Information Effect." *Quarterly Journal of Economics* 133 (3):1283–1330.

———. 2018b. "Identification in Macroeconomics." *Journal of Economic Perspectives* 32 (3):59–86.

Occhino, Filippo and Andrea Pescatori. 2015. "Debt Overhang in a Business Cycle Model." *European Economic Review* 73 (C):58–84.

Ottonello, Pablo and Thomas Winberry. 2018. "Financial Heterogeneity and the Investment Channel of Monetary Policy." NBER Working Paper No. 24221, National Bureau of Economic Research, Inc.

Peersman, Gert and Frank Smets. 2005. "The Industry Effects of Monetary Policy in the Euro Area." *Economic Journal* 115 (503):319–342.

Rajan, Raghuram G. and Luigi Zingales. 1995. "What Do We Know about Capital Structure? Some Evidence from International Data." *Journal of Finance* 50 (5):1421–1460.

Ramey, Valerie A. 2016. "Macroeconomic Shocks and Their Propagation." In *Handbook of Macroeconomics*, vol. 2A, edited by John B. Taylor and Harald Uhlig, chap. 2. North Holland, 71–162.

Stock, James H. and Mark W. Watson. 2018. "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments." *Economic Journal* 128 (610):917–948.

Tirole, Jean. 2010. *The Theory of Corporate Finance*. Princeton University Press.

Data appendix

Table A1. Summary statistics

variable	description	obs	mean	median	sd	1st pct	99th pct
$\Delta_1 \ln y_{c,s,t}$	production growth (%, mom)	27,279	-0.03	0.00	6.55	-16.59	15.95
ε_t	daily shocks (sd)	27,279	-0.05	0.00	1.00	-3.75	3.29
ε_t	intraday shocks (sd)	27,279	-0.10	0.00	1.00	-4.81	2.97
$\ell_{c,s,t-1}$	leverage (%)	27,279	63.15	63.20	9.49	40.85	87.86
$I_{c,s,t-1}$	recession (dummy)	27,279	0.29	0.00	0.46	0.00	1.00

Note. The seasonally adjusted volume index of industrial production $y_{c,s,t}$ is sourced from EUROSTAT. The time series of intraday monetary policy shocks ε_t was kindly provided by Peter Karadi and Marek Jarociński, while the daily version is based on our calculations. The ratio between total liabilities and total assets $\ell_{c,s,t-1}$ is sourced from the BACH database. The recession dummy $I_{c,s,t-1}$ takes value one when negative year-on-year growth in the industrial production index is recorded for at least six consecutive months and zero otherwise.

RECENTLY PUBLISHED "TEMI" (*)

N. 1232 – *Risky bank guarantees*, by Taneli Mäkinen, Lucio Sarno and Gabriele Zinna (July 2019).

N. 1233 – *News and consumer card payments*, by Guerino Ardizzi, Simone Emiliozzi, Juri Marcucci and Libero Monteforte (October 2019).

N. 1234 – *Forecasting with instabilities: an application to DSGE models with Financial Frictions*, by Roberta Cardani, Alessia Paccagnini and Stefania Villa (October 2019).

N. 1235 – *The real effects of 'ndrangheta: firm-level evidence*, by Litterio Mirenda, Sauro Mocetti and Lucia Rizzica (October 2019).

N. 1236 – *Forward-looking effective tax rates in the banking sector*, by Ernesto Zangari and Elena Pisano (October 2019).

N. 1237 – *A profit elasticity approach to measure banking competition in Italian credit markets*, by Michele Benvenuti and Silvia Del Prete (October 2019).

N. 1238 – *What do almost 20 years of micro data and two crises say about the relationship between central bank and interbank market liquidity? Evidence from Italy*, by Massimiliano Affinito (October 2019).

N. 1239 – *Bank credit, liquidity and firm-level investment: are recessions different?*, by Ines Buono and Sara Formai (October 2019).

