

# ***Monetary Policy Transmission in an Intangible Economy: Evidence from Firm Performance and Loan Markets***

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**Abstract.** Growing importance of software, data, R&D, brands, and organizational capital might affect the monetary policy transmission channel because intangibles cannot be easily pledged and innovative expenditure can be prohibitively expensive to undo. This paper examines whether firms with high intangible intensity are more or less vulnerable to contractionary monetary policy shocks in the US. The dataset encompasses Compustat Global, annual monetary-policy shocks for firms from Jarociński and Karadi aggregated by firms' fiscal year, and DealScan syndicated loan data. The sample includes an unbalanced panel of international firm-year observations from 2001–2023. Models with interactions between firm- and year-fixed effects and annual policy shocks lagged one period and six other lagged firm control variables are estimated. Following contractionary shocks, high-intangible-intensity firms experience a comparatively low sales growth, which means they face a relatively higher risk of being more vulnerable. However, they show a relatively higher increase in R&D intensity, R&D share, and R&D expenditure, suggesting that R&D is preferred and comparatively resilient, but not necessarily increases in total R&D expenditure. Financing restrictions exacerbate the sales decrease. Results from the loan market indicate that syndicated loan spreads do not change differentially. Greater commitment volume is seen only in annual models and weakened using monthly shock measurement and does not provide evidence of actual credit usage. The value of the paper is twofold: first, vulnerability and resilience as outcome-dependent phenomena are combined, and secondly, loan pricing, loan origination, and credit commitment are separated as channels of monetary policy transmission.

**Keywords:** intangible intensity, monetary-policy transmission, R&D resilience, financing constraints, syndicated loans

## **1. Introduction**

The capital composition has changed dramatically. Investment in software, data, research and development (R&D), brands, and organizational capabilities has become an increasingly significant element of business investment. In 29 countries that account for 57 percent of global GDP, intangible investments exceeded USD 10 trillion by 2025 and had increased by 3.6 times the rate of tangible investments since 2008 [1]. Capitalization of intangible expenditures has implications for investment and productivity growth accounting [2], and the changing role of intangibles might also

influence monetary transmission mechanisms. Intangible investment is less sensitive to changes in the interest rate than tangible investment; changes in the nature of intangible investment could have dampened the effect of monetary policy on the economy [3]. Hence arises the crucial issue: does the tightness of monetary policy make intangible-intensive firms more vulnerable or more resilient?

The current theories predict contrasting results on this issue. The low pledgeability and liquidation value of intangible assets constrain firms' borrowing capacity and increase their demand for precautionary liquidity [4]. This may make intangible-intensive firms vulnerable to tightening of financial conditions. However, because of less collateralized debt and more equity financing in such firms, they are less affected by the conventional bank lending channel. According to Döttling and Ratnovski, investment and stock prices of intangible-intensive firms are less responsive to monetary policy shocks [5]. Another theory states that financial shocks lead companies to emphasize their ability to use pledgeable tangible assets and reduce investments in non-pledgeable and intangible assets [6]. The majority of studies examine investment response or firm's behavior in general, making their approaches less effective in explaining the situations when there is a downturn in current performance and innovation-related investments are kept relatively constant. To address this gap, this study complements the collateral-channel explanation with a research and development(R&D)-smoothing mechanism. Hence, monetary tightening may reduce current operations without a corresponding decline in innovative investment.

In this regard, the current research makes three contributions to the literature. Firstly, the research changes focus from the issue of average response of investments to the joint response of the firms' current performance and innovations, thus recognizing the intangibility of assets as a boundary condition of international monetary policy transmission. U.S. monetary policy impacts the revenues, investments, and employment of firms based in foreign economies with differential impacts depending on their degree of financial constraints and foreign production ties [7]. Nevertheless, there is little empirical work that provides joint insight into how intangible intensity influences firm performance, the distribution of investments among tangible and intangible assets, and the results of syndicated loans. Second, by introducing the R&D smoothing view of firm behavior within this context, the research makes a distinction between the short-term adaptation in operations and the maintenance of innovative potential in the long run, rather than considering resilience as an overall firm-level concept. Third, it relates firm-level adjustments to the structure of syndicated loans and distinguishes credit pricing from credit rationing. It is not clear whether adjustments in the loan market take place through pricing, origination of new loans, or outstanding commitments. To address these issues, this paper combines Compustat Global, the identification of the monetary policy shock is based on the use of Jarociński and Karadi's high-frequency U.S, compiled at an high frequency, together with DealScan syndicated loans dataset [8]. This portion of the paper considers the new flows of loans apart from the committed facilities and separately analyzes loan pricing, loan quantities, and contract structure.

## 2. Theoretical foundation and research hypotheses

This section develops hypotheses for two dimensions of firm resilience. Operational resilience refers to a firm's ability to sustain current operations, proxied here by sales growth. Innovation resilience refers to the maintenance of R&D expenditure and its share in the investment portfolio. This distinction justifies the need for an analysis of real activity and the investment composition of firms separately in this paper.

## 2.1. Intangible capital and operating resilience

The first set of relevant literature reviews the impact of increased importance of intangible capital on the effects of monetary policy transmission. Aggregate data indicates that, David and Gourio show that investment in intangibles is less responsive to interest rate changes than investment in tangible capital and argue that changes in the structure of investments may have reduced the reaction of economic activity to monetary policy [3]. Using firm-level data, Döttling and Ratnovski show that investment and stock price responses to monetary policy are weaker in firms with more intangible assets, especially when financial constraints are important, and interpret this as evidence of a weaker credit channel [5]. However, this resilience argument does not apply unambiguously. Falato et al. also associate an increase in intangible capital with the decrease in debt capacity and increased precautionary demand for cash [4]. These pieces of research give rise to contradictory predictions: firms with abundant intangible capital can be resistant to collateral-based monetary transmission, but at the same time, they can be vulnerable due to the insufficient borrowing capacity of their assets. Decreased sensitivity to intangible investments does not necessarily mean resilience in operations. Since low pledgeability makes it hard to substitute financing from outside, firms that invest heavily in intangibles may cope with a contraction shock by scaling down their activities more than reducing long-term intangible investments. For this reason, the following Hypothesis 1 is put forward based on the preceding analysis:

H1: Contractionary monetary-policy shocks weaken operational resilience more among firms with high intangible intensity than among firms with low intangible intensity.

## 2.2. R&D smoothing and innovation resilience

The second strand studies the financing of innovation. Hall and Lerner provide evidence that young and small innovative firms are costly to finance externally while large firms undertaking research & development (R&D) use internal sources of funding [9]. R&D involves costs of adjustment due to heavy reliance on specialized labor and knowledge accumulation. According to Brown & Petersen, firms that have financial constraints maintain the cash buffer so that their research and development cost remains constant due to the volatile nature of external financing [10]. Thus, this literature provides a possible reason for the relative stability of R&D intensity despite the weakening of performance. Since reductions in R&D can diminish specialized human capital, knowledge accumulation, and ongoing activities, the firm may continue or give priority to innovation expenditure even as present-day sales revenues drop. Hence, innovation resilience is therefore outcome-specific and should not be interpreted as immunity from financial pressure. Thus, based on the analysis presented above, Hypothesis 2 can be expressed as:

H2: Contractionary monetary policy shocks increase the innovative resilience of firms that have high intangible intensity compared to those with low intangible intensity.

