

Macroeconomic Policy, Product Market Competition, and Growth: The Intangible Investment Channel*

JaeBin Ahn, Romain Duval, and Can Sever
International Monetary Fund

While there is growing evidence of persistent or even permanent output losses from financial crises, the causes remain unclear. One candidate is intangible capital—a rising driver of economic growth that, being nonpledgeable as collateral, is also vulnerable to financial frictions. By sheltering intangible investment from financial shocks, countercyclical macroeconomic policy could strengthen longer-term growth, particularly so where strong product market competition prevents firms from self-financing their investments through rents. Using a rich cross-country firm-level data set and exploiting heterogeneity in firm-level exposure to the sharp and unforeseen tightening of credit conditions around September 2008, we find strong support for these theoretical predictions. The quantitative implications are large, highlighting a powerful stabilizing role for macroeconomic policy through the intangible investment channel, and its complementarity with pro-competitive product market deregulation.

JEL Codes: E52, E62, O30.

*The authors would like to thank Philippe Aghion, Alejandro Cunat, Sebnem Kalemli-Özcan, William Maloney, and participants of the ASSA 2019 session on “Financial Constraints, Interest Rates and Productivity Growth,” Banque de France-Bocconi University conference on “Alternative Datasets for Macro Analysis and Monetary Policy,” 7th COMPNET Annual Conference, 2019 European Network for Research on Investment, and 2019 Conference of the Italian Economic Association. The views expressed in this paper are those of the authors and do not necessarily represent the views of the International Monetary Fund, its Executive Board, or management. Author emails: jahn@imf.org, rduval@imf.org, csever@imf.org.

1. Introduction

There is growing evidence that recessions accompanied by financial crises are associated with large permanent output losses, although the magnitude of these is still being debated (Cerra and Saxena 2008; Jordà, Schularick, and Taylor 2013; Reinhart and Rogoff 2009; Romer and Romer 2017). Even more puzzling, some have argued that even “plain-vanilla” recessions are followed by permanently lower output (Blanchard, Cerutti, and Summers 2015). The causes of such large and persistent output losses remain to be determined, but the potential implications for economic theory and policy are daunting—in particular, this gives rise to the possibility that countercyclical macroeconomic policy persistently or even permanently affects growth. This paper focuses on the role of intangible investment as a transmission channel. Using cross-country firm-level data and focusing on the 2008–09 Global Financial Crisis (henceforth, GFC), we show that countercyclical macroeconomic policy alleviates intangible investment cuts by credit-constrained firms when financial conditions tighten. We also find that product market competition has the opposite effect, pointing to a complementarity between market deregulation and countercyclical macroeconomic policy for growth.

Intangible asset investment is an increasingly important driver of economic growth in advanced economies (Corrado, Hulten, and Sichel 2005, 2009).¹ Even focusing only on those intangible assets currently captured in national accounts, and leaving aside other possible sources of undermeasurement—such as inaccurate deflators—simple growth accounting suggests that intangible capital accumulation contributed about a third to overall labor productivity growth in the European Union and the United States over the 2000–13 period (Corrado et al. 2018).²

¹At the firm level, structural estimation of various dynamic models of research and development (R&D) also point to a significant role of R&D in determining the evolution of productivity over time (e.g., Aw, Roberts, and Xu 2011; Doraszelski and Jaumandreu 2013).

²According to the latest version of the System of National Accounts (2008), only a few intangible assets are currently capitalized in national accounts, namely R&D, mineral exploration, computer software and databases, as well as entertainment, literary, and artistic originals. Expenditures for design, branding, new

However, intangible investment is also a potentially vulnerable growth driver. Because—unlike tangible investment—it cannot generally be pledged against collateral or liquidated quickly, it is likely to be particularly vulnerable to continued availability of external or internal sources of finance. Moreover, the inherent uncertainty regarding the outcome of intangible investment magnifies asymmetric information and moral hazard problems would prevail (Hall and Lerner 2010). For example, building on the work of Holmstrom and Tirole (1997), Aghion et al. (2010) show theoretically that credit constraints can lead firms to cut R&D spending—and long-term illiquid investments more broadly—during recessions. In turn, more volatile R&D spending can undermine long-term growth if research projects need continuity to bear fruit.

Countercyclical macroeconomic policy and product market reform policy should have a bearing on the availability and/or cost of internal and external finance, and thereby on the resilience of intangible investment to sudden shifts in credit conditions. Monetary and fiscal policies have an indirect impact on firms' credit constraints through their effect on output, while monetary policy also influences the cost and availability of bank and nonbank credit (Aghion et al. 2010; Aghion, Hemous, and Kharroubi 2014; Correa-Caro et al. 2021). Likewise, product market competition drives down product market rents and, thereby, the amount of internal funds available for investment projects. For these reasons, there should also be some complementarity between product market reforms and active countercyclical monetary policy. The argument runs as follows. Product market deregulation can boost growth,³ and, as such,

financial products, organizational capital, and firm-provided training are instead currently treated as intermediate costs.

³The existence of gains from easing barriers to entry in product markets has gradually become consensual since at least Blanchard and Giavazzi (2003) (e.g., Ebell and Haefke 2009; Fang and Rogerson 2011; Felbermayr and Prat 2011). A strand of studies using country-time or country-time-industry panel data documents a significant positive effect of product market reform on productivity, investment, employment, and/or output (e.g., Aghion, Askenazy, et al. 2009; Alesina et al. 2005; Bassanini and Duval 2009; Bourlès et al. 2013; Bouis, Duval, and Eugster 2019; Conway et al. 2006; Fiori et al. 2012; Inklaar, Timmer, and Van Ark 2008; Nicoletti and Scarpetta 2003). A related firm-level literature provides evidence on the impact of competitive pressures on innovation, technology

features high on the policy agenda in many advanced economies,⁴ but it also reduces product market rents. As a result, monetary policy—and, more broadly, countercyclical macroeconomic policy—can be more powerful in stabilizing intangible asset investment and thereby in fostering longer-term growth in a more deregulated economy. Aghion, Farhi, and Kharroubi (2019) build up a model that delivers these predictions, and provide some preliminary evidence using industry- and firm-level data. In particular, using data for over 2,000 listed firms in selected European economies, they find that the European Central Bank’s Outright Monetary Transactions Program announced in 2012 had a larger positive impact on firms’ sales and employment growth in industries where market concentration measures (Herfindahl indices) were low than in more concentrated industries.

In this paper, we use a large cross-country firm-level data set of several million firm-year observations, mostly covering small and medium enterprises (SMEs) on top of large listed firms, to test directly for the impact of the countercyclicality of monetary (and fiscal) policy on intangible asset investment, and whether this impact varies depending on direct measures of product market competition as predicted by the theory developed by Aghion, Farhi, and Kharroubi (2019).

Our empirical approach is a differences-in-differences strategy that exploits the sharp and unforeseen tightening of credit conditions that took place in the immediate aftermath of the collapse of Lehman Brothers on September 15, 2008. Using an extensive cross-country firm-level data set put together by merging different waves of ORBIS, we start by showing that firms with greater precrisis balance sheet vulnerabilities—higher leverage or, alternatively and as a robustness check, a higher interest expense burden—reduced their intangible investment rate more than their less vulnerable counterparts in the aftermath of the crisis. This holds within narrowly defined (four-digit NACE) country-industry cells—that is, controlling for any country-industry (supply or demand) shocks, and then

adoption, and productivity (e.g., Aghion et al. 2004, 2005; Aghion, Blundell, et al. 2009; Arnold et al. 2016; Gal and Hijzen 2016).

⁴See, for example, Draghi (2015), International Monetary Fund (2015, 2016), or Organisation for Economic Co-operation and Development (2016).

comparing firms with strong versus weak balance sheet vulnerabilities within each cell. This finding is not driven by more vulnerable firms having experienced slower intangible investment growth already before the crisis—more and less vulnerable firms do not differ significantly along these or other relevant dimensions. Instead, the results are consistent with the view that when credit markets froze after September 15, 2008, more exposed firms were forced to reduce expenditure, particularly on items such as intangible investment, that could not be pledged as collateral or translate quickly into sales. Indeed, we also find that firms with greater precrisis balance sheet vulnerabilities cut intangible asset investment more than they cut tangible asset investment.

Having established that financial frictions mattered for firm-level intangible investment after the crisis, we then explore the role of monetary (and fiscal) policy in mitigating their impact. Using various measures of the response of monetary (and fiscal) policy to the Lehman shock, we find a strong and statistically significant interaction with our measures of firm-level balance sheet vulnerabilities; monetary policy easing dampened the adverse impact of financial frictions on firms' intangible asset investment.

Finally, using various measures of product market competition at the country or country-industry-level, including Lerner indices and markups (following De Loecker and Warzynski 2012), we find that monetary policy was more powerful at stabilizing intangible investment after the collapse of Lehman Brothers where product market competition was stronger, that is, where product market rents were lower. This key finding confirms the theoretical argument laid out in Aghion, Farhi, and Kharroubi (2019) and highlights the complementarity between product market reforms and monetary policy. Our results also have significant policy implications. In particular, they suggest that product market deregulation should come hand in hand with aggressive countercyclical monetary policy—and countercyclical macroeconomic policy more broadly—to shelter intangible asset investment from macroeconomic shocks. Otherwise, there is a risk that the well-documented growth benefits from deregulation might be undermined by their side effect on intangible investment stability.

