Global Research Unit Working Paper #2020-032

Inflation Anchoring and Growth: The Role of Credit Constraints

Sangyup Choi, Yonsei University
Davide Furceri, IMF
Prakash Loungani, IMF
Myungkyu Shim, Yonsei University

香港城市大學
City University of Hong Kong
專業 創新 胸懷全球
Professional · Creative For The World
城大商學院
College of Business
CITY UNIVERSITY OF HONG KONG
Department of ECONOMICS & FINANCE

Inflation Anchoring and Growth: The Role of Credit Constraints*

Sangyup Choi† Davide Furceri‡ Prakash Loungani• Myungkyu Shim◊

Yonsei University IMF IMF Yonsei University

December 2020

Abstract

Can inflation anchoring foster growth? To answer this question, we use panel data on sectoral growth for 22 manufacturing industries from 36 advanced and emerging market economies over 1990–2014 and employ a difference-in-difference strategy based on the theoretical prediction that higher inflation uncertainty particularly depresses investment in industries that are more credit constrained. Industries characterized by high external financial dependence, liquidity needs, and R&D intensity, and low asset tangibility, tend to grow faster in countries with well-anchored inflation expectations. The results, based on an IV approach—using indicators of monetary policy transparency and central bank independence as instruments—confirm our findings.

Keywords: industry growth; inflation anchoring; inflation forecasts; credit constraints; difference-in-difference; central bank independence.

JEL codes: E52; E63; O11; O43; O47.

---

* Comments from editor Keith Kuester and two anonymous referees substantially improved the paper. We are also grateful to Yuriy Gorodnichenko, Raja Junankar, Jun Il Kim, Ksenia Koloskova, Grace Bin Li, Marc Schiffbauer, Chansik Yoon, Bok-Keun Yu, Carlos Vegh, Guillermo Vuletin, Tim Willems, and the seminar participants at the Bank of Korea. Junhyeok Shin and Seung Yong Yoo provided excellent research assistance. This paper was supported in part through a research project on macroeconomic policy in low-income countries with the U.K.'s Department for International Development (DFID). The views expressed in this paper are those of the authors and should not be reported as representing the views of the IMF or DFID. This work was supported (in part) by the Yonsei University Future-leading Research Initiative of 2019 (2019-22-0218). Any remaining errors are the authors' sole responsibility.

† School of Economics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, South Korea. Email address: sangyupchoi@yonsei.ac.kr.

‡ International Monetary Fund, 700 19th Street NW, Washington, DC 20431 Email address: dfurceri@imf.org.

• International Monetary Fund, 700 19th Street NW, Washington, DC 20431 Email address: ploungani@imf.org.

◊ School of Economics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, South Korea. Email address: myungkyushim@yonsei.ac.kr.

"*The extent to which inflation expectations are anchored has first-order implications for the performance…of the economy.*" (Ben Bernanke, July 10, 2007)

"*To the extent that a monetary authority can build a reputation and gain credibility for low inflation, it…produces tangible economic benefits.*" (Charles Plosser, April 10, 2007)

I. INTRODUCTION

Central bankers often assert that low and stable inflation fosters macroeconomic stability and growth. Former Fed chair Paul Volcker stated, "Inflation feeds in part on itself, so part of the job of returning to a more stable and more productive economy must be to break the grip of inflationary expectations" (Paul Volcker, statement before the Joint Economic Committee of the U.S. Congress, October 17, 1979). The important role of inflation expectations has led many central banks around the world to improve the transparency of their goals, often explicitly, through the adoption of an inflation target (IT) and better communication with the public.[1]

This view is underpinned by a large body of theoretical literature suggesting that inflation uncertainty makes it difficult for firms to plan (Fischer and Modigliani, 1978; Baldwin and Ruback, 1986; Huizinga, 1993). Thus, firms may reduce or delay investment when uncertainty about future prices is high.[2] While it is well established that heightened uncertainty can slow down the long-run growth of the economy via credit constraints (Aghion et al., 2010, 2014),[3] this distortion can be particularly acute in the case of inflation uncertainty.

[1] For earlier discussions of the stabilizing effect of inflation targeting, see Bernanke et al. (1999), Ball and Sheridan (2004), Mishkin (2000), and Gonçalves and Salles (2008).

[2] For example, Baldwin and Ruback (1986) showed that higher uncertainty about future relative prices increases short-term investment relative to long-term investment, which is similar to the mechanism suggested in Aghion et al. (2010, 2014)

[3] Aghion et al. (2010) developed a theoretical framework that supports credit frictions as a key channel through which uncertainty affects long-run growth. In their theory, firms can invest either in short-term projects or in productivity-enhancing longer-term projects subject to liquidity risk. If credit constraints bind only during periods of contractions, reducing the volatility of aggregate shocks via countercyclical fiscal policy increases the likelihood that long-term projects survive liquidity shocks in the bad state without affecting what happens in the good state (when credit constraints are not binding).

To the extent that most financial contracts are written in nominal terms without effective hedging instruments available, inflation uncertainty can affect a firm's borrowing costs directly.

Higher inflation uncertainty implies a higher likelihood of unexpected inflation in the future, which would arbitrarily redistribute the wealth between savers and borrowers who agree on nominal financial contracts, thereby preventing effective financial intermediation. This adverse effect is likely to be particularly detrimental for firms that heavily rely on external finance (i.e., are credit-constrained).[4] We formalize this intuition by building a simple model and test its theoretical predictions using a cross-country dataset on industry growth, a country-level proxy for inflation uncertainty (i.e., the degree of inflation anchoring), and several industry-level measures of credit constraints.

Several authors have tried to demonstrate the benefits of low inflation or inflation volatility in promoting growth. For example, Fischer (1993) and Barro (1996) used cross-section and panel data for a large sample of countries to show that very high inflation was detrimental to growth, after controlling for other factors, over the period 1960–1990. However, other authors have found it difficult to demonstrate such impacts—particularly in more recent decades, when inflation rates have been lower than in the 1970s and 1980s—or have found the evidence to be fragile. For example, using an extreme bounds analysis, Levine and Renelt (1992) concluded that inflation variables are not robustly correlated with growth. Judson and Orphanides (1999) concluded that "the empirical evidence documenting the benefits of low inflation is not very persuasive."