## 2.3. Financing constraints and operating vulnerability

The third strand identifies firm heterogeneity in reactions to monetary policies. Internationally, di Giovanni and Rogers show that the impact of U.S. monetary policies on sales, investments, and employment of foreign firms depends on financial constraints and international production linkages [7]. However, short-term stabilization of R&D should not be considered a sign of no financial constraint; it may indicate the presence of accumulated liquidity rather than access to short-term borrowing. Combined with evidence that financing constraints shape monetary-policy transmission

among intangible-intensive firms, this argument predicts that operational vulnerability will be greatest when external finance is difficult to replace. Thus, Hypothesis 3 is expressed as follows in light of the explanation above:

H3: More binding financing constraints amplify the negative effect of contractionary monetary-policy shocks on the operational resilience of firms with high intangible intensity.

## 2.4. Outstanding committed credit as a financing channel

Finally, the loan-contract literature explains why credit pricing and credit availability should be analyzed separately. According to Sufi, the line of credit of a bank is not a good alternative to cash since it is dependent on good cash flow and covenants [11]. Greenwald et al. show that big firms relied on committed credit lines during the coronavirus pandemic, and that banks which had more credit-line drawdowns subsequently reduced their term loans to smaller firms [12]. Existing commitments may therefore buffer firms from any toughened lending standards without an increase in loan spreads. firms with high intangible intensity can benefit from the capacity for pre-committed funds in providing contractually backed liquidity, especially in cases where there is a lack of access to collateralized borrowing. In such a scenario, the adjustment comes about not from increased loan spreads but from existing committed credit lines. Therefore, from the above discussion, Hypothesis 4 can be defined as follows:

H4: Following contractionary monetary-policy shocks, firms with high intangible intensity maintain more committed credit than other firms, and this pre-committed credit supports innovation resilience.

## 3. Research design

### 3.1. Sample selection and data sources

Empirically, the analysis combines three sets of data: accounting data at the firm level from Compustat Global, monetary-policy shocks in the United States compiled by Jarociński and Karadi [8], and syndicated loan information from DealScan matched to Compustat. The baseline Compustat dataset covers the period 2001–2023 and consists of about 257,502 firm-year observations from 20,498 firms. 2000 observations are used only for the purpose of constructing the lagged variables. This data set is unbalanced firm-year panel data, which results from different entry and exit times for firms as well as different levels of availability of data on the variables. The core sample of firms consists of ten economics companies based on China, Japan, South Korea, the UK, France, Netherlands, Switzerland, Germany, Taiwan and Finland. Such an international sample of firms is useful for studying the impact of U.S. monetary policies on foreign firms, just as proposed by di Giovanni and Rogers [7] through the international firm-level approach. The sample includes consolidated industrial accounts reported under Compustat's historical format and covers both active and inactive firms. Firm-level continuous variables have been winsorized at the 1st and 99th percentile in order to reduce the effect of outliers. The period covered by the matched sample from DealScan is restricted to 2004-2023 because of data quality concerns. Table 1 presents the descriptive statistics of the major variables used in the firm-level analysis.

Table 1. Descriptive statistics

| Variable     | Observations | Mean   | Std. Dev. | P25     | Median | P75    |
|--------------|--------------|--------|-----------|---------|--------|--------|
| Sales Growth | 252,481      | 0.1231 | 0.4253    | -0.0443 | 0.0552 | 0.1927 |

Table 1. (continued)

|                      |         |         |        |         |         |         |
|----------------------|---------|---------|--------|---------|---------|---------|
| Log XRD              | 151,103 | 4.5964  | 2.7286 | 2.9524  | 4.4466  | 6.3596  |
| XRD Intensity        | 151,137 | 0.0407  | 0.0638 | 0.0069  | 0.0207  | 0.0448  |
| XRD Share            | 149,919 | 0.4192  | 0.2926 | 0.1648  | 0.3744  | 0.6533  |
| CAPX Intensity       | 249,709 | 0.0528  | 0.0658 | 0.0121  | 0.0309  | 0.0659  |
| Total Investment     | 149,954 | 0.0908  | 0.0912 | 0.0338  | 0.0640  | 0.1134  |
| Intangible Intensity | 257,151 | 0.0779  | 0.1398 | 0.0039  | 0.0189  | 0.0740  |
| MPSHock              | 257,151 | -0.0543 | 0.1979 | -0.1086 | -0.0143 | 0.0393  |
| Firm Size            | 257,151 | 8.1439  | 3.1143 | 6.3134  | 8.1674  | 10.3593 |
| Lagged Cash          | 257,151 | 0.2027  | 0.1708 | 0.0785  | 0.1532  | 0.2762  |
| Lagged Debt          | 257,151 | 0.2006  | 0.1808 | 0.0381  | 0.1671  | 0.3165  |
| Lagged Profitability | 257,151 | 0.0648  | 0.1299 | 0.0359  | 0.0766  | 0.1230  |
| Log Lagged Firm Age  | 257,502 | 2.1990  | 0.8704 | 1.6094  | 2.3979  | 2.8904  |
| Lagged Tobin's Q     | 217,641 | 1.4406  | 1.4510 | 0.6259  | 0.9446  | 1.6457  |

Notes: This table reports the descriptive statistics for the major firm-level variables. Log XRD is calculated using observations where R&D expenditures are positive. The baseline specification includes six controls, including two variables: log lagged firm age and lagged Tobin's Q. The descriptive statistics reveal substantial heterogeneity in intangible intensity. Its mean (0.0779) exceeds its median (0.0189), indicating a right-skewed distribution. For firms that report R&D expenditure, the mean value of XRD intensity is 0.0407, while the mean value of XRD share is 0.4192.

### 3.2. Empirical model

The empirical strategy builds on the interaction approach used by Döttling and Ratnovski [5] to examine whether firms' exposure to monetary-policy shocks varies with intangible intensity. This study extends that approach to a multinational setting and considers investment composition, operating performance, and syndicated-loan outcomes.