This paper relates to the existing studies on the permanent output costs of financial crises we mentioned above, but also to a

related literature on macroeconomic volatility and long-term growth. Ramey and Ramey (1995) point to a negative cross-country correlation between volatility and growth. Aghion et al. (2010) focus on intangible investment as one channel through which such link may arise. They show theoretically that in the presence of credit constraints, adverse macroeconomic shocks will lead firms to cut spending on intangible and other forms of long-term, illiquid, but high-return forms of investment. Using cross-country-industry panel data, Aghion, Hemous, and Kharroubi (2014) find that countercyclical fiscal policy mitigates the impact of credit constraints on country-industry-level output growth. Aghion, Farhi, and Kharroubi (2019) focus instead on monetary policy, introduce the interaction between monetary policy and product market competition, and explore industry-level variation drawn from firm-level data. Both papers focus only on output growth without investigating the possible channel(s) at play, including whether the intangible investment channel highlighted by theory is indeed operating. Also, competition is measured indirectly through broad indices of market concentration among a small set of listed firms, with well-known practical and conceptual limitations; in particular, competing non-listed domestic firms and—even more importantly in the case of highly open European economies—foreign firms are ignored in the calculations, market contestability cannot be accounted for (Baumol 1982), and, more broadly, the relevant markets cannot be identified at such an aggregate level. In this paper, we address both issues. We explore how intangible investment at the firm level is affected by monetary (and fiscal) policy and its interplay with direct measures of product market competition at the four-digit industry level, including (firm-level-based) Lerner indices and markups à la De Loecker and Warzynski (2012).

Also related to this paper is the recent literature on how the 2008–09 GFC affected firms. Using firm-level data for the U.S., several papers find that financial frictions amplified the adverse impact of the GFC on employment; those firms with weaker corporate balance sheets (Dinlersoz et al. 2018; Giroud and Mueller 2017), that had a relationship with weak banks (Chodorow-Reich 2014), faced greater refinancing risk (Benmelech, Bergman, and Seru 2021), or were smaller and younger (Siemer 2019) experienced greater job losses, all else equal. Other papers focus on the productivity losses

from such financial frictions, such as de Ridder (2016) for U.S. firms, Huber (2018) for German firms and counties, or Duval, Hong, and Timmer (2020) for a cross-country panel of firms. The latter paper also explores the effect of financial frictions on the response of firm-level intangible investment to the GFC. We extend their analysis to the role of countercyclical monetary (and fiscal) policy and its interplay with product market competition.

The remainder of this paper is structured as follows. Section 2 outlines our empirical strategy and the data set employed in this study. Section 3 presents our econometric results, while Section 4 provides extensions and robustness checks. Section 5 concludes.

2. Empirical Strategy and Data

2.1 Empirical Strategy

The baseline empirical strategy is set on a differences-in-differences framework, thereby comparing the difference in investment in intangible assets between firms with different levels of financial vulnerabilities, before and after the drastic unforeseen credit tightening that followed the collapse of Lehman Brothers.

Our methodology bears similarities with Giroud and Mueller (2017), who investigate the impact of this credit supply shock on firm-level employment in the U.S. by regressing the change in firm-level employment around the GFC on the precrisis leverage ratio which is the measure of firm-level credit constraint. A similar approach is employed in Kalemli-Özcan, Laeven, and Moreno (2022) to study the effect of financial factors on the slowdown in tangible investment in European countries. Duval, Hong, and Timmer (2020) apply this methodology to investigate the role of firm-level financial constraints in the productivity slowdown in advanced countries following the GFC. In a first stage, we start by estimating

$$\Delta \textit{Intangible Investment}_{isc} = \beta_1 \textit{Financial Vulnerability}_{isc} + \delta_{sc} + \gamma \mathbf{X}_{isc} + \epsilon_{isc}, \quad (1)$$

where $\Delta \textit{Intangible Investment}_{isc}$ is the difference in the average investment in intangible assets (scaled by total assets) of firm i , in industry s and country c between the precrisis (2002–07) and

postcrisis (2008–13) periods. *Financial Vulnerability_{isc}* is a measure of precrisis balance sheet vulnerability, details of which are discussed below. δ_{sc} denotes country-sector fixed effects, absorbing all the country-sector-level characteristics that might commonly affect firm-level changes in intangible investment between the two periods in a given country-sector where sectors are highly disaggregated at the four-digit NACE level.⁵ In effect, this implies that we will be comparing the impact of the Lehman shock on intangible investment between firms with strong balance sheets and firms with weak balance sheets within a given country sector. Finally, $\mathbf{X}_{isc}$ is a set of firm-level controls including age, total assets, and cash flows (ratio of cash flows to assets) in the precrisis period. Our rich set of country-sector fixed effects and firm-level controls addresses key sources of omitted variable bias. Reverse causality is not a concern in our setup since the Lehman shock to credit conditions was unforeseen. Moreover, firms' debt structure prior to this event is unlikely to be correlated with other unobserved firm-level characteristics that may be correlated with the change in intangible investment after the crisis.

In a second stage, once β_1 is tested to be negative, implying that firm-level financial vulnerabilities had an adverse effect on intangible investment, we turn to the counteracting effect of countercyclical macroeconomic policy. To do so, we exploit the cross-country heterogeneity in the response of monetary conditions to the GFC and estimate

$$\begin{aligned} \Delta \text{Intangible Investment}_{isc} = & \beta_1 \text{Financial Vulnerability}_{isc} \\ & + \beta_2 \text{Financial Vulnerability}_{isc} \\ & \times \text{Expansionary Conditions}_c \\ & + \delta_{sc} + \gamma \mathbf{X}_{isc} + \epsilon_{isc}, \end{aligned} \quad (2)$$

⁵For instance, intangible investment in some sectors relying more heavily on external finance than others may have been on average more affected by the GFC. Similarly, export-intensive industries in a more export-oriented country may have been affected differently following the great trade collapse. All such potential channels that are specific at the country-industry level but common across firms in that specific country industry will be controlled by country-sector fixed effects.

where *Expansionary Conditions_c* is a measure—discussed in detail further below—of the extent to which monetary conditions eased after the GFC due to countercyclical macroeconomic policies. In this specification, together with $\beta_1 < 0$, $\beta_2 > 0$ would imply that expansionary monetary conditions dampen and—depending on its magnitude and the estimated values of β_1 and β_2 —even possibly offset the negative impact of financial vulnerabilities on the response of intangible investment to the credit supply shock. Since firm-level developments within each four-digit country sector are highly unlikely to influence monetary policy, reverse causality is not a concern here too.

In a third and final stage, we explore the complementarities between countercyclical macroeconomic policies and product market deregulation. The theoretical underpinnings are laid out in Aghion, Farhi, and Kharroubi (2019). They develop a model in which firms decide on the amount of investment in a growth-enhancing form of capital in the presence of profitability and liquidity shocks. In their setup, strong product market competition reduces profits, the ability of firms to weather liquidity shocks, and, thereby, investment. They also show that by mitigating the impact of liquidity shocks, countercyclical monetary policy incentivizes firms to invest more, particularly so where strong product market competition depresses profits.

In our empirical setup, these considerations yield two testable implications that can be checked by estimating the following specification:

$$\begin{aligned}
 \Delta \text{Intangible Investment}_{isc} = & \beta_1 \text{Financial Vulnerability}_{isc} \\
 & + \beta_2 \text{Financial Vulnerability}_{isc} \times \text{Expansionary Conditions}_c \\
 & + \beta_3 \text{Financial Vulnerability}_{isc} \times \text{Weak Competition}_{sc} \\
 & + \beta_4 \text{Financial Vulnerability}_{isc} \times \text{Expansionary Conditions}_c \\
 & \times \text{Weak Competition}_{sc} \\
 & + \delta_{sc} + \gamma \mathbf{X}_{isc} + \epsilon_{isc},
 \end{aligned} \tag{3}$$

where *Weak Competition_{sc}* is a proxy measure for the degree of product market competition, which will be discussed in detail below. First, the adverse effect of corporate balance sheet weakness on intangible investment in the aftermath of the Lehman collapse

should be greater for firms facing higher competition; this implies $\beta_3 > 0$. Second, the beneficial impact of expansionary monetary conditions should be greater for firms facing higher competition, that is, $\beta_4 < 0$ should hold. Standard errors will be clustered at the country-sector level.

2.2 Data

2.2.1 Firm-Level Variables

Our firm-level variables are constructed using ORBIS, a cross-country longitudinal data set of both listed and unlisted firms provided by Bureau van Dijk. The data set features rich information on firms' activities and financial variables based on balance sheets and income statements. We refer the reader to Diez, Fan, and Villegas-Sanchez (2021) for a more detailed description of the data set and the approach taken to clean the data, which essentially follows similar steps as in Gopinath et al. (2017) and Kalemli-Özcan et al. (2024).⁶

We focus on 17 OECD countries for which we have data on both firm-level and country-level macroeconomic variables over this period, namely Austria, Belgium, Czech Republic, Germany, Finland, France, Greece, Hungary, Ireland, Italy, Korea, Norway, Poland, Portugal, Slovakia, Spain, and the United Kingdom.⁷ We study firms in the nonfarm, nonfinancial business sector, which corresponds to the two-digit industry codes 5–82 in NACE Revision 2, covering both manufacturing and a number of service sectors (e.g., real estate and profession/scientific/technical activities). Basic firm-level summary statistics are provided in Table 1.