N. 1240 – *Youth drain, entrepreneurship and innovation*, by Massimo Anelli, Gaetano Basso, Giuseppe Ippedico and Giovanni Peri (October 2019).

N. 1241 – *Fiscal devaluation and labour market frictions in a monetary union*, by Lorenzo Burlon, Alessandro Notarpietro and Massimiliano Pisani (October 2019).

N. 1242 – *Financial conditions and growth at risk in Italy*, by Piergiorgio Alessandri, Leonardo Del Vecchio and Arianna Miglietta (October 2019).

N. 1243 – *Cross-country differences in the size of venture capital financing rounds. A machine learning approach*, by Marco Taboga (November 2019).

N. 1244 – *Shifting taxes from labour to consumption: the efficiency-equity trade-off*, by Nicola Curci and Marco Savegnago (November 2019).

N. 1245 – *Credit supply, uncertainty and trust: the role of social capital*, by Maddalena Galardo, Maurizio Lozzi and Paolo Emilio Mistrulli (November 2019).

N. 1246 – *Financial development and growth in European regions*, by Paola Rossi and Diego Scalise (November 2019).

N. 1247 – *IMF programs and stigma in Emerging Market Economies*, by Claudia Maurini (November 2019).

N. 1248 – *Loss aversion in housing assessment among Italian homeowners*, by Andrea Lamorgese and Dario Pellegrino (November 2019).

N. 1249 – *Long-term unemployment and subsidies for permanent employment*, by Emanuele Ciani, Adele Grompone and Elisabetta Olivieri (November 2019).

N. 1250 – *Debt maturity and firm performance: evidence from a quasi-natural experiment*, by Antonio Accetturo, Giulia Canzian, Michele Cascarano and Maria Lucia Stefani (November 2019).

N. 1251 – *Non-standard monetary policy measures in the new normal*, by Anna Bartocci, Alessandro Notarpietro and Massimiliano Pisani (November 2019).

(*) Requests for copies should be sent to:
Banca d'Italia – Servizio Studi di struttura economica e finanziaria – Divisione Biblioteca e Archivio storico – Via Nazionale, 91 – 00184 Rome – (fax 0039 06 47922059). They are available on the Internet www.bancaditalia.it.

2017

AABERGE, R., F. BOURGUIGNON, A. BRANDOLINI, F. FERREIRA, J. GORNICK, J. HILLS, M. JÄNTTI, S. JENKINS, J. MICKLEWRIGHT, E. MARLIER, B. NOLAN, T. PIKETTY, W. RADERMACHER, T. SMEEDING, N. STERN, J. STIGLITZ, H. SUTHERLAND, *Tony Atkinson and his legacy,* Review of Income and Wealth, v. 63, 3, pp. 411-444, **WP 1138 (September 2017).**

ACCETTURO A., M. BUGAMELLI and A. LAMORGESE, *Law enforcement and political participation: Italy 1861-65,* Journal of Economic Behavior & Organization, v. 140, pp. 224-245, **WP 1124 (July 2017).**

ADAMOPOULOU A. and G.M. TANZI, *Academic dropout and the great recession,* Journal of Human Capital, V. 11, 1, pp. 35–71, **WP 970 (October 2014).**

ALBERTAZZI U., M. BOTTERO and G. SENE, *Information externalities in the credit market and the spell of credit rationing,* Journal of Financial Intermediation, v. 30, pp. 61–70, **WP 980 (November 2014).**

ALESSANDRI P. and H. MUMTAZ, *Financial indicators and density forecasts for US output and inflation,* Review of Economic Dynamics, v. 24, pp. 66-78, **WP 977 (November 2014).**

BARBIERI G., C. ROSSETTI and P. SESTITO, *Teacher motivation and student learning,* Politica economica/Journal of Economic Policy, v. 33, 1, pp.59-72, **WP 761 (June 2010).**

BENTIVOGLI C. and M. LITTERIO, *Foreign ownership and performance: evidence from a panel of Italian firms,* International Journal of the Economics of Business, v. 24, 3, pp. 251-273, **WP 1085 (October 2016).**