The empirical framework is expressed in Equation (1).

$$Y_{i,t} = \beta_1 MPShock_{i,t}^{FY} + \beta_2 IntangibleIntensity_{i,t-1} + \beta_3 \left( MPShock_{i,t}^{FY} \times IntangibleIntensity_{i,t-1} \right) + \Gamma' X_{i,t-1} + \alpha_i + \lambda_t + \varepsilon_{i,t} \quad (1)$$

In Equation (1),  $Y_{i,t}$  stands for the dependent variable at the firm level concerning operating or innovation resilience.  $MPShock_{i,t}^{FY}$  is the aggregate of the monetary policy shock in the fiscal year of the firm, and  $IntangibleIntensity_{i,t-1}$  refers to the lagged intangible intensity.  $X_{i,t-1}$  is the set of six lagged firm control variables mentioned in Section 3.3.3, and  $\Gamma$  refers to the corresponding vector of the parameter. The firm fixed effect,  $\alpha_i$ , refers to the firm-specific factors that are time-invariant, while  $\lambda_t$  is the year fixed effect.  $\varepsilon_{i,t}$  stands for the unexplained component of firm-year variation. The key parameter of interest here is the parameter  $\beta_3$ , which shows whether those firms with greater lagged intangible intensity have different reactions to an equally restrictive monetary policy shock. A negative value of  $\beta_3$  in the sales growth regressions indicates poor operational resilience, while a positive value of  $\beta_3$  in the R&D regressions suggests higher resilience in innovation. These values indicate different reactions to the events, and therefore cannot be interpreted as an increase or decrease in general.

Standard errors are clustered at the firm level to allow for within-firm serial correlation.

### 3.3. Variable selection and measurement

#### 3.3.1. Explanatory variables

The most important explanatory variable is the lagged level of intangible intensity, as shown in Equation (2).

$$\text{IntangibleIntensity}_{i,t-1} = \frac{\text{INTAN}_{i,t-1}}{\text{AT}_{i,t-1}} \quad (2)$$

where INTAN refers to the reported value of intangibles and AT is total assets. The lagged measure helps reduce the concern that contemporaneous performance determines intangible intensity.

The key policy variable is the monetary policy element,  $MP\_pm$ , of the Jarociński-Karadi shock [8]. This variable helps differentiate monetary policy surprises from information shocks by the central bank. The approach advocated by Jarociński and Karadi relies on the correlation between interest rate shock and stock price shock when there is an announcement to determine the nature of both: an increase in the interest rate together with a decrease in the stock price change is considered a contractionary monetary policy shock. Conventional shocks are then accumulated on a monthly basis over the entire 12 months FY of a firm, as shown in Equation (3).

$$MPShock_{i,t}^{FY} = \sum_{m \in FY_{i,t}} MP\_pm_m \quad (3)$$

This aggregation aligns monetary-policy exposure to the fiscal year over which each firm's annual outcomes are measured. The main variable of interest is the interaction of  $MPShock_{i,t}^{FY}$  with lagged intangible intensity.

#### 3.3.2. Dependent variables

The dependent variables capture two dimensions of resilience. Operational resilience is proxied by annual sales growth, as defined in Equation (4).

$$\text{SalesGrowth}_{i,t} = \frac{\text{SALE}_{i,t} - \text{SALE}_{i,t-1}}{\text{SALE}_{i,t-1}} \quad (4)$$

Innovation resilience is measured using three metrics—XRD intensity, XRD share, and log XRD—as defined in Equations (5)–(7).

$$\text{XRDIntensity}_{i,t} = \frac{\text{XRD}_{i,t}}{\text{AT}_{i,t-1}} \quad (5)$$

$$\text{XRDShare}_{i,t} = \frac{\text{XRD}_{i,t}}{\text{CAPX}_{i,t} + \text{XRD}_{i,t}} \quad (6)$$

$$\text{LogXRD}_{i,t} = \ln(\text{XRD}_{i,t}), \quad \text{XRD}_{i,t} > 0 \quad (7)$$

In this setting, XRD denotes R&D expenditure, whereas CAPX denotes capital expenditure. The measure of intensity of XRD is computed by dividing XRD by lagged total assets, whereas the

measure of the share of XRD is computed as XRD divided by the sum of CAPX and XRD. The term Log XRD implies taking the natural logarithm of the positive values of XRD, which is then winsorized by 1% and 99%. The level-based outcome allows for distinguishing between variations in research and development expenditures and those in denominators of both ratios. Because not all firms disclose R&D expenditure, the XRD regressions use only reporting firms; the log-XRD specification further restricts the sample to positive XRD observations. As a robustness test, the firms switching their reporting currency within the sample period are removed from the analysis.

### 3.3.3. Control variables

The baseline regression involves six lagged firm level controls namely: size, cash, leverage, profitability, age of firm and Tobin's Q. Size is denoted by the natural log of total assets. Cash is calculated by dividing total assets by cash and short-term investments. Leverage is measured as the ratio of total debt (short term plus long term debt) to total assets. The profitability metric is derived as the operating income before depreciation divided by total assets. The firm age is measured using the natural log of the number of years the firm has been listed in Compustat. The Tobin's Q growth opportunity measure is the sum of market value equity and book value of debt divided by total asset; The Tobin's Q variable is winsorized using the 1st and 99th percentiles. All six indicators are all lagged at t-1 in order to alleviate potential problems with simultaneity.

## 4. Empirical results

### 4.1. Basic regression results

Table 2 shows the empirical findings on firm performance and investments of firms. The relationship between the fiscal-year monetary-policy shock and the lagged intangible intensity shows a negative and significant correlation with sales growth. The estimated regression coefficient is -0.2338, and its standard error is 0.0523. Its p-value is less than 0.001. This result means that firms with higher intangible intensity experience relatively lower sales growth following contractionary monetary-policy shocks, which provides evidence consistent with greater short-run operational vulnerability among intangible-intensive firms.

In terms of the interaction coefficients of outcomes related to R&D are concerned, the estimated coefficients are 0.0204 for XRD intensity and 0.0700 for XRD share; both of which are both 1% statistically significant. These findings imply that R&D is more emphasized in intangible-intensive firms. However, both of these ratios could be higher if total assets or physical investments fall.

To address this concern, the baseline regression is re-estimated using log XRD. The interaction coefficient becomes 0.4484, and the standard error equals 0.1061. It stays significant at the 1% level. The level-based result indicates that the positive ratio estimates are not driven solely by a declining denominator. Overall, R&D spending appears relatively resilient, but the estimates do not imply an absolute increase following monetary contraction.

Table 2. The effect of monetary policy on firm resilience

|                                | Operating Resilience   |                       | Innovation Resilience |                       |
|--------------------------------|------------------------|-----------------------|-----------------------|-----------------------|
|                                | (1) Sales Growth       | (2) XRD Intensity     | (3) XRD Share         | (4) Log XRD           |
| MPShock × Intangible Intensity | -0.2338***<br>(0.0523) | 0.0204***<br>(0.0060) | 0.0700***<br>(0.0241) | 0.4484***<br>(0.1061) |

Table 2. (continued)

|                       |         |         |         |         |
|-----------------------|---------|---------|---------|---------|
| Six firm controls     | Yes     | Yes     | Yes     | Yes     |
| Firm FE               | Yes     | Yes     | Yes     | Yes     |
| Year FE               | Yes     | Yes     | Yes     | Yes     |
| Observations          | 214,807 | 130,285 | 129,493 | 130,258 |
| Firms                 | 19,107  | 14,242  | 14,189  | 14,240  |
| Within R <sup>2</sup> | 0.041   | 0.088   | 0.036   | 0.225   |

Notes: The first four columns report estimates of operating resilience together with three indices of innovation resilience. In all the regressions, there are six lags of firm-level controls, namely firm size, cash ratio, leverage, profitability, logarithm of firm age, and Tobin's Q. Firm-level and year-level fixed effects are included in each of the regressions. Standard errors, which are clustered at the firm level, are presented in parentheses.