⁶ To ensure consistency and comparability of monetary variables across countries and over time, time-industry varying value-added or gross output deflators are applied to convert nominal monetary variables to real variables in 2010 constant USD for noncapital variables, while the country-level investment deflators from the World Development Indicators database are applied for capital variables. Importantly, any heterogeneous changes in country-industry-level capital price deflators will be absorbed by the country-sector fixed effects included in specifications (1)–(3). In addition, observations with likely reporting errors due to concerns related to the reliability of the data as well as the consistency of variables over time are excluded.

⁷ Although a majority of our sample consists of firms from euro-area (EA) countries, these do not appear to be driving our results; when running our baseline regression separately for the full sample and the euro-area sample, we obtain qualitatively identical results.

Table 1. Summary Statistics

	Mean	Median	25th Percentile	75th Percentile	Standard Deviation
<i>Firm-Level Variables</i>					
Δ Intangible Investment	-0.001	0.000	0.000	0.002	0.023
Δ Tangible Investment	-0.014	0.001	-0.031	0.027	0.208
Intangible/Total Assets Ratio	0.158	0.022	0.000	0.210	0.251
Leverage Ratio	0.668	0.701	0.529	0.836	0.210
Sales (in million USD)	10.5	1.8	0.8	4.5	174
Assets (in million USD)	16.6	0.9	0.3	3.2	807
Number of Employees	54.0	13.3	8.0	29.0	614.7
Firm Ages	15.9	13	7	20	13.5
<i>Macroeconomic Policy Shocks</i>					
Long-Term Bond Yield (Forecast Error)	0.12	0.45	-0.20	0.62	0.65
Deviation from Taylor Rule	0.37	0.70	-0.40	1.36	2.18
Short-Term Policy Rate (Forecast Error)	-0.04	-0.02	-0.47	0.32	0.43
Government Consumption (Forecast Error)	0.76	0.69	0.30	1.17	0.70
<i>Product Market Competition</i>					
Lerner Index (Country-Sector Median)	0.06	0.05	0.04	0.08	0.04
Markup (Country-Sector Median)	1.97	1.81	1.38	2.38	0.81
Product Market Regulation	1.58	1.52	1.40	1.62	0.25
Regulatory Protection of Incumbents	1.24	1.25	1.08	1.35	1.24
Administrative Burden for Start-Ups	2.34	2.43	1.79	2.58	0.60
Note: Δ Intangible Investment is the difference in the average net investment in intangible assets (as a ratio of total assets) between post- and precrisis periods. Δ Tangible Investment is similarly defined. Intangible/Total Assets Ratio is the ratio of intangible assets to total (tangible + intangible) assets in the precrisis period. <i>Leverage Ratio</i> is defined as the average debt-to-assets ratio in the precrisis period. Lerner Index is computed as the average of <i>(EBITDA-Depreciation and Amortization)/Operating Revenue</i> in the precrisis period. Sales and Assets in the precrisis period are in million USD. Summary statistics of firm-level variables are based on 664,086 observations of the baseline estimation sample. Macroeconomic policy shocks are constructed at country level, while product market competition measures are constructed at country or country-sector level.					

Our main dependent variable of interest is the change in intangible investment, defined as the difference in average investment in intangibles as a share of total assets between pre- and postcrisis periods:

$$\Delta \text{Intangible Investment}_{isc} = \frac{\text{Intangible Investment}_{isc,post}}{\text{Total Assets}_{isc,post}} - \frac{\text{Intangible Investment}_{isc,pre}}{\text{Total Assets}_{isc,pre}},$$

where total assets are in turn defined as the sum of intangible and tangible fixed assets, both of which are deflated by country-sector-level price indices to obtain real values.

We measure investment in intangibles on a net basis—that is, net of depreciation (or amortization), computing it as the change in real intangible assets.⁸ One potential concern regarding this measure stems from the highly complex nature of international standards for intangible assets accounting.⁹ In practice, the intangible assets reported on firms’ balance sheets tend to be mostly acquired assets—with a clear transaction price, such as patents or software—or internally generated ones at the development phase—and thereby with estimable future economic benefits. This leaves out other types of internally generated intangibles, most notably R&D projects at the research stage. Therefore, intangible assets are likely to be both imperfectly reported and underreported. As a result, our econometric analysis is likely to be subject to classical measurement

⁸To be precise, given that the measure of gross intangible investment is not available, we retrieve the net intangible investment measure by differencing the intangible assets variable between two consecutive periods similarly to Ampudia, Beck, and Popov (2021) and Chen and Lee (2023), among others. We further note that as we focus on the “change” in net intangible investment measure between two consecutive periods, unless depreciation rates vary between two consecutive periods, it should be equivalent to considering the change in gross intangible investment.

⁹In principle, intangible assets include, but are not limited to, scientific or technical knowledge, design and implementation of new processes or systems, licenses, intellectual property, market knowledge, and trademarks such as brand names and publishing titles. According to International Accounting Standard (IAS) 38, however, only those that meet three criteria—identifiability, controllability, and estimability—should be recorded on the balance sheet.

error in the dependent variable, leading to attenuation bias and overly conservative results—against finding any statistically significant relationship. We will also check the robustness of our results to alternative measures of the dependent variable that are supposed to be less prone to potential measurement errors.¹⁰

To explore the role of firm-level financial vulnerabilities for intangible investment and their interplay with policies, we consider two variables that capture potential financial constraints faced by firms. The baseline measure is the precrisis average of leverage ratio to capture the degree of debt overhang risk. Giroud and Mueller (2017) discuss that U.S. firms with a higher precrisis leverage ratio faced more acute financial constraints when credit conditions tightened afterwards. This is calculated as the ratio of the sum of current liabilities and long-term debt to total assets for corresponding periods. As a robustness check, we also consider the interest coverage ratio prior to the crisis, defined as total interest paid by the firm over its earnings before taxes, depreciation, and amortization of capital (EBITDA). This is supposed to capture the degree of drags on financing that stem from debt payments (Kalemli-Özcan, Laeven, and Moreno 2022).

2.2.2 Macroeconomic Policy Conditions

Postcrisis monetary conditions in a given country are measured in four alternative ways. The baseline measure is the average forecast error of long-term (10-year) government bond yields in the postcrisis period, relative to OECD forecasts for the year considered, as published in the fall issue of the *OECD Economic Outlook* in the previous year. This is intended to capture the surprise component of monetary

¹⁰There are growing economics, finance, and accounting literatures on the measurement of intangible investment and capital that propose alternative and robust approaches to measuring intangible capital and investment (e.g., Eisfeldt, Kim, and Panikolaou 2022; Enache and Srivastava 2018; Peters and Taylor 2017). However, they are mostly applicable to large, listed firms rather than to SMEs that comprise a large fraction of our sample firms. Instead, we checked the validity of our intangible assets variable by confirming a strong positive correlation with the number of patent applications from a within-firm regression of intangible assets on the number of patent applications in a subsample with firm-patent matches between PATSTAT and the ORBIS data sets provided by Bureau van Dijk.

conditions, that is, the extent to which they were more expansionary than expected postcrisis. One advantage of this measure, beyond its simplicity, is to capture relevant monetary conditions for firms better than short-term policy rates do, and to encompass the impact of both conventional and unconventional monetary policy measures that were implemented by major central banks after the crisis.

Alternatively, we consider more direct measures of monetary policy shocks. One is the deviation of the policy rate from its simple Taylor-rule-implied value in the postcrisis period, using standard Taylor rule parameters and following extensive previous literature (e.g., Bordo and Landon-Lane 2014; Bruno and Shin 2015; Coibion et al. 2017; Dell’Ariccia, Laeven, and Suarez 2017). Another monetary policy shock measure is the forecast error of the short-term policy rate that is orthogonal to unexpected changes in output growth and inflation.¹¹ This is computed in two steps. In a first step, the difference between the actual and forecast short-term rate is calculated, along with similar differences for inflation and gross domestic product (GDP) growth, where the forecasts of short-term policy rates, inflation, and output growth are taken from Consensus Economics in October of the same year. In a second step, forecast errors for the short-term rate are regressed on forecast errors for inflation and GDP growth; residuals from this panel regression are then taken as the exogenous monetary policy shock in a given country and year. As such, both of these alternative measures, by construction, could also address potential concerns that our baseline measure might simply reflect correlated aggregate GDP growth conditions.

Finally, since fiscal policy can ease firms’ credit constraints by raising aggregate demand and output, we also consider a fiscal policy shock measure in an extension of our analysis. We use the forecast error of the ratio of government consumption to GDP, following Auerbach and Gorodnichenko (2012). The forecasts are taken from the fall issue of the *OECD Economic Outlook* in the same year.

2.2.3 Product Market Competition Measures

The degree of competition faced by firms is measured in three ways, two of which are derived from firm-level market power measures.

¹¹See, for example, Duval and Furceri (2018).