BRONZINI R. and A. D'IGNAZIO, *Bank internationalisation and firm exports: evidence from matched firm-bank data,* Review of International Economics, v. 25, 3, pp. 476-499 **WP 1055 (March 2016).**

BRUCHE M. and A. SEGURA, *Debt maturity and the liquidity of secondary debt markets,* Journal of Financial Economics, v. 124, 3, pp. 599-613, **WP 1049 (January 2016).**

BURLON L., *Public expenditure distribution, voting, and growth,* Journal of Public Economic Theory,, v. 19, 4, pp. 789–810, **WP 961 (April 2014).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Macroeconomic effectiveness of non-standard monetary policy and early exit. a model-based evaluation,* International Finance, v. 20, 2, pp.155-173, **WP 1074 (July 2016).**

BUSETTI F., *Quantile aggregation of density forecasts,* Oxford Bulletin of Economics and Statistics, v. 79, 4, pp. 495-512, **WP 979 (November 2014).**

CESARONI T. and S. IEZZI, *The predictive content of business survey indicators: evidence from SIGE,* Journal of Business Cycle Research, v.13, 1, pp 75–104, **WP 1031 (October 2015).**

CONTI P., D. MARELLA and A. NERI, *Statistical matching and uncertainty analysis in combining household income and expenditure data,* Statistical Methods & Applications, v. 26, 3, pp 485–505, **WP 1018 (July 2015).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, v. 49, pp. 74-83, **WP 787 (January 2011).**

D'AMURI F. and J. MARCUCCI, *The predictive power of google searches in forecasting unemployment,* International Journal of Forecasting, v. 33, 4, pp. 801-816, **WP 891 (November 2012).**

DE BLASIO G. and S. POY, *The impact of local minimum wages on employment: evidence from Italy in the 1950s,* Journal of Regional Science, v. 57, 1, pp. 48-74, **WP 953 (March 2014).**

DEL GIOVANE P., A. NOBILI and F. M. SIGNORETTI, *Assessing the sources of credit supply tightening: was the sovereign debt crisis different from Lehman?,* International Journal of Central Banking, v. 13, 2, pp. 197-234, **WP 942 (November 2013).**

DEL PRETE S., M. PAGNINI, P. ROSSI and V. VACCA, *Lending organization and credit supply during the 2008–2009 crisis,* Economic Notes, v. 46, 2, pp. 207–236, **WP 1108 (April 2017).**

DELLE MONACHE D. and I. PETRELLA, *Adaptive models and heavy tails with an application to inflation forecasting,* International Journal of Forecasting, v. 33, 2, pp. 482-501, **WP 1052 (March 2016).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, v. 40, 10, pp. 2078-2096, **WP 877 (September 2012).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, v. 17, 6, pp. 1251-1282, **WP 898 (January 2013).**

LOBERTO M. and C. PERRICONE, *Does trend inflation make a difference?,* Economic Modelling, v. 61, pp. 351–375, **WP 1033 (October 2015).**

MANCINI A.L., C. MONFARDINI and S. PASQUA, *Is a good example the best sermon? Children's imitation of parental reading,* Review of Economics of the Household, v. 15, 3, pp 965–993, **WP No. 958 (April 2014).**

MEEKS R., B. NELSON and P. ALESSANDRI, *Shadow banks and macroeconomic instability,* Journal of Money, Credit and Banking, v. 49, 7, pp. 1483–1516, **WP 939 (November 2013).**

MICUCCI G. and P. ROSSI, *Debt restructuring and the role of banks' organizational structure and lending technologies,* Journal of Financial Services Research, v. 51, 3, pp 339–361, **WP 763 (June 2010).**

MOCETTI S., M. PAGNINI and E. SETTE, *Information technology and banking organization,* Journal of Journal of Financial Services Research, v. 51, pp. 313-338, **WP 752 (March 2010).**