## 4.2. Robustness tests

### 4.2.1. Parallel-trends (dynamic placebo) test

Because the analysis uses continuous measures of both monetary-policy shocks and firm exposure, a dynamic no-anticipation test provides an appropriate diagnostic. The specification includes two leads and two lags of  $\text{MPShock} \times \text{Intangible Intensity}$ , six firm-level controls, firm fixed effects, country-year fixed effects, and standard errors clustered at the firm level.

Table 3 shows that none of the lead coefficients is significant by itself, while the null hypothesis that both leads are jointly equal to zero cannot be rejected ( $p = 0.482$ ). This result confirms the presence of no observable pre-trend in the country-year fixed-effect model. The second lag is positive and significant at the 5% significance level, whereas interaction with the present value and the first lag are insignificant. Since the lead coefficients are more sensitive in different fixed-effect models, this test can be treated as supportive diagnostic evidence.

Table 3. Parallel-trends (dynamic placebo) test

| Variable                                                                 | (1) Sales Growth     |
|--------------------------------------------------------------------------|----------------------|
| Lead +2: $\text{MPShock}_{t+2} \times \text{Intangible Intensity}_{t-1}$ | -0.0261<br>(0.1036)  |
| Lead +1: $\text{MPShock}_{t+1} \times \text{Intangible Intensity}_{t-1}$ | -0.1170<br>(0.1105)  |
| Current: $\text{MPShock}_t \times \text{Intangible Intensity}_{t-1}$     | -0.1479<br>(0.1163)  |
| Lag -1: $\text{MPShock}_{t-1} \times \text{Intangible Intensity}_{t-1}$  | -0.0337<br>(0.1039)  |
| Lag -2: $\text{MPShock}_{t-2} \times \text{Intangible Intensity}_{t-1}$  | 0.1568**<br>(0.0658) |
| Joint p-value for the two leads                                          | 0.482                |
| Observations                                                             | 147,523              |
| Firms                                                                    | 14,390               |
| Within R <sup>2</sup>                                                    | 0.050                |

Table 3. (continued)

|                   |      |
|-------------------|------|
| Six firm controls | Yes  |
| Firm FE           | Yes  |
| Country-Year FE   | Yes  |
| Clustered SE      | Firm |

Notes: Lead +2 and Lead +1 test whether future monetary-policy shocks predict sales growth conditional on past intangible intensity. Standard errors are reported in parentheses. The joint p-value for the two leads is reported directly as 0.482. The constant is absorbed by the fixed effects. Standard errors are clustered at the firm level. \*, \*\*, and \*\*\* denote statistical significance at the 10%, 5%, and 1% levels, respectively.

#### 4.2.2. Firm-level robustness checks

Table 4 assesses the robustness of the main results across alternative fixed effects, samples, shock measures, and measures of intangible intensity. Interaction coefficients for sales growth stay negative and statistically significant after the use of firm plus country-year fixed effects (coefficient: -0.3371) and firm plus industry-year fixed effects (coefficient: -0.2177). XRD intensity remains positive and statistically significant in both specifications. While XRD share stays positive, it becomes statistically insignificant when country-year fixed effects are included.

Main findings are not driven by insufficient fiscal-year shock coverage toward the end of the sample period. After excluding 2023, interaction coefficients for sales growth remain significantly negative, while those for XRD intensity remain significantly positive under all three fixed-effect specifications. Results are robust to the replacement of MP\_pm shock with the alternative pc1\_hf shock. Under pc1\_hf shock, coefficients for sales growth vary from -0.2792 to -0.2029, while those for XRD intensity vary from 0.0202 to 0.0206; all are statistically significant.

Excluding XRD outliers yields similar results. In the cleaned XRD sample, the interaction coefficient for XRD intensity remains positive and statistically significant across all three fixed-effect specifications, while XRD share remains positive under all specifications. Specifications that define high-intangible firms using a country-year top-quartile indicator yield significantly negative sales-growth coefficients and positive XRD-related coefficients. Finally, the sales result remains stable after exclusion of China, Japan, or both countries. The R&D-related estimates also have a positive directional sign in such subsamples, although their statistical significance is weakened when both China and Japan are excluded.

Table 4. Selected robustness checks

| Specification             | (1) Sales Growth       | (2) XRD Intensity     | (3) XRD Share         |
|---------------------------|------------------------|-----------------------|-----------------------|
| Baseline: Firm + Year FE  | -0.3058***<br>(0.0498) | 0.0180***<br>(0.0059) | 0.0937***<br>(0.0222) |
| Firm + Country-Year FE    | -0.3371***<br>(0.0568) | 0.0210***<br>(0.0079) | 0.0423<br>(0.0268)    |
| Firm + Industry-Year FE   | -0.2177***<br>(0.0525) | 0.0180***<br>(0.0065) | 0.0721***<br>(0.0233) |
| Excluding 2023            | -0.2942***<br>(0.0500) | 0.0181***<br>(0.0059) | 0.0926***<br>(0.0221) |
| Alternative shock: pc1_hf | -0.2792***             | 0.0202***             | 0.0919***             |

Table 4. (continued)

|                               | (0.0417)   | (0.0055)  | (0.0197)  |
|-------------------------------|------------|-----------|-----------|
| XRD-clean sample              | -          | 0.0164*** | 0.0941*** |
|                               |            | (0.0057)  | (0.0222)  |
| Top-quartile intangible dummy | -0.0614*** | 0.0040*** | 0.0188*** |
|                               | (0.0115)   | (0.0011)  | (0.0060)  |
| Excluding China and Japan     | -0.2773*** | 0.0125*   | 0.0542**  |
|                               | (0.0571)   | (0.0075)  | (0.0263)  |

Notes: The cells show the interaction coefficients, with standard errors clustered at the firm level in parentheses. All regressions control for lagged firm characteristics, and use the fixed effects listed. *pc1\_hf* represents a different high-frequency shock. Statistical significance is shown using the conventional asterisks.

## 5. Further analysis

Thus, in general, the tightening of monetary policy makes intangible-intensive firms exhibit the two opposite reactions. They are relatively more vulnerable in terms of actual operations, but their R&D spending is relatively more resilient and receives greater weight in the investment portfolio. The resilience of R&D expenditures is not explained by better loan terms and higher rates of loan origination. If financing facilitates this adjustment, it is most likely to happen through internal liquidity or pre-committed credit lines. Given the fragility of the cash results and absence of DealScan data on the drawdowns, these are plausible explanations rather than proven channels.