The main challenge in identifying a link between inflation and growth using aggregate data is that it is very difficult to control for all possible factors that are correlated with inflation

[4] Inflation uncertainty can also reduce investment by increasing the firm's opportunity cost of holding cash. For example, Berentsen et al. (2012) explored the opportunity cost of holding cash, R&D investment, and growth, based on a money search model where liquidity is essential for investing in innovative investments. Chu and Cozzi (2014) analyzed the effect of price uncertainty on economic growth in a Schumpterian model with a cash-in-advance requirement on R&D investment. Recently, Evers et al. (2020) presented a model with financial frictions where inflation increases the cost of holding liquid assets to hedge risky production against expenditure shocks, and they tested this prediction using a large firm-level dataset from developing economies. However, Dotsey and Sarte (2000) showed that in a model where money is introduced via a cash-in-advance constraint, inflation uncertainty has a positive effect on growth via a precautionary savings motive, while the level of inflation reduces growth.

(or inflation volatility) and that may, at the same time, affect growth. Moreover, to the extent to which a rise in inflation raises inflation uncertainty, which again increases the level of inflation (Ball, 1992), disentangling the effect of the level of inflation from that of inflation uncertainty is not a trivial task. The current paper tries to overcome this limitation by using cross-country sectoral (industry-level) data and applying a difference-in-difference (DID) strategy à la Rajan and Zingales (1998). Our theoretical prediction about which industries should benefit more from inflation anchoring (therefore reducing inflation uncertainty) is motivated by Aghion et al. (2010, 2014). Their work suggests that volatility in the economic environment is particularly harmful to growth for those firms and industries that are credit-constrained, as it pushes them toward short-term investment rather than long-term investment that boosts long-run growth.

We build a stylized model where firms borrow from banks to finance their investment, and the central bank has an option for anchoring inflation expectations. In our model, since the debt contract is written in nominal terms, inflation anchoring effectively lowers the nominal interest rate and the borrowing costs in the long run, thereby facilitating the provision of credit and the production of output. This positive effect on growth increases with the degree of financial frictions captured by the share of output that the firm can divert in case of default in the model. In other words, credit constraints amplify the growth-enhancing effect of inflation anchoring.

We test this theoretical prediction by examining the sectoral output growth effect of the interaction between a country's measure of inflation anchoring and sector-specific measures of credit constraints, after controlling for the unobserved country- and sector-specific characteristics. The framework is estimated for an unbalanced panel of 22 manufacturing industries in 36 advanced and emerging market economies over the period 1990–2014. As explained above, we expect credit-constrained industries to have achieved relatively faster growth in countries where inflation expectations are well anchored.

The advantages of a cross-industry analysis are twofold:

- First, we measure the degree of inflation anchoring by the sensitivity of inflation expectations to inflation surprises—a unique time-invariant parameter that varies only across countries. Thus, the country-fixed effect—designed to control for unobserved cross-country heterogeneity in a standard cross-country analysis—would absorb the country-specific inflation anchoring coefficient, which calls for a more disaggregated level of analysis.

- Second, it mitigates concerns about reverse causality. While it is difficult to identify causal effects using aggregate data, it is much more likely that inflation anchoring at the country level affects industry-level outcomes than the other way around. Since we control for country-fixed effects—and therefore for aggregate output—reverse causality in our setup would imply that differences in output across sectors influence inflation anchoring at the aggregate level—which seems implausible. Moreover, our main independent variable is the interaction between the degree of inflation anchoring and industry-specific credit constraints measured by U.S. firm-level data, which makes it even less plausible that causality runs from industry-level growth to this composite variable.[5]

The main finding of our paper is that inflation anchoring fosters growth in industries that are more credit-constrained. Figure 1 summarizes our key finding intuitively. We plot the average value-added growth of each manufacturing industry from 1990 to 2014 against the sensitivity of inflation expectations in response to inflation surprises—our measure of inflation anchoring estimated for each country—after controlling for the initial share of each manufacturing industry.[6] The left panel in Figure 1 plots this relationship only for industries with the below-median level of external financial dependence (i.e., less credit-constrained industries), whereas the right panel plots the relationship only for industries with the above-median level of external financial dependence (i.e., more credit-constrained industries).

[5] Following Rajan and Zingales (1998) and many subsequent works, industry-level indicators capturing the degree of credit constraints are constructed from U.S. firm-level data because U.S. measures of industrial characteristics are assumed to represent technological characteristics in a relatively frictionless environment, thereby serving as a conceptual benchmark for our analysis.

[6] To be more specific, we regress the average value-added growth of an industry i in a country c on the measure of inflation anchoring, a set of industry dummies, and the initial share of the industry i in a country c.

Clearly, only in credit-constrained industries is higher sensitivity (i.e., higher inflation uncertainty) negatively associated with average sectoral growth.[7]

Our empirical analysis contributes to three streams of literature. The first is the long-standing literature on the link between inflation and growth (e.g., Dornbusch and Frenkel, 1973; De Gregorio, 1993; Barro, 1996; Loungani and Sheets, 1997; Judson and Orphanides,1999; López-Villavicencio and Mignon, 2011).[8] The second is the more recent literature on the role of financial frictions in amplifying the effect of uncertainty on growth (e.g., Aghion et al., 2014; Christiano et al., 2014; Choi et al., 2018; Arellano et al., 2019).[9] The third is the literature documenting heterogeneity across industries in terms of their interaction with monetary policy (e.g., Dedola and Lippi, 2005; Peersman and Smets, 2005; Aghion et al., 2015).[10]

The rest of the empirical analysis aims to establish the robustness of this main finding. First, we extend the measure of credit constraints to include liquidity needs, asset tangibility, and R&D intensity, in addition to external financial dependence. These characteristics are widely used as a proxy for credit constraints at the industry level (Braun and Larrain, 2005; Raddatz, 2006; Ilyina and Samaniego, 2011; Aghion et al., 2014). While we confirm the robustness of the key finding using these alternative measures, external financial dependence still appears the most robust predictor of growth differentials. To the extent to which external financial dependence better captures *ex ante* credit constraints relevant for long-term fixed investment than other measures, our empirical findings are consistent with the prediction of the model.

---

[7] The slope coefficients of the left (right) panel are -4.49 and -39.66, and the associated t-statistics using robust standard errors are -0.67 and -3.04, respectively.

[8] See Judson and Orphanides (1999) and the references therein for a more comprehensive review of the literature.

[9] See Bernanke (1983) and Pindyck (1991) for their earlier theoretical contributions to show that that uncertainty increases the real option value of delaying irreversible investment.

[10] For example, Dedola and Lippi (2005) found that the sectoral output response to monetary policy shocks is systematically related to the degree of industry-level credit constraint, including external financial dependence. Aghion et al. (2015) formulated a theoretical framework where countercyclical short-term interest rates relax credit or liquidity constraints and test the theoretical prediction using a similar DID approach to ours.