MOCETTI S. and E. VIVIANO, *Looking behind mortgage delinquencies,* Journal of Banking & Finance, v. 75, pp. 53-63, **WP 999 (January 2015).**

NOBILI A. and F. ZOLLINO, *A structural model for the housing and credit market in Italy,* Journal of Housing Economics, v. 36, pp. 73-87, **WP 887 (October 2012).**

PALAZZO F., *Search costs and the severity of adverse selection,* Research in Economics, v. 71, 1, pp. 171-197, **WP 1073 (July 2016).**

PATACCHINI E. and E. RAINONE, *Social ties and the demand for financial services,* Journal of Financial Services Research, v. 52, 1–2, pp 35–88, **WP 1115 (June 2017).**

PATACCHINI E., E. RAINONE and Y. ZENOU, *Heterogeneous peer effects in education,* Journal of Economic Behavior & Organization, v. 134, pp. 190–227, **WP 1048 (January 2016).**

SBRANA G., A. SILVESTRINI and F. VENDITTI, *Short-term inflation forecasting: the M.E.T.A. approach,* International Journal of Forecasting, v. 33, 4, pp. 1065-1081, **WP 1016 (June 2015).**

SEGURA A. and J. SUAREZ, *How excessive is banks' maturity transformation?,* Review of Financial Studies, v. 30, 10, pp. 3538–3580, **WP 1065 (April 2016).**

VACCA V., *An unexpected crisis? Looking at pricing effectiveness of heterogeneous banks,* Economic Notes, v. 46, 2, pp. 171–206, **WP 814 (July 2011).**

VERGARA CAFFARELI F., *One-way flow networks with decreasing returns to linking,* Dynamic Games and Applications, v. 7, 2, pp. 323-345, **WP 734 (November 2009).**

ZAGHINI A., *A Tale of fragmentation: corporate funding in the euro-area bond market,* International Review of Financial Analysis, v. 49, pp. 59-68, **WP 1104 (February 2017).**

2018

ACCETTURO A., V. DI GIACINTO, G. MICUCCI and M. PAGNINI, *Geography, productivity and trade: does selection explain why some locations are more productive than others?,* Journal of Regional Science, v. 58, 5, pp. 949-979, **WP 910 (April 2013).**

ADAMOPOULOU A. and E. KAYA, *Young adults living with their parents and the influence of peers,* Oxford Bulletin of Economics and Statistics,v. 80, pp. 689-713, **WP 1038 (November 2015).**

ANDINI M., E. CIANI, G. DE BLASIO, A. D'IGNAZIO and V. SILVESTRINI, *Targeting with machine learning: an application to a tax rebate program in Italy,* Journal of Economic Behavior & Organization, v. 156, pp. 86-102, **WP 1158 (December 2017).**

BARONE G., G. DE BLASIO and S. MOCETTI, *The real effects of credit crunch in the great recession: evidence from Italian provinces,* Regional Science and Urban Economics, v. 70, pp. 352-59, **WP 1057 (March 2016).**

BELOTTI F. and G. ILARDI *Consistent inference in fixed-effects stochastic frontier models,* Journal of Econometrics, v. 202, 2, pp. 161-177, **WP 1147 (October 2017).**

BERTON F., S. MOCETTI, A. PRESBITERO and M. RICHIARDI, *Banks, firms, and jobs,* Review of Financial Studies, v.31, 6, pp. 2113-2156, **WP 1097 (February 2017).**

BOFONDI M., L. CARPINELLI and E. SETTE, *Credit supply during a sovereign debt crisis,* Journal of the European Economic Association, v.16, 3, pp. 696-729, **WP 909 (April 2013).**

BOKAN N., A. GERALI, S. GOMES, P. JACQUINOT and M. PISANI, *EAGLE-FLI: a macroeconomic model of banking and financial interdependence in the euro area,* Economic Modelling, v. 69, C, pp. 249-280, **WP 1064 (April 2016).**