The baseline measure is the (median value of the) Lerner index for each country sector in the precrisis period. It is calculated as $(EBITDA-Depreciation\ and\ Amortization)/(Operating\ Revenue)$ and represents an inverse measure of country-sector-level competition. Alternatively, we use firm-level markups. These are computed following the approach proposed by De Loecker and Warzynski (2012) and applied by De Loecker, Eeckhout, and Unger (2020) or Diez, Fan, and Villegas-Sanchez (2021) to document rising corporate market power in advanced economies. We take the median of firm markups in each country sector as a measure of (weak) competition.¹²

While firm-level-based measures are our preferred indicators because they aim to measure directly the strength of market competition and can be computed for each country industry, we also confirm the robustness of our results to using instead the economy-wide product market regulation (PMR) indicators published by the OECD. These are based on responses by national governments to extensive questionnaires covering a wide range of anticompetitive product market regulations (for details, see Koske et al. 2015). In our analysis, we consider the overall PMR indicator but also, given our focus on the role of incumbent firms' product market rents, two specific subindicators on barriers to entry and regulatory protection of incumbents.

2.3 Stylized Facts

For our differences-in-differences strategy to be valid, two conditions should be met. First, the 2008 GFC shock should be exogenous, and second, firms with different levels of financial vulnerabilities should have had a parallel trend in intangible investment growth prior to the crisis, with any divergence materializing only after the crisis. Regarding the first condition, there is broad consensus that the GFC was unforeseen by individual firms; for example, Cheng, Raina, and Xiong (2014) show that even managers in the securitized finance industry failed to identify the housing bubble. The second condition requires a careful look at the data to ensure that

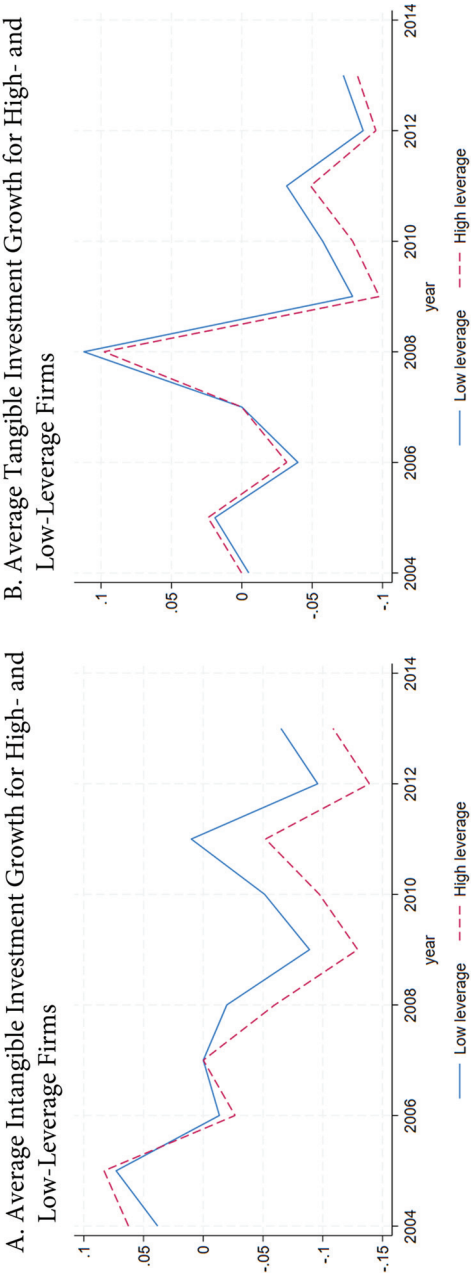
¹²We are grateful to Federico Diez, Jiayue Fan, and Carolina Villegas-Sanchez for sharing the estimated markup data with us.

our estimates will not be driven by more vulnerable firms having experienced slower intangible investment growth already before the crisis.

To this end, we run a regression of firm-level intangible investment growth on year dummies and four-digit country-sector fixed effects separately for high-leverage and low-leverage firms, where the leverage threshold used to split firms in those two groups is, in each country sector separately, the median across firms of the average leverage ratio over the precrisis period. Panel A in Figure 1 reports the evolution of the year dummy variable derived from these regressions—which basically captures average annual growth in intangible investment, expressed as a deviation from its country-sector average over the sample period—across high-leverage (red dashed line) and low-leverage (blue solid line) firms, respectively. The figure confirms that the second condition is satisfied: intangible investment by both sets of firms grew at a similar pace until the GFC, after which high-leverage firms started experiencing a greater decline in intangible investment than their low-leverage counterparts. Moreover, a corresponding chart for tangible investment in panel B indicates that the postcrisis divergence between high- and low-leverage firms was less pronounced for tangible investment, supporting our underlying premise that intangible investment is likely to be more dependent on continuous availability of external or internal sources of finance due, in particular, to its inherently limited pledgeability.

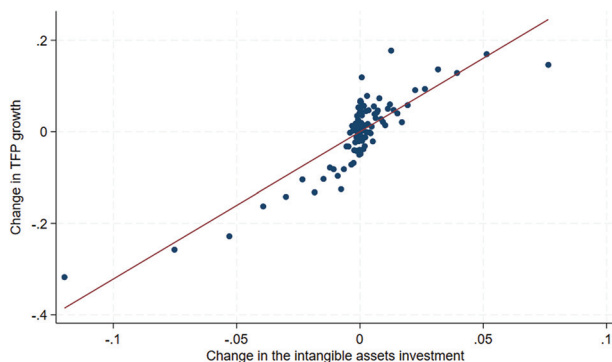
Figure 2 illustrates the relevance of these changes in intangible investment for changes in total factor productivity (TFP) between the precrisis and postcrisis periods. The TFP series for each firm is derived here from the estimation of a production function with labor and tangible capital, using the generalized method of moments (GMM) procedure proposed by Wooldridge (2009) to address the simultaneity problem stemming from the input choices and the firm's productivity, and also the critique of Akerberg, Caves, and Frazer (2015). For each firm in the sample, the change in the intangible-to-total-assets ratio (in percent) between the pre- and postcrisis periods is calculated and then ranked. The resulting data are then broken into 100 quantiles, for each of which the median value of the change in the intangible-to-total-assets ratio is calculated. Each dot in the

Figure 1. Pre- and Post-GFC Trends in Intangible and Tangible Investment Growth in High-Leverage vs. Low-Leverage Firms



Note: This figure illustrates the evolution of average intangible (panel A) and tangible (panel B) investment growth in high-leverage versus low-leverage firms. Each series in the panel represents a coefficient estimate on year dummy variables from a regression of firm-level intangible (panel A) or tangible (panel B) investment growth on year dummies and country-sector fixed effects separately for high-leverage firms (red dashed line) and low-leverage firms (blue solid line), where the leverage threshold used to split the data in two groups is, in each country sector separately, the median across firms of the average leverage ratio over the precrisis period.

Figure 2. Change in Average TFP Growth and Average Intangible Investment Growth between the Pre-GFC and Post-GFC Periods



Note: For each firm in the sample, the change in the intangible-to-total-assets ratio (in percent) between the pre- and postcrisis periods is calculated and then ranked. The resulting data are then broken into 100 quantiles, for each of which the median value of the change in the intangible-to-total-assets ratio is calculated. Each dot in the figure represents this quantile-median, as a deviation from a country-sector fixed effect (x-axis). It is plotted against the quantile-median of the deviation of the change in average TFP growth from a country-sector fixed effect (y-axis). The post- and precrisis periods include five years after and before the 2008 crisis, respectively.

figure represents this quantile-median, as a deviation from a country-sector fixed effect (x-axis). It is plotted against the quantile-median of the deviation of the change in average TFP growth from a country-sector fixed effect (y-axis). The post- and precrisis periods include five years after and before the 2008 crisis, respectively. Overall, the figure shows a strong positive correlation between changes in intangible investment and TFP growth between the pre- and postcrisis periods, consistent with recent literature pointing to a sizable impact of intangible capital on productivity (e.g., Aw, Roberts, and Xu 2011; Doraszelski and Jaumandreu 2013). Incidentally, Figure 2 also confirms that, although far from fully comprehensive, the intangible assets included in firm balance sheets do contain relevant information for productivity growth and are therefore worth studying.

Now, we turn to investigating the role of financial frictions for intangible investment and their interplay with policies.

Table 2. Baseline Estimation Results: Intangible Investment and Leverage

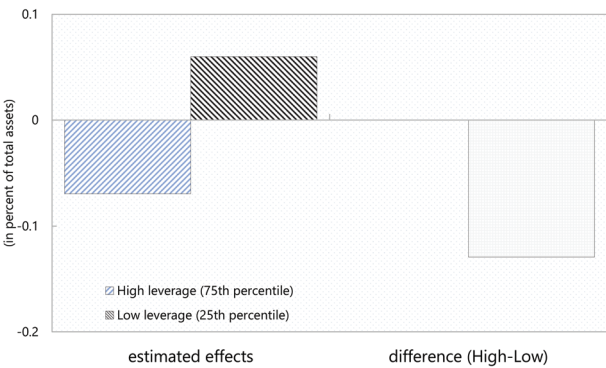
	(1)	(2)
$Vulnerability_{isc}$	−0.005*** (0.000)	−0.014*** (0.005)
$Vulnerability_{isc} \times Precrisis \ Physical \ Assets \ Ratio_{isc}$		0.010* (0.006)
Observations	664,086	664,086
R-squared	0.061	0.065
Country-Sector Fixed Effects	Yes	Yes
Note: The dependent variable is the difference in the average net investment ratio in intangible assets (ratio of intangible to total assets) between post- and precrisis periods. Firm-level vulnerability is the average debt-to-assets ratio in the precrisis period. The postcrisis period starts in 2008. Firm-specific controls (included but not reported) are firm age, total assets, and cash flow/assets ratio; the precrisis average ratio of physical assets in total assets and its interaction terms with the former three variables. All columns include country-sector fixed effects. Standard errors are clustered at the country-sector level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.		