Second, we disentangle the effect of inflation anchoring from various confounding factors, including the effect of the level of inflation, by explicitly controlling for the interaction between the level of inflation and industry-specific measures of credit constraints. While these two channels tend to be correlated—since low inflation is often achieved by better inflation anchoring (or a low-inflation environment fosters well-anchored inflation expectations as in Ball [1992]), our findings suggest that it is the well-anchored inflation expectations, and not the level of inflation, that is robustly associated with growth.

Third, our main results are also robust to an instrumental variables (IV) approach, using monetary policy transparency and central bank independence as instruments. Although our reduced-form approach in the simple model takes inflation anchoring as a choice variable of the central bank, it is likely achieved via the credibility of the central bank. Thus, instrumenting the inflation anchoring measure using several measures of central bank credibility strengthens the structural interpretation of our findings. Subsample analyses further indicate that our findings are not driven by the inclusion of euro-area countries with a common monetary policy framework during the second half of the sample period or extreme events such as the Global Financial Crisis and its aftermath.

The remainder of the paper is organized as follows. Section II builds a simple model that illustrates the credit constraint channel through which inflation anchoring can affect growth. Section III discusses our DID methodology and describes various data used in the empirical analysis to test the model's theoretical predictions. Section IV presents the main results and the results from a battery of robustness exercises. Section V offers conclusions.

II. INFLATION ANCHORING AND GROWTH: A THEORETICAL CONSIDERATION

What are the channels through which inflation anchoring affects growth? In principle, inflation anchoring reduces uncertainty regarding the future level of inflation so that firms and households can make more informed decisions *ex ante* regarding their investment and consumption (or saving). To the extent that most financial contracts are offered in nominal terms, uncertainty about future inflation translates into uncertainty about borrowing costs. In the presence of credit constraints, the uncertainty about borrowing costs can affect real decisions even if the agents are risk-neutral, and relatively more adversely the investment of firms that are credit-constrained. This mechanism is distinct from the theoretical channels suggested in the earlier literature to explain cross-country evidence on the negative link between growth and inflation, which emphasizes the role of high realized-inflation in amplifying the misallocation of resources in the economy.

In this section, we introduce a simple theoretical model that formally highlights the role of inflation anchoring in reducing *ex ante* inflation uncertainty and its interaction with a firm's credit constraints. Our model shares some similarities with a recent study by Evers et al. (2020), who presented a model with financial frictions where inflation increases the cost of holding liquid assets to hedge risky production against expenditure shocks. As a result, firms are forced to shift their investment from long-term to short-term, resulting in lower productivity growth, which is similar to the mechanism suggested in Aghion et al. (2014). The major deviation of our model from theirs is the inflation information structure and the explicit role of the central bank, to be discussed more in detail further on.

A. Model

We consider an environment where firms need external funds to finance their investment projects with different (idiosyncratic) productivity; banks provide a nominal debt contract to firms, and the central bank chooses whether to commit to inflation anchoring that affects uncertainty about future inflation.[11] To highlight the role of inflation anchoring, we assume the following information structure: each firm is located on an island and does not have any (good) information on the rate of future inflation measured at the aggregate level (the

[11] One possible critique of this assumption is that the central bank might affect inflation expectations of private agents through its reputation or credibility on the monetary policy. For example, see Ball (1992) for the model of monetary policy in which the public does not know the tastes of future policymakers, and thus does not know whether disinflation will occur when the current inflation rate is high. Here, we take a reduced-form approach to simplify our analysis. Inflation anchoring is achieved when the central bank has built sufficient credibility via various policies it has taken. It would be interesting to extend the model by endogenizing the credibility of the central bank and assuming that inflation anchoring is a function of the credibility; however, as long as there is a one-to-one positive relationship between the two variables, the model's prediction would be preserved. Nevertheless, such a critique motivates our instrumental variables approach in the empirical part of the paper.

Lucas Islands model).[12] The central bank can provide information on the rate of inflation either by committing to (i) perfect inflation anchoring or (ii) not committing to anchoring.

As shown later, in our model, committing to perfect inflation anchoring is socially optimal in the sense that it maximizes aggregate output. Nevertheless, we assume that the central bank may not (or cannot) choose inflation anchoring because of some associated costs that we do not explicitly model here. Examples include the lack of central bank credibility or instruments to achieve inflation targeting, political pressures, or constraint by central bank mandates other than price stability.

We assume that there are two periods in this economy. Each firm, denoted by $i \in [0,1]$, takes an investment project that requires a normalized cost in the first periods ($t = 0$), yielding output $y_i > 0$ in the next period ($t = 1$). We interpret y_i as the value-added by the firm i, which can also be interpreted as idiosyncratic productivity of the firm. The firm is assumed to have no internal fund to finance the project; thus, it should rely on external funds provided by banks.[13] We assume that the firm knows its productivity and therefore output, but banks only know the distribution of y_i, denoted by $f(y)$ with support $[\underline{y}, \infty)$, when it offers a debt contract to the firm. We further assume that there is no state-contingent contract, i.e., the asset market is incomplete, which is the source of credit constraints in this economy.

We assume that there is no time discounting for simplicity, therefore, the Fisher equation implies $I = R\Pi^e$ (capital letter indicates the gross rate). We normalize the gross real interest rate, R to one, which is exogenously determined from the perspective of banks. Since there is no state-contingent contract, each firm will face the same gross nominal interest rate, $I = \Pi^e > 1$.[14] The firm is risk-neutral and maximizes dividend payout. Following Gertler and

[12] This assumption might be relaxed by allowing firms to possess partial information on the rate of future inflation. As long as there is an information gap between the firm and the central bank, the firm will rely more on public information provided by the central bank. For example, Svensson (2006) argues that it is more likely that public information (information disseminated by the central bank) is more accurate than private information. Thus, our assumption appears innocuous for our purpose—to highlight the relationship between inflation anchoring and growth.

[13] The model's predictions do not alter when we allow the firms to have a positive net worth to fund the project.

[14] The assumption of a positive nominal interest rate is not crucial here. Our theoretical predictions hold even when we allow zero lower bound of the nominal interest rate.

Kiyotaki (2015), we introduce financial frictions to the economy by allowing the firm to default on the debt.

The dividend payout is $x^{nd} = y_i - I$ if the firm does not default on the debt and $x^d = \lambda y_i$ with $\lambda \in (0,1)$ if the firm declares default. λ denotes the share of output that the firm can divert in case of default, which measures the degree of financial frictions in our model economy. Thus, a larger value of λ implies a higher risk for banks in making loans. One might interpret λ as an auditing cost borne by banks to identify the output of the firm (costly state verification à la Townsend, 1979). It is straightforward to show a threshold level of $\hat{y}$ so that firms with productivity above the threshold will be able to borrow from banks. Formally, $\hat{y} - \mathrm{I} = \lambda\hat{y}$ or equivalently $\hat{y} = \frac{I}{1-\lambda}$. Thus, (gross) output in our model would be determined by the following equation: $Y = \int_{\hat{y}}^{\infty} y f(y) dy$.