BRILLI Y. and M. TONELLO, *Does increasing compulsory education reduce or displace adolescent crime? New evidence from administrative and victimization data,* CESifo Economic Studies, v. 64, 1, pp. 15–4, **WP 1008 (April 2015).**

BUONO I. and S. FORMAI *The heterogeneous response of domestic sales and exports to bank credit shocks,* Journal of International Economics, v. 113, pp. 55-73, **WP 1066 (March 2018).**

BURLON L., A. GERALI, A. NOTARPIETRO and M. PISANI, *Non-standard monetary policy, asset prices and macroprudential policy in a monetary union,* Journal of International Money and Finance, v. 88, pp. 25-53, **WP 1089 (October 2016).**

CARTA F. and M. DE PHLIPPIS, *You've Come a long way, baby. Husbands' commuting time and family labour supply,* Regional Science and Urban Economics, v. 69, pp. 25-37, **WP 1003 (March 2015).**

CARTA F. and L. RIZZICA, *Early kindergarten, maternal labor supply and children's outcomes: evidence from Italy,* Journal of Public Economics, v. 158, pp. 79-102, **WP 1030 (October 2015).**

CASIRAGHI M., E. GAIOTTI, L. RODANO and A. SECCHI, *A "Reverse Robin Hood"? The distributional implications of non-standard monetary policy for Italian households,* Journal of International Money and Finance, v. 85, pp. 215-235, **WP 1077 (July 2016).**

CECCHETTI S., F. NATOLI and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, v. 14, 1, pp. 35-71, **WP 1025 (July 2015).**

CIANI E. and C. DEIANA, *No Free lunch, buddy: housing transfers and informal care later in life,* Review of Economics of the Household, v.16, 4, pp. 971-1001, **WP 1117 (June 2017).**

CIPRIANI M., A. GUARINO, G. GUAZZAROTTI, F. TAGLIATI and S. FISHER, *Informational contagion in the laboratory,* Review of Finance, v. 22, 3, pp. 877-904, **WP 1063 (April 2016).**

DE BLASIO G, S. DE MITRI, S. D'IGNAZIO, P. FINALDI RUSSO and L. STOPPANI, *Public guarantees to SME borrowing. A RDD evaluation,* Journal of Banking & Finance, v. 96, pp. 73-86, **WP 1111 (April 2017).**

GERALI A., A. LOCARNO, A. NOTARPIETRO and M. PISANI, *The sovereign crisis and Italy's potential output,* Journal of Policy Modeling, v. 40, 2, pp. 418-433, **WP 1010 (June 2015).**

LIBERATI D., *An estimated DSGE model with search and matching frictions in the credit market,* International Journal of Monetary Economics and Finance (IJMEF), v. 11, 6, pp. 567-617, **WP 986 (November 2014).**

LINARELLO A., *Direct and indirect effects of trade liberalization: evidence from Chile,* Journal of Development Economics, v. 134, pp. 160-175, **WP 994 (December 2014).**

NUCCI F. and M. RIGGI, *Labor force participation, wage rigidities, and inflation,* Journal of Macroeconomics, v. 55, 3 pp. 274-292, **WP 1054 (March 2016).**

RIGON M. and F. ZANETTI, *Optimal monetary policy and fiscal policy interaction in a non_ricardian economy,* International Journal of Central Banking, v. 14 3, pp. 389-436, **WP 1155 (December 2017).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, v. 22, 2, pp. 661-697, **WP 1100 (February 2017).**

2019

ALBANESE G., M. CIOFFI and P. TOMMASINO, *Legislators' behaviour and electoral rules: evidence from an Italian reform,* European Journal of Political Economy, v. 59, pp. 423-444, **WP 1135 (September 2017).**

ARNAUDO D., G. MICUCCI, M. RIGON and P. ROSSI, *Should I stay or should I go? Firms' mobility across banks in the aftermath of the financial crisis,* Italian Economic Journal / Rivista italiana degli economisti, v. 5, 1, pp. 17-37, **WP 1086 (October 2016).**