3. Empirical Results

Our starting point, as specified in (1), is to show, as also found by Duval, Hong, and Timmer (2020), that firms with preexisting balance sheet vulnerabilities tended to reduce intangible investment in the postcrisis period more than their less vulnerable peers within a given country-industry. The results are presented in Table 2. The estimated coefficient implies that firms with a 10 percentage point higher leverage ratio reduced their intangible investment rate more by around 0.05 percentage point (column 1). To get a better sense of the estimated effect, Figure 3 illustrates the difference in the estimated decline in intangible investment rate (relative to country-sector averages) between the 75th percentile (blue bar) and 25th percentile firms (shaded bar) in terms of the leverage ratio, which amounts to 0.15 percentage point (red bar).

Insofar as firms could still bring their physical assets as collateral or liquidate them to avoid cutting intangible investment

Figure 3. Illustration of the Baseline Estimation Results: Financial Frictions and Intangible Investment



Note: High (low) leverage corresponds to the 75th (25th) percentile of the cross-firm distribution of precrisis average leverage ratio. The green shaded bar indicates the difference in estimated effects for high- and low-leverage firms. Estimated coefficients are from column 1 in the baseline results table.

expenditure—which cannot be collateralized or liquidated easily—the extent to which firms cut intangible investment might be expected to be greater for firms that have few or no physical assets. To test for this, we further differentiate among firms depending on their asset pledgeability, measured as the share of tangible assets in total assets in the precrisis period, by interacting this measure with leverage. The results, which are reported in column 2 of Table 2, lend further support to the hypothesis that financial frictions affected intangible investment after the crisis: as shown by the statistical significance (at the 10 percent confidence level) of the interaction term, firms with a larger (smaller) share of physical assets turn out to have been less (more) affected by the tightening of credit conditions in 2008.

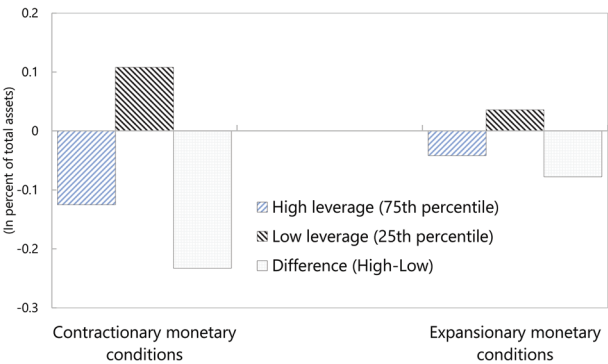
Turning to the role of expansionary monetary conditions in mitigating the adverse impact of financial constraints on intangible investment, Table 3 reports regression results from specification (2) in column 1. The positive and statistically significant coefficient estimate on the interaction term implies that more expansionary monetary conditions could dampen, and indeed prevent, a cut in intangible investment by financially constrained firms. The size of

Table 3. Baseline Estimation Results: Intangible Investment, Leverage, and Macro Policies

	(1)	(2)	(3)
$Vulnerability_{isc}$	-0.005*** (0.000)	-0.007*** (0.001)	-0.009*** (0.001)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c$	0.005*** (0.001)		0.009*** (0.001)
$Vulnerability_{isc} \times Weak Competition_{sc}$		0.047*** (0.011)	0.061*** (0.013)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c \times Weak Competition_{sc}$			-0.074*** (0.019)
Observations	664,086	664,086	664,086
R-squared	0.062	0.061	0.062
Country-Sector Fixed Effects	Yes	Yes	Yes

Note: The dependent variable is the difference in the average net investment ratio in intangible assets (as a ratio of total assets) between post- and precrisis periods. Firm-level vulnerability is measured as the average debt-to-assets ratio in the precrisis period. Expansionary monetary conditions is the average OECD forecast error for long-term (10-year government bond) interest rate in the postcrisis period as a measure of more-than-expected policy loosening. Weak competition is measured as the median precrisis Lerner index value in each country sector, reflecting the degree of profitability. The postcrisis period starts in 2008. Firm-specific controls (included in regressions but not reported) are firm age, total assets, and cash flow/assets ratio as well as their interaction terms with expansionary monetary conditions and/or weak competition measures. All columns include country-sector fixed effects. Standard errors are clustered at the country-sector level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

**Figure 4. Illustration of the Baseline Estimation Results:
The Role of Countercyclical Policy**



Note: High (low) leverage corresponds to the 75th (25th) percentile of the cross-firm distribution of precrisis average leverage ratio. The green shaded bars indicate the difference in estimated effects for high- and low-leverage firms, separately for contractionary and expansionary monetary conditions. Estimated coefficients are from column 2 in the baseline results table. Expansionary/contractionary monetary conditions are defined as forecast errors in 10-year government bond yields by ± 50 bps.

the coefficient estimates is such that a more-than-expected reduction in the long-term external financing cost of some 100 basis points fully negates the adverse impact on intangible investment stemming from debt overhang risk. Figure 4 contrasts the estimated effects for firms with high and low leverage under two different scenarios—more-than-expected expansionary (right bars) and contractionary monetary conditions (left bars) by 50 bps—suggesting that adverse effects of financial frictions on intangible investment can be reduced by one-third under the cases considered (red bars in the middle).

These estimates have sizable implications for output. A back-of-the-envelope calculation of the output effects of weaker postcrisis intangible investment in more leveraged firms requires using an elasticity of output with respect to intangible capital, for which available estimates tend to vary substantially across data samples and methodologies, ranging roughly from 20 to 40 percent (Doraszelski and Jaumandreu 2013; Hall, Mairesse, and Mohnen 2010). Based on this range, our estimation results would imply that a 100 basis point negative surprise on monetary conditions could prevent a cumulative

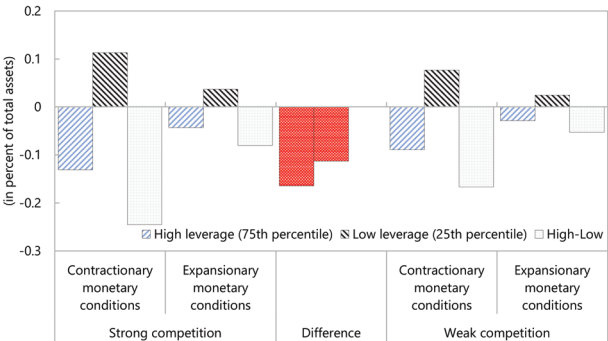
output loss of 1 to 2 percent for high-leverage firms (75th percentile of the leverage distribution) vis-à-vis their low-leverage counterparts over the five years after the crisis.¹³

As an intermediate step toward investigating potential complementarity between monetary and competition policies, we first check if competition had any impact on the relationship between financial frictions and intangible investment. Our premise is that the adverse effects of financial frictions on intangible investment should have been greater for firms facing high competition because, unlike their low-competition counterparts, they could not use monopoly rents to keep on financing intangible investment after the crisis. Regression results in column 2 of Table 3 support this view: we find that financial constraints have a larger adverse effect on intangible investment when competition is stronger (i.e., when the country-sector median Lerner index is lower).

We then examine potential complementarity between monetary and competition policies by running a regression of specification (3). To the extent that expansionary monetary conditions could help alleviate the adverse impact of financial constraints on intangible investment (column 1) and that such adverse effects are particularly strong in a more competitive environment (column 2), it should be the case that the role of countercyclical macroeconomic policy is more pronounced for firms facing high competition, suggesting potential complementarity—countercyclical policy that prevents a slowdown in intangible investment by constrained firms is more effective in a more competitive environment. This is precisely what column 3 in Table 3 reports, as illustrated in Figure 5. Coefficient estimates on

¹³The 0.15 percentage point difference in the decline in the ratio of intangible investment to total assets in Figure 1 corresponds to about a 1 percentage point difference in the ratio of intangible investment to intangible assets, or about a $1 \times 5 = 5$ percent cumulative loss in intangible capital. Applying a 20 to 40 percent return on this capital implies a 1 to 2 percent output loss in the high-leverage firm vis-à-vis its low-leverage counterpart—which, per the estimates in Table 3, is therefore the output loss prevented by a 100 basis point negative surprise on monetary conditions. Note that this back-of-the-envelope calculation is performed only within each country sector. We conjecture that the aggregate effects of financial frictions on intangible investment, and thereby on output, are also likely to have played out across country sectors, with the more leveraged among them being more affected. Any such effects are absorbed by our four-digit country-sector fixed effects here.