### 5.1. Mechanism analysis

#### 5.1.1. Loan pricing

As reported in Table 5, the DealScan results provide little support for the loan-price channel. Although intangible-intensive firms may face higher spreads on average, contractionary shocks do not produce a statistically significant additional increase in their borrowing spreads. This finding applies to both outstanding and newly originated facilities and holds under the pre-signing monthly shock windows. The weaker sales outcome therefore does not appear to operate through higher syndicated-loan spreads.

Loan pricing is therefore an explicitly tested but unsupported mechanism. Examining this channel helps distinguish the absence of spread evidence from positive evidence for alternative mechanisms.

Table 5. Monetary-policy shocks and syndicated-loan spreads

| Loan-Price Results                |                                 |                              |                              |                              |                               |
|-----------------------------------|---------------------------------|------------------------------|------------------------------|------------------------------|-------------------------------|
|                                   | (1) Outstanding<br>SpreadAnnual | (2) New-Loan<br>SpreadAnnual | (3) New-Loan<br>Spread3m Pre | (4) New-Loan<br>Spread6m Pre | (5) New-Loan<br>Spread12m Pre |
| MPShock ×<br>Intangible Intensity | 2.5130<br>(13.8026)             | -9.9617<br>(18.5333)         | -7.3272<br>(92.5574)         | 62.7633<br>(69.8742)         | 31.7550<br>(40.6119)          |
| Intangible Intensity              | 29.8797**<br>(12.7144)          | 25.0087<br>(16.1636)         | —                            | —                            | —                             |
| Firm controls                     | Yes                             | Yes                          | Yes                          | Yes                          | Yes                           |

Table 5. (continued)

|               |        |        |       |       |       |
|---------------|--------|--------|-------|-------|-------|
| Loan controls | Yes    | Yes    | Yes   | Yes   | Yes   |
| Firm FE       | Yes    | Yes    | Yes   | Yes   | Yes   |
| Year FE       | Yes    | Yes    | Yes   | Yes   | Yes   |
| Observations  | 19,558 | 10,882 | 8,908 | 8,908 | 8,908 |
| R-squared     | 0.800  | 0.703  | 0.742 | 0.742 | 0.742 |

Notes: Loan spreads are shown in basis points. Regressions in columns (1)-(2) use annual shocks, while those in columns (3)-(5) use pre-signing shocks excluding the signing month. Standard errors are clustered at the firm level. Statistical significance is shown using the conventional asterisks.

### 5.1.2. Outstanding committed credit

As reported in Table 6, the more informative evidence concerns outstanding committed facilities. Under the annual shock specification, intangible-intensive firms hold larger committed amounts and average facility sizes following monetary-policy shocks. Such commitments may provide liquidity when new external finance becomes harder to obtain, although access remains conditional on firms' financial condition and covenant compliance [11].

However, DealScan reports contractual facility amounts rather than actual drawdowns. Larger outstanding commitments therefore do not demonstrate that firms borrow more after a shock or obtain greater access to credit. In addition, the estimates become weaker when monthly shocks are used and disappear for the flows of new loans. Thus, the committed credit explanation is only suggestive.

Table 6. Monetary-policy shocks and loan quantities

| Panel A. Outstanding Committed Facilities: Annual Shock |                      |                     |                       |                    |
|---------------------------------------------------------|----------------------|---------------------|-----------------------|--------------------|
|                                                         | (1) Log Amount       | (2) Log Number      | (3) Log Avg. Size     | (4) Maturity       |
| MPSHock $\times$ Intangible Intensity                   | 0.4282**<br>(0.1958) | 0.0391<br>(0.1174)  | 0.3897***<br>(0.1246) | 0.0804<br>(0.2183) |
| Firm controls                                           | Yes                  | Yes                 | Yes                   | Yes                |
| Firm FE                                                 | Yes                  | Yes                 | Yes                   | Yes                |
| Year FE                                                 | Yes                  | Yes                 | Yes                   | Yes                |
| Observations                                            | 19,559               | 19,559              | 19,559                | 19,558             |
| Firms                                                   | 2,015                | 2,015               | 2,015                 | 2,014              |
| R-squared                                               | 0.877                | 0.612               | 0.927                 | 0.700              |
| Panel B. Key Monthly and New-Loan Checks                |                      |                     |                       |                    |
|                                                         | (1) 3m Pre           | (2) 6m Pre          | (3) 12m Pre           |                    |
| Outstanding committed amount                            | 1.8468<br>(1.6411)   | 1.6171<br>(1.1236)  | 1.0916*<br>(0.6605)   |                    |
| Outstanding average facility size                       | 1.0336<br>(1.1007)   | 1.0818<br>(0.7221)  | 0.6792<br>(0.4246)    |                    |
| New-loan amount                                         | -0.7141<br>(0.8594)  | -0.1362<br>(0.6134) | 0.1552<br>(0.3886)    |                    |

Table 6. (continued)

|                                |             |             |             |
|--------------------------------|-------------|-------------|-------------|
| Firm controls                  | Yes         | Yes         | Yes         |
| Firm FE                        | Yes         | Yes         | Yes         |
| Year FE                        | Yes         | Yes         | Yes         |
| Observations: outstanding      | 19,564      | 19,564      | 19,564      |
| Observations: new loans        | 8,935       | 8,935       | 8,935       |
| Firms: outstanding / new loans | 2015 / 1840 | 2015 / 1840 | 2015 / 1840 |

Note: The numbers for amount, number, and facility size are in logarithms while maturity is in years. "Outstanding facilities" refer to contract commitments but not draws. The pre-signing periods do not include the month of signing. The standard errors are clustered by the firm. An asterisk refers to a conventionally significant relationship.

### 5.1.3. Financing constraints and internal liquidity

This combination of outcomes is economically plausible. Intangible assets have low collateral and liquidation values, which may constrain debt capacity and increase firms' sensitivity to deteriorating financial conditions [4]. Conversely, firms with greater intangible intensity rely less on collateralized finance, making their investment less responsive to the bank-lending channel [5]. The sales result is consistent with the vulnerability channel, while the XRD result suggests relative resilience of the innovative investment.

In order to examine this channel directly, the base interaction is further interacted with the lagged Hadlock–Pierce SA index, as defined in Equation (8) [13]:

$$SA_{i,t-1} = -0.737 Size_{i,t-1} + 0.043 Size_{i,t-1}^2 - 0.040 Age_{i,t-1} \quad (8)$$

In this case, Size refers to the natural log of the value of real total assets in millions of 2004 U.S. dollars with an upper limit of  $\ln(4,500)$ . Meanwhile, Age refers to the number of years of operations in the database with a maximum value of 37 years. A higher SA would imply that there are more stringent financing constraints. The continuous-SA triple interaction is negatively associated with each of the three fixed-effect models and is significantly different from zero at the 1% level for the year fixed-effect and industry-year fixed-effect models, and at the 10% level in country-year fixed effect specification. In addition, the high-SA triple interaction term is negative and statistically significant at the 5% level in all three models. Thus, contractionary shocks result in a more negative sales growth differential reaction by financially constrained, intangible-rich firms.