The following remark immediately follows from the definition of $\hat{y}$, which is the standard prediction of this class of models:

Remark 1. *In the model economy, the output is lower when (i) banks set a high gross interest rate (I) or (ii) financial frictions (λ) are severe.*

Given that the high interest rate is the result of a high inflation rate in this economy, the above observation is consistent with the theoretical predictions of Evers et al. (2020). One can interpret the firm's problem in our paper as an alternative modeling strategy to Evers et al. (2020) that allows the firm to choose between the basic technology (no investment, in our model) and the advanced technology (positive investment, in our model). As discussed below, we opt for the simplest possible model to describe the theoretical channel, given the lack of industry-level data to distinguish basic and advanced technology.

We now turn to a bank's problem. We assume that there is a risk-neutral representative bank that maximizes its expected profit from the loan contract offered to firms. Let $F(y)$ denote the cumulative density function of the firm's productivity (value-added). From the firm's problem, the bank knows that only a fraction of firms with high productivity, $1 - F(\hat{y})$, will produce. Hence, the profit of the bank would be $\left(1 - F(\hat{y})\right)I$, and the bank's problem is to set I to maximize its profit.

B. Main Predictions

Suppose that the rate of future inflation can take two values; $\Pi^e = \{\Pi^H, \Pi^L\}$ and without loss of generality, assume $\Pi^H > \Pi^L > 1$. To demonstrate the role of inflation anchoring clearly, we consider the following two scenarios:[15]

(i) Without inflation anchoring: the central bank does not provide any reliable information on the rate of future inflation, and the bank knows that the future inflation rate would be either Π^H or Π^L but does not know the probability (or distribution of the rate of inflation).

(ii) Perfect inflation anchoring: the central bank provides credible signals about the rate of future inflation at $\Pi^L < \Pi^* < \Pi^H$ and banks form their expectations at Π^*, accordingly.

We first consider a benchmark case with perfect inflation anchoring. Given its inflation expectation at Π^*, the bank offers a debt contract with the gross nominal interest rate $I = \Pi^*$, the only available option for the bank and the firm. Then $\hat{y}^* = \frac{\Pi^*}{1-\lambda}$ becomes the equilibrium threshold level, and the output of the economy under perfect inflation anchoring would be $Y^* = \int_{\hat{y}^*}^{\infty} y f(y) dy$, where $\hat{y}^* = \frac{\Pi^*}{1-\lambda}$.

In an economy without inflation anchoring, the bank will set either $I = \Pi^H$ or $I = \Pi^L$ by comparing the associated profit in each case. Using the fact that $\hat{y}^H > \hat{y}^L$ from $\hat{y} = \frac{I}{1-\lambda}$ and, therefore, $F(\hat{y}^H) > F(\hat{y}^L)$, the following remark always holds.

Remark 2. *In the model economy without inflation anchoring, banks always set a high nominal interest rate at equilibrium.*

[15] One might generalize our assumption here by allowing the intermediate case with loose inflation anchoring in which banks know the distribution of the future rate of inflation. We do not consider this scenario because it complicates the analysis without providing additional insights.

Proof. It can be shown that $\frac{\Pi^H}{\Pi^L} > \frac{1-F(\hat{y}^H)+F(\underline{y})}{1-F(\hat{y}^L)+F(\underline{y})}$ is the condition for the profit from setting a high interest rate is larger than that from setting a low interest rate. Since $F(\hat{y}^H) > F(\hat{y}^L)$, the right-hand side of the condition is always smaller than 1, implying that the condition is always satisfied when $\Pi^H > \Pi^L$, thus $\frac{\Pi^H}{\Pi^L} > 1$.

The equilibrium level of output in this alternative economy would be $Y^* = \int_{\hat{y}^H}^{\infty} yf(y)dy$, where $\hat{y}^H = \frac{\Pi^H}{1-\lambda}$. We then present the first main prediction of the model.[16]

<u>Proposition 1.</u> Effect of inflation anchoring on growth. *Under the assumptions made above, aggregate output is higher in the economy under perfect inflation anchoring than in the economy without anchoring, as more firms would produce output.*

The above proposition implies that there are growth benefits to anchoring inflation. This is because the bank can set a low interest rate under inflation anchoring so that more firms can finance their investment, thereby boosting the aggregate output. Turning our focus on the role of credit constraints, we obtain the following predictions:

<u>Proposition 2.</u> Effect of credit constraints on growth. *Under the assumptions made, and let $\lambda_c > \lambda_{nc}$, then the following would hold.*

(i) When the central bank commits to full inflation anchoring, the number of firms that produce output increases more in the economy with higher λ.

(ii) Let $\hat{y}_j^*$ and $\hat{y}_j^H$ be the threshold levels in the economy with different degrees of financial frictions ($j = c, nc$). If $\int_{\hat{y}_{nc}^H}^{\hat{y}_c^H} yf(y)dy > \int_{\hat{y}_{nc}^*}^{\hat{y}_c^*} yf(y)dy$ holds, the effect on output is larger in the economy with higher λ.

The first part of Proposition 2 is straightforward. In the economy with higher λ (i.e., λ_c), the changes in the threshold level of productivity, $\hat{y}^H$ to $\hat{y}^*$, are greater than those

[16] Proofs for Proposition 1 and 2 are omitted since they are direct consequences of Remark 1 and 2.

characterized by lower λ (i.e., λ_{nc}). With changes in the interest rate of the same magnitude, more firms can access external financing and produce output. However, more participation of firms does not guarantee a higher output of the economy. We need an additional assumption that $\int_{\hat{y}_{nc}^{H}}^{\hat{y}_c^H} yf(y)dy > \int_{\hat{y}_{nc}^{*}}^{\hat{y}_c^*} yf(y)dy$ to obtain the second part of the above proposition. This assumption requires the property that additional output from the participation of relatively high-productivity firms ($\int_{\hat{y}_{nc}^{H}}^{\hat{y}_c^H} yf(y)dy$) dominates the output from the participation of relatively low-productivity firms ($\int_{\hat{y}_{nc}^{*}}^{\hat{y}_c^*} yf(y)dy$). Under this assumption, the higher the participation of firms with high productivity, the higher the increase in aggregate output in the economy characterized by more severe financial frictions.