Figure 5. Illustration of the Baseline Estimation Results: Complementarity between Product Market Competition and Countercyclical Policy



Note: High (low) leverage corresponds to the 75th (25th) percentile of the cross-firm distribution of precrisis average leverage ratios. The green shaded bars indicate the difference in estimated effects for high- and low-leverage firms in contractionary and expansionary monetary conditions, respectively, while the red bars measure the difference between them, separately for strong and weak competition environments. Estimated coefficients are from column 4 in the baseline results table. Expansionary/contractionary monetary conditions are defined as forecast errors in 10-year government bond yields by ± 50 bps. Weak (strong) competition corresponds to the 75th (25th) percentile of the country-sector distribution of precrisis average Lerner index values.

the triple interaction term are negative and statistically significant, reinforcing the alleviating role of expansionary conditions when firms face stronger competition. These results provide evidence of a complementarity between procompetitive product market reforms and countercyclical macroeconomic policy.

The estimated magnitude of this complementarity between procompetitive product market reforms and countercyclical macroeconomic policy is illustrated in Figure 5, which is an extension of Figure 4. Specifically, when product market competition is stronger (at the 25th percentile of the precrisis distribution of Lerner indices), the estimated cut in intangible investment by more-leveraged firms relative to their less-leveraged counterparts can be reduced from 0.25 to 0.08 percentage point when monetary conditions are more (rather than less) expansionary than expected (green shaded bars on the left). When competition is weaker (at the 75th percentile of the

Lerner index distribution), the corresponding numbers are smaller at 0.16 and 0.05 (green shaded bars on the right), and so is the difference between them— $0.25 - 0.08 = 0.17$ versus $0.16 - 0.05 = 0.11$ (red solid and shaded bars in the middle), implying an overall 50 percent stronger effect of countercyclical macroeconomic policies in more competitive environments.

Table 4 checks whether our baseline results reflect the effects on intangible investment only or also capture those relative to tangible investment. We replace the dependent variable with the difference in the average ratio of intangible to tangible assets (column 1) or the difference in the average investment in tangible assets (scaled by total assets; column 2), both between the pre- and postcrisis periods. The estimation results confirm that the identified channel—financial frictions—through which countercyclical macroeconomic policies and product market competition shape the response of investment to credit conditions is more pronounced for intangible assets than it is for tangible ones.

4. Extensions and Robustness Checks

We perform a wide range of sensitivity analyses on our baseline results reported in the previous section. In particular, we show that our findings are robust to alternative measures of expansionary macroeconomic policies, product market competition, and firm balance sheet vulnerability.

Table 5 confirms that the baseline results are robust to alternative measures of expansionary monetary conditions. Keeping the baseline competition measure, we alternate the policy shocks measures: the deviation of the actual policy rate from Taylor-rule-implied rate (column 1); the forecast error of the actual short-term rate that is orthogonal to changes in inflation and output growth (column 2); and the forecast error of the government consumption expenditure to GDP (column 3). All of them show qualitatively identical results to the baseline results reported in Table 3. In particular, all double and triple interaction terms featured in column 3 of Table 3 remain statistically significant, with the partial exception of the triple interaction term testing for the complementarity between competition and countercyclical monetary policy, which is only borderline significant (at

Table 4. Baseline Estimation Results: Intangible Investment vs. Tangible Investment

	Intangible-to- Total-Assets Ratio (1)	Investment in Tangible Assets (2)
$Vulnerability_{isc}$	-0.022*** (0.004)	-0.017*** (0.003)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c$	0.027*** (0.006)	0.002 (0.005)
$Vulnerability_{isc} \times Weak Competition_{sc}$	0.141*** (0.053)	-0.001 (0.048)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c \times Weak Competition_{sc}$	-0.233*** (0.079)	0.007 (0.075)
Observations	664,086	674,266
R-squared	0.012	0.033
Country-Sector Fixed Effects	Yes	Yes

Note: The dependent variable is the difference in the average ratio of intangible assets to total (tangible + intangible) assets between post- and precrisis periods in column 1; it is the difference in the average net investment in tangible assets (as a ratio of total assets) between post- and precrisis periods in column 2. Firm-level vulnerability is measured as the average debt-to-assets ratio in the precrisis period. Expansionary monetary conditions is the average OECD forecast error for long-term (10-year government bond) interest rate in the postcrisis period as a measure of more-than-expected policy loosening. Weak competition is measured as the median precrisis Lerner index value in each country sector, reflecting the degree of profitability. The postcrisis period starts in 2008. Firm-specific controls (included in regressions but not reported) are firm age, total assets, and cash flow/assets ratio as well as their interaction terms with expansionary monetary conditions and/or weak competition measures. All columns include country-sector fixed effects. Standard errors are clustered at the country-sector level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

Table 5. Alternative Measures of Macroeconomic Policy Shocks

	Deviation from Taylor Rule (1)	Forecast Errors in Short-Term Policy Rate (2)	Forecast Errors in Government Consumption (3)
$Vulnerability_{isc}$	-0.005*** (0.001)	-0.011*** (0.001)	-0.015*** (0.001)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c$	0.004*** (0.000)	0.010*** (0.003)	0.014*** (0.001)
$Vulnerability_{isc} \times Weak Competition_{sc}$	0.019*** (0.010)	0.062*** (0.015)	0.099*** (0.015)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c \times Weak Competition_{sc}$	-0.016** (0.006)	-0.072* (0.038)	-0.121*** (0.017)
Observations	664,086	571,482	647,836
R-squared	0.063	0.062	0.063
Country-Sector Fixed Effects	Yes	Yes	Yes

Note: The dependent variable is the difference in the average net investment in intangible assets (as a ratio of total assets) between post- and precrisis periods. Firm-level vulnerability is measured as the average debt-to-assets ratio in the precrisis period. Expansionary monetary conditions as a measure of more-than-expected policy loosening is the average deviation of policy rates from the Taylor-rule-implied one in the postcrisis period in column 1; the forecast error in monetary policy rates from Duval and Furceri (2018) in column 2; and the forecast error of government consumption expenditure to GDP from Duval and Furceri (2018) in column 3. Weak competition is measured as the median precrisis Lerner index value in each country sector, reflecting the degree of profitability. Firm-specific controls (included in regressions but not reported) are firm age, total assets, and cash flow/assets ratio as well as their interaction terms with expansionary monetary conditions and/or weak competition measures. All columns include country-sector fixed effects. Standard errors are clustered at the country-sector level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

the 10 percent level) when the forecast error of the short-term rate is used.¹⁴

Likewise, Table 6 confirms that the baseline results are robust to alternative measures of product market competition. This time, we keep the baseline monetary condition measure, and alternate the competition measures: the country-sector median of estimated markups (column 1); OECD's overall product market regulation (PMR) indicator (column 2); OECD's subindicator on regulatory protection of incumbents (column 3); and OECD's subindicator on administrative burdens on start-ups (column 4). All columns indicate qualitatively identical results to the baseline results, with all relevant effects showing statistical significance at the 1 percent confidence level.

We conduct three additional sets of robustness checks on the sample, baseline specification, and firm-level balance sheet vulnerability variable, the results of which are summarized in Table 7. First, we shorten the time window to 2005–10 (two years before versus two years after the GFC), which also has the advantage of fully removing the 2010–12 euro-area crisis period. Since the adverse effects of financial frictions are likely to have been more acute right after the crisis, we expect the estimated effects to be at least as big as the baseline results. This is confirmed by slightly larger point estimates in absolute terms compared with those from the baseline estimation (column 1).

Second, we check the robustness of our results to an alternative measure of firm-level financial vulnerability, namely the interest coverage ratio. The higher the ratio is, the greater the debt burden is, and the more vulnerable the firm should be to a tightening of credit conditions. Again, this yields qualitatively identical results to the baseline regression (column 2).

Moreover, given that intangible investment data are potentially noisy, as discussed earlier, we replace the dependent variable with a

¹⁴In addition, we checked the possibility that the expansionary monetary policies could be associated with lower economic policy uncertainty and, hence, our findings might reflect the channel via the latter rather than the former. Specifically, we ran a horse race regression between expansionary policy and uncertainty measures by including an exhaustive list of interaction variables and could confirm that the main findings are driven by expansionary policy measures rather than uncertainty measures.

Table 6. Alternative Measures of Product Market Competition

	Median Markup (Country Sector) (1)	Product Market Regulation (2)	Regulatory Protection of Incumbents (3)	Administrative Burden for Start-Ups (4)
$Vulnerability_{isc}$	-0.011*** (0.001)	-0.018*** (0.002)	-0.042*** (0.003)	-0.030*** (0.003)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c$	0.011*** (0.002)	0.041*** (0.003)	0.067*** (0.005)	0.052*** (0.005)
$Vulnerability_{isc} \times Weak Competition_{sc}$	0.003*** (0.001)	0.008*** (0.001)	0.030*** (0.003)	0.009*** (0.001)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c \times Weak Competition_{sc}$	-0.004*** (0.001)	-0.021*** (0.002)	-0.049*** (0.004)	-0.017*** (0.002)
Observations	664,086	664,086	664,086	664,086
R-squared	0.062	0.062	0.062	0.062
Country-Sector Fixed Effects	Yes	Yes	Yes	Yes

Note: The dependent variable is the difference in the average net investment in intangible assets (as a ratio of total assets) between post- and precrisis periods. Firm-level vulnerability is measured as the average debt-to-assets ratio in the precrisis period. Expansionary monetary conditions is the average OECD forecast error for long-term (10-year government bond) interest rate in the postcrisis period as a measure of more-than-expected policy loosening. Weak competition is measured as the median markup estimate in each country sector, reflecting the degree of profitability in column 1; the OECD indicator of product market regulation (PMR) in 2008 in column 2; the OECD indicator of regulatory protection of incumbents (RPI) in 2008; and the OECD indicator of administrative burdens for start-ups (ABS) in 2008 in column 4. The postcrisis period starts in 2008. Firm-specific controls (included in regressions but not reported) are firm age, total assets, and cash flow/assets ratio as well as their interaction terms with expansionary monetary conditions and/or weak competition measures. All columns include country-sector fixed effects. Standard errors are clustered at the country-sector level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