Table 7. Financing constraints and real-activity vulnerability

| Specification           | (1) Continuous SA      | (2) High-SA Dummy     |
|-------------------------|------------------------|-----------------------|
| Firm + Year FE          | -0.1891***<br>(0.0687) | -0.4140**<br>(0.1871) |
| Firm + Country-Year FE  | -0.1244*<br>(0.0689)   | -0.4224**<br>(0.1838) |
| Firm + Industry-Year FE | -0.1958***<br>(0.0685) | -0.4189**<br>(0.1861) |
| Six firm controls       | Yes                    | Yes                   |
| Firm FE                 | Yes                    | Yes                   |

Table 7. (continued)

|              |         |         |
|--------------|---------|---------|
| Observations | 214,807 | 214,807 |
| Firms        | 19,107  | 19,107  |
| Clustered SE | Firm    | Firm    |

Note: The estimated coefficients pertain to the three-way interaction term MPSHock  $\times$  Intangible Intensity  $\times$  Financing Constraint. In column (1), the continuous standardized SA score is used; in column (2), the high-SA score is used. All regression equations include the full lower-order terms, six lags of firm control variables, firm fixed effects, further fixed effects as stated, and clustered firm standard errors. \*, \*\*, and \*\*\* refer to significance levels of 10%, 5%, and 1%, respectively.

One possible reason for this is that R&D is costly to cut since it requires dedicated employees, accumulated knowledge, and ongoing research projects. Thus, when facing financing difficulties, firms may use available liquidity to smooth R&D expenditures [10]. Innovative firms may rely primarily on internal finance [9]. The financing-constraint results are consistent with an amplification of real-activity vulnerability. However, they do not constitute a mediation test, and the cash-related results remain sensitive to specification choices; liquidity smoothing should therefore be viewed as complementary rather than established evidence.

## 5.2. Heterogeneity analysis

The heterogeneity analysis determines whether there is a difference in the baseline effect between innovative firms and non-innovative firms, and whether there exists such an effect among both developed country and developing country subsamples.

### 5.2.1. Innovation-oriented and non-innovation-oriented firms

The results highlight the distinction between firms' current performance and investment structure. Following contractionary monetary-policy shocks, companies with higher intangible intensity experience relatively slower sales growth, indicating real-activity vulnerability in the short run. At the same time, these firms have relatively higher XRD intensity and share in comparison with firms with lower intangible intensity. The findings therefore do not support a uniform contraction across all forms of investment.

Innovation-firm is identified using an innovation index equal to 1 when the previous period's intangible intensity is located in the upper quartile of the firm's country-year distribution. In terms of sales growth, the interaction index is negative and significant in all three fixed-effect models. The coefficient on the XRD intensity is positive and significant at the 1% level for the year fixed effect model and 10% for the country-year and industry-year fixed effect model. The coefficient of XRD share turns out to be positive in all cases but becomes significant only at the 5% level in the year-fixed-effects regression model.

Table 8. Heterogeneity analysis—innovation orientation

| Outcome / specification                | Non-innovation   | Innovation          | Difference          |
|----------------------------------------|------------------|---------------------|---------------------|
| Sales Growth — Firm + Year FE          | 0.0045(0.0169)   | -0.0508*** (0.0190) | -0.0552*** (0.0122) |
| Sales Growth — Firm + Country-Year FE  | 0.0407* (0.0222) | -0.0145 (0.0238)    | -0.0551*** (0.0119) |
| Sales Growth — Firm + Industry-Year FE | 0.0047 (0.0173)  | -0.0291 (0.0193)    | -0.0338*** (0.0125) |
| XRD Intensity — Firm + Year FE         | 0.0005 (0.0015)  | 0.0034* (0.0018)    | 0.0029*** (0.0011)  |
| XRD Intensity — Firm + Country-Year FE | -0.0007 (0.0022) | 0.0013 (0.0024)     | 0.0019* (0.0011)    |

Table 8. (continued)

|                                         |                  |                  |                  |
|-----------------------------------------|------------------|------------------|------------------|
| XRD Intensity — Firm + Industry-Year FE | 0.0007(0.0016)   | 0.0027(0.0018)   | 0.0020*(0.0012)  |
| XRD Share — Firm + Year FE              | 0.0066(0.0085)   | 0.0191**(0.0094) | 0.0125**(0.0062) |
| XRD Share — Firm + Country-Year FE      | 0.0030(0.0112)   | 0.0100(0.0120)   | 0.0070(0.0062)   |
| XRD Share — Firm + Industry-Year FE     | 0.0089(0.0087)   | 0.0191**(0.0097) | 0.0102(0.0064)   |
| Observations / firms — Sales Growth     | 214,807 / 19,107 | 214,807 / 19,107 | 214,807 / 19,107 |
| Observations / firms — XRD Intensity    | 130,285 / 14,242 | 130,285 / 14,242 | 130,285 / 14,242 |
| Observations / firms — XRD Share        | 129,493 / 14,189 | 129,493 / 14,189 | 129,493 / 14,189 |

Notes: Innovation-oriented firms are those firms that belong to the top quartile of lagged intangible intensity in each country-year pair; all other firms fall into the non-innovation-oriented category. Group-specific MPSHOCK  $\times$  Intangible Intensity coefficients and their differences for the innovation and non-innovation groups are provided in the table. All regression models control for six lagged firm-level variables, firm fixed effects, and the fixed effects mentioned in the table. Standard errors are shown in parentheses with firm-clustering. \* represents 10%, \*\* 5%, and \*\*\* 1% significance levels.

### 5.2.2. Advanced- and developing-economy subsamples

In the second set of tests, the nine advanced economies and China are reported separately. Within the advanced-economy subsample, the interaction coefficients for sales growth remain negative and statistically significant across all three fixed-effect specifications. XRD intensity and XRD share are positive and significant under year and industry-year fixed effects, but statistically insignificant under country-year fixed effects. Within China, the sales-growth coefficient is negative and significant under year and industry-year fixed effects; XRD intensity is positive but only weakly significant under industry-year fixed effects, and XRD share is statistically insignificant. Because China is the only developing economy in the sample, this is a descriptive subsample comparison rather than a formal estimate of development-level heterogeneity.