BASSO G., F. D'AMURI and G. PERI, *Immigrants, labor market dynamics and adjustment to shocks in the euro area,* IMF Economic Review, v. 67, 3, pp. 528-572, **WP 1195 (November 2018).**

BUSETTI F. and M. CAIVANO, *Low frequency drivers of the real interest rate: empirical evidence for advanced economies,* International Finance, v. 22, 2, pp. 171-185, **WP 1132 (September 2017).**

CAPPELLETTI G., G. GUAZZAROTTI and P. TOMMASINO, *Tax deferral and mutual fund inflows: evidence from a quasi-natural experiment,* Fiscal Studies, v. 40, 2, pp. 211-237, **WP 938 (November 2013).**

CARDANI R., A. PACCAGNINI and S. VILLA, *Forecasting with instabilities: an application to DSGE models with financial frictions,* Journal of Macroeconomics, v. 61, **WP 1234 (September 2019).**

CIANI E., F. DAVID and G. DE BLASIO, *Local responses to labor demand shocks: a re-assessment of the case of Italy,* Regional Science and Urban Economics, v. 75, pp. 1-21, **WP 1112 (April 2017).**

CIANI E. and P. FISHER, *Dif-in-dif estimators of multiplicative treatment effects,* Journal of Econometric Methods, v. 8. 1, pp. 1-10, **WP 985 (November 2014).**

CHIADES P., L. GRECO, V. MENGOTTO, L. MORETTI and P. VALBONESI, *Fiscal consolidation by intergovernmental transfers cuts? The unpleasant effect on expenditure arrears,* Economic Modelling, v. 77, pp. 266-275, **WP 985 (July 2016).**

COLETTA M., R. DE BONIS and S. PIERMATTEI, *Household debt in OECD countries: the role of supply-side and demand-side factors,* Social Indicators Research, v. 143, 3, pp. 1185–1217, **WP 989 (November 2014).**

COVA P., P. PAGANO and M. PISANI, *Domestic and international effects of the Eurosystem Expanded Asset Purchase Programme,* IMF Economic Review, v. 67, 2, pp. 315-348, **WP 1036 (October 2015).**

GIORDANO C., M. MARINUCCI and A. SILVESTRINI, *The macro determinants of firms' and households' investment: evidence from Italy,* Economic Modelling, v. 78, pp. 118-133, **WP 1167 (March 2018).**

GOMELLINI M., D. PELLEGRINO and F. GIFFONI, *Human capital and urban growth in Italy,1981-2001,* Review of Urban & Regional Development Studies, v. 31, 2, pp. 77-101, **WP 1127 (July 2017).**

MAGRI S, *Are lenders using risk-based pricing in the Italian consumer loan market? The effect of the 2008 crisis,* Journal of Credit Risk, v. 15, 1, pp. 27-65, **WP 1164 (January 2018).**

MIGLIETTA A, C. PICILLO and M. PIETRUNTI, *The impact of margin policies on the Italian repo market,* The North American Journal of Economics and Finance, v. 50, **WP 1028 (October 2015).**

MONTEFORTE L. and V. RAPONI, *Short-term forecasts of economic activity: are fortnightly factors useful?,* Journal of Forecasting, v. 38, 3, pp. 207-221, **WP 1177 (June 2018).**

MERCATANTI A., T. MAKINEN and A. SILVESTRINI, *The role of financial factors for european corporate investment,* Journal of International Money and Finance, v. 96, pp. 246-258, **WP 1148 (October 2017).**

NERI S. and A. NOTARPIETRO, *Collateral constraints, the zero lower bound, and the debt–deflation mechanism,* Economics Letters, v. 174, pp. 144-148, **WP 1040 (November 2015).**

RIGGI M., *Capital destruction, jobless recoveries, and the discipline device role of unemployment,* Macroeconomic Dynamics, v. 23, 2, pp. 590-624, **WP 871 (July 2012).**

FORTHCOMING

ALBANESE G., G. DE BLASIO and P. SESTITO, *Trust, risk and time preferences: evidence from survey data,* International Review of Economics, **WP 911 (April 2013).**