Table 7. Further Robustness Checks

	Shorter Window (2005–10) (1)	Alternative Vulnerability (Interest Coverage) (2)	Linear Probability (3)	Excluding Zeros (No Intangible Assets) (4)	Excluding M&A Firms (No Goodwill) (5)
$Vulnerability_{isc}$	-0.013*** (0.001)	-0.002*** (0.000)	-0.175*** (0.013)	-0.010*** (0.001)	-0.008*** (0.001)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c$	0.011*** (0.002)	0.004*** (0.001)	0.078*** (0.023)	0.011*** (0.002)	0.009*** (0.001)
$Vulnerability_{isc} \times Weak Competition_{sc}$	0.093*** (0.015)	0.012* (0.007)	0.879*** (0.209)	0.069*** (0.016)	0.060*** (0.013)
$Vulnerability_{isc} \times Expansionary Monetary Conditions_c \times Weak Competition_{sc}$	-0.100*** (0.024)	-0.028*** (0.009)	-0.623* (0.322)	-0.096*** (0.023)	-0.073*** (0.020)
Observations	615,143	664,453	664,086	518,048	650,533
R-squared	0.074	0.060	0.087	0.072	0.063
Country-Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the difference in the average net investment in intangible assets (as a ratio of total assets) between post- and precrisis periods. Firm-level vulnerability is measured as the average debt-to-assets ratio in the precrisis period except for in column 2, where it is measured as the interest coverage ratio (the average ratio of interest payments to earnings (EBITDA)) in the precrisis period. Expansionary monetary conditions is the average OECD forecast error for long-term (10-year government bond) interest rate in the postcrisis period as a measure of more-than-expected policy loosening. Weak competition is measured as the median precrisis Lerner index value in each country sector, reflecting the degree of profitability. Column 1 considers a shorter window between 2005 and 2010; column 3 corresponds to linear probability model by replacing the non-negative dependent variable with 1 (and 0 otherwise). Column 4 excludes observations without intangible assets in both periods, and hence, no change in intangible investment during the periods. Column 5 excludes observations with any M&A activity during the periods. The postcrisis period starts in 2008. Firm-specific controls (included in regressions but not reported) are firm age, total assets, and cash flow/assets ratio as well as their interaction terms with expansionary monetary conditions and/or weak competition measures. All columns include country-sector fixed effects. Standard errors are clustered at the country-sector level. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

dummy variable that takes value 1 for non-negative changes in net intangible investment between the pre- and postcrisis periods, and 0 otherwise (negative change). This linear probability model has the advantage of being potentially less prone to measurement error in the dependent variable. Again, results are qualitatively identical to the baseline specification (column 3). In a similar vein, we exclude those firms that have never had any intangible assets throughout the sample period—about 10 percent of the full sample. The estimation results are almost identical to the baseline results, with slightly bigger point estimates (column 4).

Relatedly, potential measurement issues due to mergers and acquisitions can be substantial to the extent that goodwill—an intangible asset that is created when one company acquires another company for a price greater than its net asset value—is likely to be unrelated to internally generated intangible assets (e.g., Ewens, Peters, and Wang 2024). We confirmed that our results are not simply driven by potential measurement issues due to mergers and acquisitions (M&As) by excluding all the firms with M&A activities, which are identified from the Zephyr, a comprehensive M&A data set compiled by Bureau Van Dijk. This subsample result is summarized in column 5.

5. Conclusion

Investment in intangible assets is an increasingly important driver of economic growth but, being nonpledgeable as collateral and hard to liquidate quickly, it is also potentially vulnerable to financial frictions. This implies that countercyclical macroeconomic policy could strengthen longer-term growth by sheltering intangible investment from adverse shocks, particularly so where strong product market competition prevents firms from self-financing their investments through rents. Using a large cross-country firm-level data set and focusing on the Global Financial Crisis and its aftermath, this paper finds strong support for these theoretical predictions. Our results highlight a complementarity between procompetition product market deregulation and countercyclical monetary (and fiscal) policy in fostering intangible investment and growth.

Our findings thus have strong implications for economic theory and policy that give rise to the possibility that countercyclical

macroeconomic policy persistently or even permanently affects growth. Moreover, insofar as product market competition can backfire when credit constraints bite in downturns, our results call for strengthening countercyclical macro policies alongside any market deregulation to foster growth.

References

- Akerberg, D., K. Caves, and G. Frazer. 2015. "Identification Properties of Recent Production Function Estimators." *Econometrica* 83 (6): 2411–51.
- Aghion, P., G. Angeletos, A. Banerjee, and K. Manova. 2010. "Volatility and Growth: Credit Constraints and the Composition of Investment." *Journal of Monetary Economics* 57 (3): 246–65.
- Aghion, P., P. Askenazy, R. Bourlès, G. Clette, and N. Dromel. 2009. "Education, Market Rigidities and Growth." *Economics Letters* 102 (1): 62–65.
- Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt. 2005. "Competition and Innovation: An Inverted-U Relationship." *Quarterly Journal of Economics* 120 (2): 701–28.
- Aghion, P., R. Blundell, R. Griffith, P. Howitt, and S. Prantl. 2004. "Entry and Productivity Growth: Evidence from Microlevel Panel Data." *Journal of the European Economic Association* 2 (2–3): 265–76.
- . 2009. "The Effects of Entry on Incumbent Innovation and Productivity." *Review of Economics and Statistics* 91 (1): 20–32.
- Aghion, P., E. Farhi, and E. Kharroubi. 2019. "Monetary Policy, Product Market Competition and Growth." *Economica* 86 (343): 431–70.
- Aghion, P., D. Hemous, and E. Kharroubi. 2014. "Cyclical Fiscal Policy, Credit Constraints, and Industry Growth." *Journal of Monetary Economics* 62 (March): 41–58.
- Alesina, A., S. Ardagna, G. Nicoletti, and F. Schiantarelli. 2005. "Regulation and Investment." *Journal of the European Economic Association* 3 (4): 791–825.
- Ampudia, M., T. Beck, and A. Popov. 2021. "Out with the New, In with the Old? Bank Supervision and the Composition of Firm Investment." CEPR Discussion Paper No. 16225.

- Arnold, J., B. Javorcik, M. Lipscomb, and A. Mattoo. 2016. "Services Reform and Manufacturing Performance: Evidence from India." *Economic Journal* 126 (590): 1–39.
- Auerbach, A., and Y. Gorodnichenko. 2012. "Measuring the Output Responses to Fiscal Policy." *American Economic Journal: Economic Policy* 4 (2): 1–27.
- Aw, B., M. Roberts, and D. Xu. 2011. "R&D Investment, Exporting, and Productivity Dynamics." *American Economic Review* 101 (4): 1312–44.
- Bassanini, A., and R. Duval. 2009. "Unemployment, Institutions, and Reform Complementarities: Reassessing the Aggregate Evidence for OECD Countries." *Oxford Review of Economic Policy* 25 (1): 40–59.
- Baumol, W. 1982. "Contestable Markets: An Uprising in the Theory of Industry Structure." *American Economic Review* 72 (1): 1–15.
- Benmelech, E., N. Bergman, and A. Seru. 2021. "Financing Labor." *Review of Finance* 25 (5): 1365–93.
- Blanchard, O., E. Cerutti, and L. Summers. 2015. "Inflation and Activity: Two Explorations and their Monetary Policy Implications." IMF Working Paper No. 15/230.
- Blanchard, O., and F. Giavazzi. 2003. "Macroeconomic Effects of Regulation and Deregulation in Goods and Labor Markets." *Quarterly Journal of Economics* 118 (3): 879–907.
- Bordo, M., and J. Landon-Lane. 2014. "Does Expansionary Monetary Policy Cause Asset Price Booms: Some Historical and Empirical Evidence." In *Macroeconomic and Financial Stability: Challenges for Monetary Policy*, ed. S. Bauducco, L. Christiano, and C. Raddatz, 61–116. Santiago, Chile: Central Bank of Chile Press.
- Bouis, R., R. Duval, and J. Eugster. 2019. "How Fast Does Product Market Deregulation Pay Off? New Evidence from Non-Manufacturing Industry Deregulation in Advanced Economies." *Journal of Comparative Economics* 48 (1): 198–217.
- Bourlès, R., G. Cetté, J. Lopez, J. Mairesse, and G. Nicoletti. 2013. "Do Product Market Regulations in Upstream Sectors Curb Productivity Growth? Panel Data Evidence for OECD Countries." *Review of Economics and Statistics* 95 (5): 1750–68.