Discussion of the model. One might ask whether our assumption of the firm's productivity distribution is too restrictive. Here, we present some evidence supporting our assumption. First, the recent literature on firm size supports the view that there is a granularity in firm size and profit distribution. For example, as is well surveyed by Gabaix (2016), empirical evidence supports the Pareto distribution of a firm's profit (and productivity).[17] Second, the well-known role of superstar firms (Rosen, 1981) is another piece of evidence supporting our assumption about a firm's productivity distribution, which requires sufficient mass on the right side of the distribution.

We further remark on the role of the net worth of the firm. While we are abstracting from the net worth of the firm, it is straightforward that the extended model—where firms are allowed to hold a net worth—reaches the same prediction but the threshold productivity level decreases with a higher net worth. This implies that, similar to Proposition 2, the effect of inflation anchoring on economic growth would be larger in an economy where firms have a lower net worth.

Lastly, we make a cautionary note that the model developed in this section does not aim to explain the behavior of economies whose level of inflation is below its target, which is

[17] About 25% of output is represented by the sales of top 50 firms in the United States. In Korea, about 50% of GDP is produced by the ten biggest business groups.

the case studied in Ehrman (2015). Our model describes a transition from a high-inflation environment with a lack of inflation anchoring to an environment where inflation expectations are well-anchored at a low level (e.g., inflation targeting by both advanced and emerging market economies in the 1990s and 2000s). As discussed theoretically in Ball (1992), inflation uncertainty is less of a concern in a low-inflation environment because the public understands that policymakers do not face a dilemma.[18] Moreover, the recent phenomenon in advanced economies is instead described by relatively well-anchored inflation expectations, so a falling realized inflation does not translate into a marked decline in inflation expectations.[19]

III. Empirical Model and Data

Aghion et al. (2014) confirmed their theoretical prediction—that the higher the fraction of credit-constrained firms are, the larger the positive effect of the stabilization policy—by applying the same DID strategy as we do to international industry-level data from 15 OECD countries. We follow the same approach, but unlike Aghion et al. (2014), who used industry-level data from KLEMS, we use the United Nations Industrial Development Organization (UNIDO) database for both advanced and emerging market economies.

After illustrating an empirical framework, we introduce our measure of inflation anchoring at the country level, then discuss several intrinsic characteristics as a measure of credit constraints at the industry level. Our discussion draws largely from previous studies using similar data and methodology (Braun and Larrain, 2005; Raddatz, 2006; Kroszner et al., 2007; Ilyina and Samaniego, 2011; Samaniego and Sun, 2015).

[18] In contrast, when inflation is high, policymakers face a dilemma: they would prefer to have disinflation but fear the resulting recession. Since the public is aware of such a policy dilemma, the central bank announcement of future monetary policy becomes less credible, which raises uncertainty about future inflation.

[19] In a low-inflation environment, firms' expectations of future inflation do not appear to be substantially affected by either monetary policy announcements or forward guidance (Boneva et al., 2016; Coibion et al., 2020). Using micro-level data from professional forecasts of long-term inflation expectations, Dovern and Kenny (forthcoming) did not find evidence of the central tendency of long-run distribution becoming unanchored.

A. Estimation Framework

To assess the effect of inflation anchoring on long-run growth and identify a relevant transmission channel, we closely follow the methodology proposed by Rajan and Zingales (1998). The following specification is estimated for an unbalanced panel of 36 countries and 22 manufacturing industries:

$$g_{i,c} = \alpha_i + \alpha_c + \delta const_i \times inf_c + \mu y_{i,c}^0 + \varepsilon_{i,c}, \quad (1)$$

where *i* denotes industries and *c* denotes countries. $g_{i,c}$ is a measure of industry growth, which is the average value-added growth from 1990 to 2014; $y_{i,c}^0$ is the initial share of each manufacturing sector *i* of country *c*'s total manufacturing output in 1990; $const_i$ is a measure of credit constraints for industry i, such as external financial dependence; inf_c is our measure of inflation anchoring for country c;[20] α_i and α_c are industry and country fixed effects, respectively.

Following Dell'Ariccia et al. (2009), Equation (1) is estimated using ordinary least squares (OLS)—and standard errors are clustered at the country level—as the inclusion of fixed effects is likely to address the endogeneity concern related to omitted variable bias. Also, reverse causality issues are unlikely. First, since we use the measures of industry characteristics constructed from U.S. firm-level data, it is hard to conceive that sectoral growth in other countries influences a particular industry's intrinsic characteristics. Second, it is also implausible that growth at the sectoral level can influence the aggregate measures of inflation anchoring. Moreover, since we are interested in the interaction effect of country-level inflation anchoring and U.S. industry-level variables, claiming reverse causality is equivalent to arguing that differences in growth across sectors lead to differences in the composite variable—which we believe to be highly unlikely.

However, since industry characteristics are measured using only U.S. firm-level data, one potential problem is that U.S. industry characteristics may not be representative of the whole sample. While this issue is unlikely to be important for advanced economies, extending

[20] A higher sensitivity coefficient means a lower degree of inflation anchoring.

it to emerging market economies requires caution. We do not attempt to use country-specific measures of credit constraints—even if they are available—since they do not necessarily improve the identification of the underlying mechanism. For example, it is still possible that the rapid growth of the textile industry in China relaxes its credit constraints over time, although it is unlikely to affect the credit constraints of the U.S. textile industry. Thus, using country-specific characteristics may exacerbate the reverse causality issue. Nevertheless, following Kroszner et al. (2007), we also use an alternative measure of external financial dependence constructed from non-U.S. firm-level data.

A remaining possible concern in estimating Equation (1) with OLS is that other macroeconomic variables could affect industry growth when interacting with industries' credit constraints, and they are also correlated with our inflation anchoring measure. In this case, our estimates will suffer from an omitted variable bias. For example, this concern could be the case for financial development—the original channel assessed by Rajan and Zingales (1998)—but also for the level of inflation itself or the stance of monetary policy. We address this issue in the subsection devoted to robustness checks.

In the following section, we introduce empirical proxies for the key variables in Equation (1), and discuss how to test the theoretical predictions of the model using these proxies. The key prediction of the model hinges on the interaction between the degree of inflation anchoring at the macro level and the degree of credit constraints at the micro level. We measure inflation anchoring by how well inflation expectations are anchored in response to inflation surprises. We use four alternative measures of credit constraints (external financial dependence, liquidity needs, asset tangibility, and R&D intensity) to capture the comprehensive degree of credit constraints.