Table 9. Heterogeneity analysis—advanced economies and China

| Outcome / specification                 | Advanced economies  | China              |
|-----------------------------------------|---------------------|--------------------|
| Sales Growth — Firm + Year FE           | -0.2293*** (0.0537) | -0.5283** (0.2601) |
| Sales Growth — Firm + Country-Year FE   | -0.2671*** (0.0609) | —                  |
| Sales Growth — Firm + Industry-Year FE  | -0.1523*** (0.0571) | -0.6321** (0.2639) |
| XRD Intensity — Firm + Year FE          | 0.0199*** (0.0064)  | 0.0114 (0.0076)    |
| XRD Intensity — Firm + Country-Year FE  | 0.0120 (0.0087)     | —                  |
| XRD Intensity — Firm + Industry-Year FE | 0.0142** (0.0070)   | 0.0146* (0.0082)   |
| XRD Share — Firm + Year FE              | 0.0759*** (0.0247)  | -0.0788 (0.0992)   |
| XRD Share — Firm + Country-Year FE      | 0.0396 (0.0301)     | —                  |
| XRD Share — Firm + Industry-Year FE     | 0.0658** (0.0262)   | -0.0858 (0.0999)   |
| Observations / firms — Sales Growth     | 162,815 / 14,132    | 51,992 / 4,975     |
| Observations / firms — XRD Intensity    | 98,977 / 9,501      | 31,308 / 4,741     |
| Observations / firms — XRD Share        | 98,219 / 9,448      | 31,274 / 4,741     |

Notes: The advanced economies category includes CHE, DEU, FIN, FRA, GBR, JPN, KOR, NLD, and TWN, while the developing economies category includes CHN, which is the sole developing economy in the data set. The China country-year model cannot be estimated separately as country-year fixed effects are the same as year fixed effects in a single-country model. Six lagged firm controls along with firm fixed effects and other fixed effects as mentioned in the table have been included in all the regressions.

Coefficients are presented with firm-clustered standard errors in parentheses. \*, \*\*, and \*\*\* represent significance at 10%, 5%, and 1%, respectively.

## 6. Discussion

This empirical finding gives rise to a larger question regarding how resilience ought to be defined in settings where capacity for operation, innovativeness, and finance are all able to be adjusted at different margins.

The following discussion places the paper's empirical findings in the context of competing theoretical and empirical studies. It considers what the findings contribute to the debate, which questions remain unresolved, and why the distinction between operational and innovation resilience matters.

### 6.1. Does greater intangibility make firms resilient or vulnerable

At first glance, the literature seems to favor an interpretation of resilience. From a macro perspective, David and Gourio find that intangible investments are less sensitive to interest rate changes relative to tangible investments and that such a change in the composition of investment may dampen the impact of monetary policy on total activity [3]. From a micro perspective, Döttling and Ratnovski find that monetary policy shocks have a smaller effect on the investment and stock prices of firms that are more reliant on intangible investments, especially when there are constraints related to collateral availability [5]. Taken alone, these papers seem to imply that intangibility acts as a safeguard against monetary tightening.

Taken together, these studies give rise to contradictory predictions: firms with abundant intangible capital can be resistant to collateral-based monetary transmission, but at the same time, they can be vulnerable due to the insufficient borrowing capacity of their assets. According to Falato et al., lack of pledgeability decreases borrowing capacity and increases the need for precautionary liquidity [4]. Ahn et al. [14] characterize non-pledgeable intangibles as particularly exposed to financial constraints, and Lopez and Olivella expect adverse financial shocks to lead to the safeguarding of pledgeable tangibles and reduction in intangible investments [6]. The vulnerability and resilience frameworks therefore describe different margins of adjustment rather than mutually exclusive characterizations of the firm as a whole.

The current paper contributes to reconciling these contrasting views by changing the set of outcomes. Whereas previous studies focus on total investment, firm-level investment, or market value, this study jointly examines sales, the allocation of R&D expenditure, and syndicated-credit outcomes in an international firm panel. In this way, while R&D expenditure may appear resilient, it might at the same time be vulnerable when it comes to sales. It is not an alternative approach to the weak-credit channel finding by Döttling and Ratnovski, but rather a further clarification of that view, in the sense that low sensitivity to one type of investment does not necessarily mean resilience of current activities [5]. In contrast, weak sales do not imply that all investments vary by the same proportion. Intangibility should be seen as signaling a change in the nature of adjustments and not as a requirement for an equal and unconditional resilience of every firm.

### 6.2. Does relative R&D resilience imply financial insulation

A second question is whether relatively resilient R&D spending indicates that intangible-intensive firms face limited financing frictions. The literature on innovation finance suggests the opposite. However, the research on the interaction between innovation and financing suggests quite the

opposite. According to Hall and Lerner, R&D is hard to finance externally due to the fact that the process of creation involves non-pledgeable knowledge, the necessity to rely on specialized labor, and significant informational problems [9]. In turn, Brown and Petersen show that constrained firms use cash buffers to manage the investment in R&D under conditions of financing shocks [10]. In this case, R&D stability can be indicative of costly prioritization and accumulated liquidity rather than of financial irrelevance.

However, short-term stabilization of R&D should not be considered a sign of no financial constraint; it may indicate the presence of accumulated liquidity rather than access to short-term borrowing. When financing constraints tighten, operational vulnerability may increase even if innovative investment remains relatively stable. This viewpoint is consistent with the one taken by Bahaj et al., who suggest that young and heavily indebted firms are especially sensitive to monetary policy due to financial constraints [15]. The additional importance of intangibility found in this paper implies that the same financial state can have opposite consequences for operations and investment.

This behavior can also be motivated by the long-run costs of reduced intangible investment. Ahn et al. show that tightness in credit conditions reduces non-collateralizable investment in intangibles, and that this effect can be mitigated by countercyclical policy [14]. Hence, firms may want to preserve the relative share of R&D despite reduced sales. This difference between sales and R&D in the same period, therefore, can be seen as a form of triage, where firms endure more of the shock via the current operation since the halt of the research efforts could potentially reduce the firm's human capital and future revenue sources. This result challenges the reallocation hypothesis by Lopez and Olivella [6]. Instead, it implies that there is a high cost involved in channeling for those firms undertaking R&D.

Nonetheless, ratio-based results alone cannot distinguish genuine R&D resilience from a mechanical decline in the denominator. The level-based log-XRD outcome reduces the risk of interpreting higher R&D intensity or share as evidence of resilience when assets or capital expenditure have fallen. Even so, it indicates relatively preserved rather than increased R&D spending because international comparisons remain affected by currencies, prices, and disclosure practices.

### 6.3. What does the loan-market evidence reveal

A lack of differential widening in syndicated-loan spreads poses yet another interpretative problem: does a muted spread response mean that credit-market conditions are irrelevant? As the loan contract literature suggests, this would be an exaggerated interpretation. According to Sufi, credit lines provide liquidity but still depend on cash flows and covenant observance [11]. Greenwald et al. show that companies can use the pre-committed credit in case of shock and that big draws can affect future allocation practices in bank lending [12]. Therefore, pricing, committed capacity, use, and origination represent separate dimensions of credit transmission.