- Bruno, V., and H. Shin. 2015. "Capital Flows and the Risk-Taking Channel of Monetary Policy." *Journal of Monetary Economics* 71 (April): 119–32.
- Cerra, V., and S. Saxena. 2008. "Growth Dynamics: The Myth of Economic Recovery." *American Economic Review* 98 (1): 439–57.
- Chen, S., and D. Lee. 2023. "Small and Vulnerable: SME Productivity in the Great Productivity Slowdown." *Journal of Financial Economics* 147 (1): 49–74.
- Cheng, I.-H., S. Raina, and W. Xiong. 2014. "Wall Street and the Housing Bubble." *American Economic Review* 104 (9): 2797–829.
- Chodorow-Reich, G. 2014. "The Employment Effects of Credit Market Disruptions: Firm-Level Evidence from the 2008-9 Financial Crisis." *Quarterly Journal of Economics* 129 (1): 1–59.
- Coibion, O., Y. Gorodnichenko, L. Kueng, and J. Silvia. 2017. "Innocent Bystanders? Monetary Policy and Inequality." *Journal of Monetary Economics* 88 (June): 70–89.
- Conway, P., D. de Rosa, F. Steiner, and G. Nicoletti. 2006. "Product Market Regulation and Productivity Convergence." *OECD Economic Studies* 43 (2): 39–76.
- Corrado, C., J. Haskel, C. Jona-Lasinio, and M. Iommi. 2018. "Intangible Investment in the EU and US Before and Since the Great Recession and Its Contribution to Productivity Growth." *Journal of Infrastructure, Policy and Development* 2 (1): 1–26.
- Corrado, C., C. Hulten, and D. Sichel. 2005. "Measuring Capital and Technology: An Expanded Framework." In *Measuring Capital in New Economy*, ed. J. Haltiwanger, C. Corrado, and D. Sichel, 114–46. Chicago, IL: University of Chicago Press.
- . 2009. "Intangible Capital and U.S. Economic Wealth." *Review of Income and Wealth* 55 (3): 661–85.
- Correa-Caro, C., L. Medina, M. Poplawski-Ribeiro, and B. Sutton. 2021. "Fiscal Stimulus and Firms' Sales and Capital Expenditure During the Global Financial Crisis." *Comparative Economic Studies* 63: 489–535.
- De Loecker, J., J. Eeckhout, and G. Unger. 2020. "The Rise of Market Power." *Quarterly Journal of Economics* 135 (2): 561–644.
- De Loecker, J., and F. Warzynski. 2012. "Markups and Firm-Level Export Status." *American Economic Review* 102 (6): 2437–71.

- de Ridder, M. 2016. "Investment in Productivity and the Long-Run Effect of Financial Crises on Output." Cambridge-INET Working Paper No. 2016/18; Cambridge Working Papers in Economics No. 1659, University of Cambridge.
- Dell'Ariccia, G., L. Laeven, and G. Suarez. 2017. "Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States." *Journal of Finance* 72 (2): 613–54.
- Diez, F., J. Fan, and C. Villegas-Sanchez. 2021. "Global Declining Competition." *Journal of International Economics* 132 (September): Article 103492.
- Dinlersoz, E., S. Kalemli-Özcan, H. Hyatt, and V. Penciakova. 2018. "Leverage over the Life Cycle and Implications for Firm Growth and Shock Responsiveness." NBER Working Paper No. 25226.
- Doraszelski, U., and J. Jaumandreu. 2013. "R&D and Productivity: Estimating Endogenous Productivity." *Review of Economic Studies* 80 (4): 1338–83.
- Draghi, M. 2015. "Monetary Policy and Structural Reforms in the Euro Area." Speech at Prometeia40, Bologna, December 14. <https://www.ecb.europa.eu/press/key/date/2015/html/sp151214.en.html>.
- Duval, R., and D. Furceri. 2018. "The Effects of Labor and Product Market Reforms: The Role of Macroeconomic Conditions and Policies." *IMF Economic Review* 66 (1): 31–69.
- Duval, R., G. Hong, and Y. Timmer. 2020. "Financial Frictions and the Great Productivity Slowdown." *Review of Financial Studies* 33 (2): 475–503.
- Ebell, M., and C. Haefke. 2009. "Product Market Deregulation and the U.S. Employment Miracle." *Review of Economic Dynamics* 12 (3): 479–504.
- Eisfeldt, A., E. Kim, and D. Papanikolaou. 2022. "Intangible Value." *Critical Finance Review* 11 (2): 299–332.
- Enache, L., and A. Srivastava. 2018. "Should Intangible Investments Be Reported Separately or Commingled with Operating Expenses? New Evidence." *Management Science* 64 (7): 3446–68.
- Ewens, M., R. Peters, and S. Wang. 2024. "Measuring Intangible Capital with Market Prices." *Management Science* 71 (1): 407–27. <https://doi.org/10.1287/mnsc.2021.02058>.

- Fang, L., and R. Rogerson. 2011. "Product Market Regulation and Market Work: A Benchmark Analysis." *American Economic Journal: Macroeconomics* 3 (2): 163–88.
- Felbermayr, G., and J. Prat. 2011. "Product Market Regulation, Firm Selection, and Unemployment." *Journal of the European Economic Association* 9 (2): 278–317.
- Fiori, G., G. Nicoletti, S. Scarpetta, and F. Schiantarelli. 2012. "Employment Outcomes and the Interaction between Product and Labor Market Deregulation: Are They Substitutes or Complements?" *Economic Journal* 122 (558): 79–104.
- Gal, P., and A. Hijzen. 2016. "The Short-Term Impact of Product Market Reforms: A Cross-Country Firm-Level Analysis." IMF Working Paper No. 16/116.
- Giroud, X., and H. Mueller. 2017. "Firm Leverage, Consumer Demand, and Employment Losses during the Great Recession." *Quarterly Journal of Economics* 132 (1): 271–316.
- Gopinath, G., S. Kalemli-Özcan, L. Karabarbounis, and C. Villegas-Sanchez. 2017. "Capital Allocation and Productivity in South Europe." *Quarterly Journal of Economics* 132 (4): 1915–67.
- Hall, B., and J. Lerner. 2010. "The Financing of R&D and Innovation." In *Handbook of the Economics of Innovation*, Vol. 1, ed. B. H. Hall and N. Rosenberg. Elsevier.
- Hall, B., J. Mairesse, and P. Mohnen. 2010. "Measuring the Returns to R&D." In *Handbook of the Economics of Innovation*, Vol. 2, ed. B. H. Hall and N. Rosenberg. Elsevier.
- Holmstrom, B., and J. Tirole. 1997. "Financial Intermediation, Loanable Funds, and the Real Sector." *Quarterly Journal of Economics* 112 (3): 663–91.
- Huber, K. 2018. "Disentangling the Effects of a Banking Crisis: Evidence from German Firms and Counties." *American Economic Review* 108 (3): 868–98.
- Inklaar, R., M. Timmer, and B. Van Ark. 2008. "Market Services Productivity Growth across Europe and the US." *Economic Policy* 23 (53): 139–94.
- International Monetary Fund. 2015. "Where Are We Headed? Perspectives on Potential Output." In *World Economic Outlook: Uneven Growth: Short- and Long-Term Factors*. Washington, DC: International Monetary Fund.

- . 2016. “Time for a Supply-Side Boost? Macroeconomic Effects of Labor and Product Market Reforms in Advanced Economies.” In *World Economic Outlook: Too Slow for Too Long*. Washington, DC: International Monetary Fund.
- Jordà, Ò., M. Schularick, and A. Taylor. 2013. “When Credit Bites Back.” *Journal of Money, Credit and Banking* 45 (s2): 3–28.
- Kalemli-Özcan, S., L. Laeven, and D. Moreno. 2022. “Debt Overhang, Rollover Risk, and Corporate Investment: Evidence from the European Crisis.” *Journal of the European Economic Association* 20 (6): 2353–95.
- Kalemli-Özcan, S., B. Sorensen, C. Villegas-Sanchez, V. Volosovych, and S. Yesiltas. 2024. “How to Construct Nationally Representative Firm Level Data from the Orbis Global Database.” *American Economic Journal: Macroeconomics* 16 (2): 353–74.
- Koske, I., I. Wanner, R. Bitetti, and O. Barbiero. 2015. “The 2013 Update of the OECD Product Market Regulation Indicators: Policy Insights for OECD and Non-OECD Countries.” OECD Economics Department Working Paper No. 1200.
- Nicoletti, G., and S. Scarpetta. 2003. “Regulation, Productivity and Growth: OECD Evidence.” *Economic Policy* 18 (36): 9–72.
- Organisation for Economic Co-operation and Development (OECD). 2016. “Economic Policy Reforms: Going for Growth.” Report.
- Peters, R., and L. Taylor. 2017. “Intangible Capital and the Investment-q Relation.” *Journal of Financial Economics* 123 (2): 251–72.
- Ramey, G., and V. Ramey. 1995. “Cross-Country Evidence on the Link between Volatility and Growth.” *American Economic Review* 85 (5): 1138–51.
- Reinhart, C., and K. Rogoff. 2009. “The Aftermath of Financial Crises.” *American Economic Review* 99 (2): 466–72.
- Romer, C., and D. Romer. 2017. “New Evidence on the Aftermath of Financial Crises in Advanced Countries.” *American Economic Review* 107 (10): 3072–118.

- Siemer, M. 2019. "Employment Effects of Financial Constraints during the Great Recession." *Review of Economics and Statistics* 101 (1): 16–29.
- Wooldridge, J. M. 2009. "On Estimating Firm-level Production Functions Using Proxy Variables to Control for Unobservables." *Economics Letters* 104 (3): 112–14.