B. Measuring Inflation Anchoring

We measure the degree of inflation anchoring by estimating the sensitivity of medium-term inflation expectations in response to short-term inflation surprises using data from 1990 to 2014. This sensitivity captures how well inflation expectations are anchored in the economy, thereby proxying the degree of *ex ante* inflation uncertainty. The idea is straightforward: if inflation expectations are well anchored due to credible monetary policy, medium- or long-term inflation expectations will not change swiftly in response to inflation surprises in the short run. We use survey-based measures of professional forecasters' inflation expectations from Consensus Economics available at different horizons for a large set of countries.[21]

Though easily observable, we do not use the level of inflation or (realized) inflation volatility as a measure of inflation anchoring because they are an *ex post* economic outcome, rather than *ex ante* uncertainty surrounding the economic environment that matters to a firm's decisions. Such an *ex post* measure of inflation anchoring is subject to an endogeneity concern since a higher level of, or volatility in, inflation, can result from poor economic performance. Moreover, given that a firm's investment decision is forward-looking, what matters is the decision expectations about future inflation, not the current level of inflation.

Specifically, we relate changes in future inflation expectations to current inflation forecast errors, in order to estimate the degree of inflation anchoring. In particular, the following equation is estimated for each country *c* in the sample:

$$\Delta\pi^{e}_{c,t+h} = \alpha_c + \beta^{h}_{c}\pi^{news}_{c,t} + \varepsilon_{c,t+h}, \tag{2}$$

where $\Delta\pi^{e}_{c,t+h}$ denotes the first difference in expectations of inflation h years-ahead in the future, and $\pi^{news}_{c,t}$ denotes current inflation forecast errors, defined as the difference between actual inflation and short-term inflation expectations from Consensus Economics formed in the previous period. Equation (2) is estimated with the inclusion of a time trend for each economy in the final sample, which consists of an unbalanced panel of 36 countries with consistent and sufficient data available for both Consensus Economics and UNIDO.

The coefficient β^{h}_{c} captures the degree of anchoring in h-years-ahead inflation expectations, a term usually referred to as "shock anchoring" (Ball and Mazumder, 2011), with a smaller value of the coefficient denoting well-anchored inflation expectations or low uncertainty about future inflation. Our setup is similar to Levine et al. (2004), who estimated the sensitivity of inflation expectations to inflation shocks for measuring the effects of inflation targeting on inflation anchoring, except that we use inflation forecast errors on the right side,

[21] See IMF (2016) for further details on how Consensus Economics forecasts are constructed.

not changes in realized inflation. If a monetary policy is credible, the value of this parameter at a sufficiently far horizon should be close to zero. That is, inflation forecast errors should not lead to changes in medium-term expectations if agents believe that the central bank can counteract any short-term developments to bring inflation back to the target over the medium term.

The quarterly forecast errors are used as a baseline measure of inflation surprises because it is less subject to reverse causality or measurement error than other measures, such as actual changes in inflation or deviations of inflation from its target. The baseline specification is estimated using five-year-ahead inflation expectations for three reasons: (i) inflation expectations at this horizon are a close proxy for central banks' inflation targets so that the parameter $\beta_c^{h=5}$ can be interpreted as the degree to which the headline inflation is linked to the central bank's target—a phenomenon typically referred to as "level anchoring" (Ball and Mazumder, 2011); (ii) medium-term inflation expectations are less correlated with current and lagged inflation, and hence are less subject to problems of multicollinearity and reverse causality; and (iii) this corresponds to the average duration of corporate bond issuance, thereby capturing a relevant planning horizon firms in borrowing decisions.[22] Nevertheless, we use inflation expectations at various horizons and check the sensitivity of the results to alternative horizons.

Table 1 summarizes the final country coverage and the number of industries used in the analysis per country. We do not include the United States in the final sample, as the industrial characteristics are measured from U.S. firm-level data. Given the possibility that inflation anchoring in the United States might influence U.S. firms from different industries in a systematic way, the inclusion of the United States would bias the result.

In Figure 2, we first present the evolution of the left-side (top panel) and right-side (bottom panel) variables in Equation (2) for advanced and emerging market economies. Not surprisingly, changes in inflation expectations have been more volatile at shorter horizons for both groups of countries. Expectations were on a downward path throughout the 1990s in both

[22] We would like to thank an anonymous referee for this suggestion.

advanced and emerging market economies. This trend was particularly strong in emerging market economies. Inflation expectations have been remarkably stable throughout the 2000s in advanced economies, especially at longer horizons, but recently their volatility has somewhat increased. In contrast, for emerging market economies, the volatility of expectations during 2010–14 has been lower than in the previous decade.

Inflation forecast errors have been relatively modest in advanced economies, except for the period of the global financial crisis. These errors were mostly negative in the 1990s, suggesting that realized inflation was generally lower than expected, though it has been close to zero in the 2000s. Since 2011, the median inflation forecast errors in advanced economies have become negative again. In emerging market economies, inflation errors were negative on average in the 1990s and early 2000s, but less so more recently.

In Figure 3, we plot the coefficient of the sensitivity of medium-term inflation expectations estimated in Equation (2) for the final sample of 36 countries used in the analysis. Most coefficients are tightly estimated, and the statistically significant (at 10 percent) coefficients are denoted with a star. While the average of the sensitivity coefficients is 0.03, their standard deviation is 0.04, implying large variations across countries. As shown, there is considerable heterogeneity in the size of the sensitivity among countries, with advanced economies having stronger inflation anchoring than emerging market economies (i.e., smaller coefficients). We will exploit this cross-country variation to identify the link between inflation anchoring and sectoral growth.[23]

C. Measuring Credit Constraints

Finance literature has long pursued a measure of firm-level financial constraints to analyze how they affect a firm's investment, R&D, or cash-holding decisions (e.g., Fazzari et al., 1988; Kaplan and Zingales, 2000; Almeida and Campello, 2007). However, given our focus on the effect of inflation anchoring on industry growth, we employ several widely used measures of credit constraints that are readily available at an industry level. To the extent to

[23] Table A.1 in the Appendix provides the estimates of β_c^h for all available horizons h and country c.

which these measures capture somewhat different aspects of credit constraints, considering multiple measures provides a more reliable result.

External financial dependence. As a baseline measure of credit constraints, we use external financial dependence, which has been widely used in the related literature (for example, Rajan and Zingales, 1998; Braun and Larrain, 2005; Ilyina and Samaniego, 2011). Recently, Aghion et al. (2014) also used external financial dependence as a proxy for industry-level credit constraints and found that industries with a relatively heavier reliance on external financing tend to grow faster in countries with more countercyclical fiscal policies. Testing whether inflation anchoring has a similar stabilizing effect through the credit constraint channel requires examining the role of external financial dependence.