Existing commitments might protect firms from the effects of tighter lending standards without necessarily leading to any narrowing of loan spreads. One of the important contributions of this study, from a methodology perspective, is that it treats existing commitments separately from new loan flows and compares the exposure on an annual basis to the policy shock that occurs before the contract is signed. Such a treatment provides insight into why the lack of loan spread effect in itself cannot be used to refute the presence of the credit availability channel. The limitations of the evidence come through here as well.

It is particularly instructive to compare the results to those of Greenwald et al., While supervisory data in their case refer to draws on the credit lines, DealScan contains only information about facility sizes and does not include any information about their usage [12]. Thus, the present analysis captures potential rather than realized liquidity. Similarly, the findings on financial constraint suggest that constraints modify the operating reaction to monetary policy, but do not prove the role of committed credit in transmitting the policy effects to R&D. These findings weaken a pure spread-based explanation and are consistent with liquidity constraints, but they do not establish committed credit as the mechanism.

#### 6.4. Broader implications and scope conditions

The international setting also shapes the interpretation of the results, the international environment affects the proper positioning of the results. According to the research by Di Giovanni and Rogers, the monetary policy of the United States affects the sales, investment, and employment of foreign companies, with effects that vary according to the constraints on finance and the production process internationally [7]. The current research adds intangible intensity as another boundary condition, showing that the pattern of operations still exists in the case of advanced economies. However, because the sample contains nine advanced economies and only one non-advanced economy, it cannot identify a causal effect of development status.

Consequently, the effects of monetary policy on the intangible economy cannot be gauged merely by aggregate investment or financing costs. From the perspective of economic policymakers and analysts, this means that consistent ratios of R&D expenses or stable loan spreads cannot be taken to mean that companies with heavy intangibles are unaffected by monetary tightening. Examination of the current operations, internal liquidity, committed credit capacity, and investment composition may reveal changes that go unnoticed using aggregate measures. From the firm's side, maintaining liquidity buffers and credit lines could be useful in protecting research projects that are faced with high adjustment costs, but neither is a cheap substitute to external financing. Credit lines become less useful precisely when the flow of cash becomes difficult and covenants become more binding [11].

However, these implications should be kept proportional to the empirical design. This paper examines the differential reactions to U.S. monetary policy surprises based on externally identified U.S. monetary-policy surprises, but it does not evaluate the welfare consequences of maintaining research and development activities, the actual amount of borrowing, or innovations outcomes. The next step is to connect syndicated facilities with use and covenants, track their patents and profits over long periods of time, and compare American spillovers to monetary policy shocks within the country. Future work should link syndicated facilities to drawdowns and covenants, track patents and profits over longer horizons, and compare international spillovers from U.S. shocks with domestic monetary-policy shocks.

### 7. Conclusion

#### 7.1. Main conclusions

This paper examines whether intangible-intensive firms are vulnerable or resilient to shocks from U.S. monetary policy. The empirical study uses Compustat Global firm-level data, high-frequency monetary policy shocks by Jarociński and Karadi, aggregated at the firm fiscal-year level, and DealScan syndicated-loan data. As a whole, the evidence suggests that monetary policy tightening

does not generate a uniform response among intangible-intensive firms. Short-term vulnerability to operations exists alongside relatively intact innovation expenditures, with financing constraints and committed credit capacity defining the boundaries of the adjustment process.

(1)Intangible-intensive firms experience relatively lower sales growth after monetary policy shocks, which indicates their vulnerability in terms of short-run real activity. The negative differential remains with the six lagged firm controls.

(2)The firms with high intangible intensity exhibit more positive interaction effects for XRD intensity, XRD share, and log XRD. These findings indicate that R&D investments R&D spending is relatively more resilient following contractionary shocks and are given more priority within the investment portfolio. The findings imply resilience as well as an emphasis on R&D investments rather than on an unrestricted increase in R&D spending.

(3)The additional analysis identifies conditions under which operational vulnerability is more pronounced. More binding financing constraints amplify the negative sales response among firms with greater intangible intensity. Yet, The evidence does not establish mediation but rather indicates differential risk exposure. The robustness is evident in the sales measure in companies that pursue innovations and in the subsample of the advanced economies; yet, the robustness of R&D heterogeneity is less stable under fixed effects regressions. The exercise for advanced economies should be seen as a advanced-economy subsample test on the subsample rather than a comparison exercise between the developed and developing nations.

(4)Because DealScan records committed amounts rather than actual drawdowns, outstanding facilities should be interpreted as potential sources of liquidity. The committed-credit channel is therefore suggestive rather than causally established. However, the theory of committed credit is merely suggestive and not necessarily causal.

## 7.2. Policy recommendations

Policy recommendations should be made in line with the four findings discussed above and in a manner that is proportional to the weight of evidence.

(1)In times of tight monetary policy, central banks, financial regulators, and risk managers within companies need to separately examine their operational resilience and innovation resilience. These dimensions should be assessed jointly using sales growth, internal liquidity, R&D expenditure, and access to credit. Stable aggregate interest rates or financing costs do not imply that the operations of intangible-intensive firms are unaffected.

(2)The innovation policy must be formulated in such a way that it avoids any disruption to ongoing R&D operations, which entail very high adjustment costs, without assuming that an increase in the R&D intensity ratio improves welfare.

(3)Priority should be given to highly intangible-intensive firms facing binding financing constraints, because monetary tightening is likely to affect them most strongly. Policymakers can provide better access to appropriately priced working capital and innovation funds, whereas companies can increase precautionary liquidity and lengthen debt maturity schedules, and limit dependence on refinancing. This approach addresses the conditional role of financing constraints without treating them as the only transmission mechanism.

(4)Banks and regulators should improve the monitoring of committed credit by distinguishing facility size from actual usage and tracking unused capacity, covenants, and renewal risk. Businesses with hard-to-pledge assets can may benefit from committed facilities arranged before the deterioration of financial conditions, but these facilities should not be treated as assured liquidity. Because the loan evidence is only suggestive, this recommendation concerns disclosure,

contingency planning, and contract design rather than a claim that larger commitments have been shown to increase resilience.

### 7.3. Limitations and future research

These two limitations provide the main areas that should be considered in future research.

(1) Reported intangible assets do not capture internally generated intangibles, which are typically expensed rather than capitalized. Besides, XRD is reported in the firm's reporting currency. Even after removing those firms that switch their reporting currency, the Log-XRD is still affected by price and exchange rate changes across countries. Future research could incorporate capitalization-based metrics along with patents, trademarks, organizational capital, and other innovations in addition to using appropriate deflators and currency conversions for firms or countries to see if the findings hold true outside of accounting metrics of intangibles.

(2) DealScan records facility commitments rather than actual drawdowns. The annual aggregation of monetary-policy surprises does not reveal the precise time of facility issuance, covenant changes, or the innovative output generated by continuous R&D efforts. The sample composition does not permit a credible comparison between advanced and developing economies. In future work, the analysis needs to combine syndicated facilities with drawdowns and covenants, use more frequent credit events, compare U.S. spillovers with domestic monetary policy surprises, and look at patenting, productivity, and sales on longer timescales.

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