APRIGLIANO V., G. ARDIZZI and L. MONTEFORTE, *Using the payment system data to forecast the economic activity,* International Journal of Central Banking, **WP 1098 (February 2017).**

ARDUINI T., E. PATACCHINI and E. RAINONE, *Treatment effects with heterogeneous externalities,* Journal of Business & Economic Statistics, **WP 974 (October 2014).**

BRONZINI R., G. CARAMELLINO and S. MAGRI, *Venture capitalists at work: a Diff-in-Diff approach at late-stages of the screening process,* Journal of Business Venturing, **WP 1131 (September 2017).**

BELOTTI F. and G. ILARDI, *Consistent inference in fixed-effects stochastic frontier models,* Journal of Econometrics, **WP 1147 (October 2017).**

CIANI E. and G. DE BLASIO, *European structural funds during the crisis: evidence from Southern Italy,* IZA Journal of Labor Policy, **WP 1029 (October 2015).**

COIBION O., Y. GORODNICHENKO and T. ROPELE, *Inflation expectations and firms' decisions: new causal evidence,* Quarterly Journal of Economics, **WP 1219 (April 2019).**

CORSELLO F. and V. NISPI LANDI, *Labor market and financial shocks: a time-varying analysis,* Journal of Money, Credit and Banking, **WP 1179 (June 2018).**

COVA P., P. PAGANO, A. NOTARPIETRO and M. PISANI, *Secular stagnation, R&D, public investment and monetary policy: a global-model perspective,* Macroeconomic Dynamics, **WP 1156 (December 2017).**

D'AMURI F., *Monitoring and disincentives in containing paid sick leave,* Labour Economics, **WP 787 (January 2011).**

D'IGNAZIO A. and C. MENON, *The causal effect of credit Guarantees for SMEs: evidence from Italy,* Scandinavian Journal of Economics, **WP 900 (February 2013).**

ERCOLANI V. and J. VALLE E AZEVEDO, *How can the government spending multiplier be small at the zero lower bound?,* Macroeconomic Dynamics, **WP 1174 (April 2018).**

FEDERICO S. and E. TOSTI, *Exporters and importers of services: firm-level evidence on Italy,* The World Economy, **WP 877 (September 2012).**

FERRERO G., M. GROSS and S. NERI, *On secular stagnation and low interest rates: demography matters,* International Finance, **WP 1137 (September 2017).**

GERALI A. and S. NERI, *Natural rates across the Atlantic,* Journal of Macroeconomics, **WP 1140 (September 2017).**

GIACOMELLI S. and C. MENON, *Does weak contract enforcement affect firm size? Evidence from the neighbour's court,* Journal of Economic Geography, **WP 898 (January 2013).**

LIBERATI D. and M. LOBERTO, *Taxation and housing markets with search frictions,* Journal of Housing Economics, **WP 1105 (March 2017).**

LOSCHIAVO D., *Household debt and income inequality: evidence from italian survey data,* Review of Income and Wealth, **WP 1095 (January 2017).**

NATOLI F. and L. SIGALOTTI, *Tail co-movement in inflation expectations as an indicator of anchoring,* International Journal of Central Banking, **WP 1025 (July 2015).**

PANCRAZI R. and M. PIETRUNTI, *Natural expectations and home equity extraction,* Journal of Housing Economics, **WP 984 (November 2014).**

PEREDA FERNANDEZ S., *Teachers and cheaters. Just an anagram?,* Journal of Human Capital, **WP 1047 (January 2016).**

RAINONE E., *The network nature of otc interest rates,* Journal of Financial Markets, **WP 1022 (July 2015).**

RIZZICA L., *Raising aspirations and higher education. evidence from the UK's widening participation policy,* Journal of Labor Economics, **WP 1188 (September 2018).**

SEGURA A., *Why did sponsor banks rescue their SIVs?,* Review of Finance, **WP 1100 (February 2017).**