Following Rajan and Zingales (1998), dependence on external financing in each industry is measured, across all U.S. firms in each industry, as the median of the ratio of total capital expenditures minus the current cash flow to total capital expenditures. We use an updated version of this indicator taken from Tong and Wei (2011).[24] Based on the suggestive empirical evidence and the prediction of our model, we expect a positive sign on the interaction term between the degree of external finance and the measure of inflation anchoring.

Liquidity needs. More recently, Raddatz (2006) proposed liquidity needs as a measure of credit constraints and found that financial system development led to a comparatively larger reduction in the volatility of output in sectors with high liquidity needs. While external financial dependence mainly captures a firm’s reliance on external financing for fixed investment (i.e., long-term investment), liquidity needs capture the importance of financing working capital (i.e., short-term investment). Since neither our theoretical model nor the dataset employed in our analysis distinguishes long-term investment from short-term investment, we expect a similar effect of inflation anchoring via the channel of liquidity needs.

Liquidity needs are measured by the ratio of inventories to sales, which captures the fraction of inventory investment that can be typically financed with ongoing revenue. A higher value of this ratio means that a smaller fraction of inventory investment can be financed by

[24] The updated data have been kindly provided by Hui Tong.

ongoing revenue, and represents a higher level of external liquidity needs. We take the liquidity needs indicator from Raddatz (2006), who built a measure of the liquidity needs of different industries using balance sheet data of U.S. public manufacturing firms from Compustat.

Asset tangibility. If inflation anchoring affects industry growth through the credit constraint channel, we should expect that inflation anchoring increases growth more in industries with lower asset tangibility. To the extent to which intangible assets are harder to use as collateral (Hart and Moore, 1994), an industry with less tangible capital tends to be more credit constrained. In the presence of high inflation uncertainty, firms without sufficient collateral are more likely to lose their access to external financial markets than firms that have sufficient tangible assets to be collateralized. We take the asset tangibility indicator from Samaniego and Sun (2015), who updated the values in Braun and Larrain (2005) and Ilyina and Samaniego (2011) using the ratio of fixed assets to total assets from Compustat.

R&D intensity. R&D-intensive industries are comparatively likely to be credit-constrained for several reasons. First, while R&D typically requires large startup investments, the return on it comes with a significant lag. In the meantime, firms may find it difficult to finance their operational costs and be forced to rely on external financing. Second, R&D is an intangible asset that is difficult to collateralize, which also makes it difficult for R&D-intensive firms to raise external financing. This channel is also consistent with most of the empirical evidence suggesting a negative relationship between uncertainty and R&D investment (Goel and Ram, 2001; Czarnitzki and Toole, 2011; Furceri and Jalles, 2019). We adopt the R&D intensity indicator from Samaniego and Sun (2015), who measured R&D intensity as R&D expenditures over total capital expenditure using Compustat data.

We report these measures of credit constraints for 22 manufacturing industries using INDSTAT2 classifications. INDSTAT2 industry classification is similar to that of INDSTAT3 used in recent literature (Braun and Larrain, 2005; Ilyina and Samaniego, 2011) but is available for a longer period and fewer industries.[25] We make some adjustments to the industry measures based on 15the INDSTAT3 classification in the literature. For example, while "manufacture

[25] There are 28 manufacturing industries in INDSTAT3.

of food products and beverages" (ISIC 16) is the first industry in the INDSTAT2 dataset, the INDSTAT3 dataset disaggregates them into "manufacture of food products" (ISIC 311) and "manufacture of beverages" (ISIC 313). Following Choi et al. (2020), we take the weighted average of each measure for ISIC 311 and ISIC 313 to obtain the value for ISIC 16 in this case, using the average share of value-added in the United States as a weight. If two datasets share the same industry, we simply use the values of INDSTAT3. Table A.2 in the Appendix compares the industry classification under INDSTAT2 and INDSTAT3.

Table 2 reports the industry value of four measures of credit constraints. In the following analysis, these measures will be normalized (i.e., zero mean and unit variance) to facilitate the comparison of the size of coefficients across the models. Table 3 shows the correlation matrix among these variables. The correlations among measures of industry credit constraints are intuitive and consistent with what existing theories would predict. For example, as described in Choi et al. (2018), an industry that relies more heavily on external financing also tends to have lower asset tangibility and higher R&D intensity, but the correlation between external financial dependence and asset tangibility is far from perfect. Consistent with Raddatz (2006), the correlation between external financial dependence on fixed investment and external dependence on working capital is low, suggesting that they capture quite different dimensions in credit constraints.

D. Sectoral Growth from the UNIDO Database

As explained earlier, industry-level outcome variables are taken from the UNIDO database. While many existing studies, including Aghion et al. (2014) and Choi et al. (2018), use the KLEMS database in their analysis of advanced economies regarding the effect of higher uncertainty on growth, the UNIDO database allows us to study not only advanced but emerging and developing economies.[26] Extending the analysis to these economies is particularly meaningful for the econometric setup in our analysis.

[26] In addition to the increase in country coverage, UNIDO provides information on more disaggregated manufacturing industries compared to KLEMS.

Although our DID methodology mitigates endogeneity issues by controlling for unobserved heterogeneity and reducing the chance of reverse causality, as discussed in Aghion et al. (2014), successful identification hinges critically on variations in the degree of inflation anchoring across countries. To the extent that the conduct of monetary policy in many emerging market economies suffers from the lack of transparency or independence of their monetary authorities, a study of these economies provides an extra opportunity to study a causal link between inflation anchoring and long-run growth.

Following the practice in the literature, we measure sectoral growth by value-added growth, although similar results are obtained using gross output instead. All nominal variables are deflated by the country-level Consumer Price Index in local currency taken from the World Economic Outlook database. All these variables are reported for 22 manufacturing industries based on the INDSTAT2 2016, ISIC Revision 3.[27] Some countries in UNIDO do not have sufficiently long industry-level data, which likely induces measurement errors. We restrict the sample to those industries with at least 15 years of data on value-added growth.

IV. EMPIRICAL FINDINGS

A. Baseline Results

Table 4 presents the results obtained by estimating Equation (1). The results show the interaction effects of inflation anchoring and various industrial characteristics capturing the credit constraint channel on sectoral growth, together with the convergence coefficient on the initial share of the industry. The main findings are summarized as follows. First, convergence exists strongly, as the coefficient on the initial share is negative and statistically significant at the one percent level. Second, the signs of the interaction terms are consistent with the credit constraint channel.

We find that well-anchored inflation expectations—that is, the low sensitivity of inflation expectations in response to inflation surprises—increases growth more for industries

[27] While the original INDSTAT 2 database includes 23 manufacturing industries, we exclude the "manufacture of recycling" industry due to insufficient observations.

with (i) higher external financial dependence, (ii) higher liquidity needs, (iii) lower asset tangibility, and (iv) higher R&D intensity than other industries. Effects through these four channels are statistically significant at the five percent level. To gauge the magnitude of each channel, we measure differential growth gains from a reduction in the sensitivity coefficient from the 75th to the 25th percentile of the distribution for an industry at the 75th percentile of the distribution compared to the industry at the 25th percentile in their intrinsic characteristics.[28] The magnitude of the interaction effects of inflation anchoring ranges from 0.73 percentage points for asset tangibility to 1.38 percentage points for external financial dependence. For example, the results suggest that the differential growth gains from improving inflation anchoring from the level of the Czech Republic to that of Italy for an industry with severe credit constraints, such as "rubber and plastic products" (i.e., the 75th percentile of external financial dependence), compared to an industry with mild credit constraints, such as "basic metals" (i.e., the 25th percentile of external financial dependence), are 1.38 percentage points. While these magnitudes seem large at first glance, moving from the 75th to the 25th percentile in the sensitivity of inflation expectations implies a quite dramatic enhancement in the credibility of monetary policy, which is unlikely to happen in any individual country over a short period.

B. Robustness Checks and Additional Exercises

Alternative measure of the degree of inflation anchoring. Our baseline measure of inflation anchoring measure is based on the response of medium-term inflation expectations to inflation forecast errors, defined as the difference between actual inflation and short-term inflation expectations. The reasons for using medium-term expectations are that: (i) inflation expectations at the medium-term horizon are a close proxy for central banks' inflation targets so that the parameter β can be interpreted as the degree to which the headline inflation is linked to the central bank's target, a phenomenon typically referred to as "level anchoring" (Ball and Mazumder 2011), and (ii) medium-term inflation expectations are less correlated with current

[28] Since we normalized each of credit constraint indicators, the magnitude of each interaction term is directly comparable.

and lagged inflation and hence are less subject to problems of multicollinearity and reverse causality.

However, in practice, inflation at five-years-ahead might react very little to any current shock (apart from inflation target shock), independent of whether the central bank is capable of anchoring inflation or not.[29] To test the robustness of our findings, we use alternative measures of the degree of inflation anchoring by using: (i) the standard deviation of medium-term inflation expectations themselves, (ii) alternative inflation shocks, defined as the change in short-term inflation, (iii) the squared sensitivity of the medium-term inflation expectations to inflation forecast errors, and (iv) inflation expectations of the short-term horizon (one-year-ahead).

The first alternative is motivated by the fact that agents in a country with well-anchored inflation should expect inflation at five-years-ahead to be equal to the central bank's inflation target with little variation over time. The second alternative guards against the possibility that agents perceive actual inflation changes to be different from inflation forecast errors. The third alternative addresses the concern of how to treat a negative anchoring coefficient. For example, one cannot argue that inflation expectations are more anchored in a country with a negative anchoring coefficient than one with a zero coefficient. The last alternative concerns the relatively small variability in medium-term expectations and uses short-term expectations instead. The correlation between the baseline measure of the degree of inflation anchoring with these alternative measures is 0.23, 0.63, 0.81, and 0.32, respectively.

The results obtained by re-estimating Equation (1) with these alternative measures of inflation anchoring are reported in Table 5. To save space, the coefficient on the initial share—which is always negative and highly statistically significant—and the magnitude of differential gains are omitted. The results based on these specifications largely confirm a statistically significant effect of inflation anchoring on industry growth through credit constraints. All the interaction coefficients are highly statistically significant, except for using the volatility of inflation expectations that has the lowest correlation with the baseline measure. In this case,

[29] We thank an anonymous referee for detailed suggestions for these robustness checks.

the interaction effects are statistically significant only for external financial dependence and R&D intensity.[30]

Alternative growth measure. While value-added growth measures an industry's ability to generate income and contribute to GDP, gross output principally measures overall production at market prices. The difference between gross output and value-added of an industry is intermediate inputs. To the extent that the intensity of intermediate inputs varies across countries within the same industry, our growth measures, based on value-added, might not necessarily give us the same picture as a gross output measure. To check this possibility, we repeat our analysis using the average growth rate of the gross output. Gross output is also deflated using the CPI to obtain real values. Table A.3 confirms that the sign, size, and statistical significance of the interaction effects using gross output are largely similar to those using value-added growth, lending support to our baseline results. The only difference is that the asset tangibility channel is no longer statistically significant.

Subsample analysis. We further test the robustness of our findings to four alternative subsample analyses. First, our findings might have been driven by the extreme event of the global financial crisis and the constrained monetary policy in many advanced economies in the recent period. A sequence of such unconventional events might have changed the role of inflation uncertainty in driving growth. Thus, we investigate the effect of inflation anchoring on industry growth from 1990 to 2007. For this exercise, we re-estimate the degree of inflation anchoring in Equation (2) but using the data from 1990 to 2007 only. These anchoring coefficients are also plotted in Figure 3.[31] Second, inflation expectations were on a downward path throughout the 1990s in both groups, as monetary frameworks were improving and actual

[30] The results are robust when replacing one-year-ahead inflation expectations with two-, three-, and four-years-ahead inflation expectations. To save space, the results are available upon request.

[31] While the anchoring coefficients estimated from the pre-crisis sample are tightly correlated with the those from the full sample (0.83), there are few cases where they diverge from one another significantly (e.g., the United Kingdom and Switzerland).

inflation was falling. This fact alone might have contributed to the findings of this paper. To guard against this possibility, we re-estimate Equation (1) using the post-2000 sample.[32]

Third, our findings might have been driven by a common monetary policy framework adopted in the euro area. Given the same degree of monetary policy credibility, heterogeneous estimates of inflation anchoring in the region might reflect a confounding factor that affects industry growth at the same time. To address this issue, we re-estimate Equation (1) after dropping ten euro-area countries from the sample. Lastly, to the extent to which firms in emerging market economies face more severe borrowing constraints, their growth will be lower regardless of the degree of inflation anchoring. To mitigate this concern, we restrict our analysis to the sample of emerging market economies, thereby exploiting the variation within only this group. As seen from Table 6, the key findings hardly change in each subsample analysis.

Alternative measure of external financial dependence. As noted above, one of the concerns for using the industry-level indicators derived from U.S. firm-level data is that they might not necessarily be a good proxy for credit constraints for industries in emerging market economies. However, even if our industry measures of credit constraints are only imperfectly correlated across countries, the assumption that they are industry-specific would induce an attenuation bias in the main regression coefficient, thereby working against finding any significant results (Raddatz, 2006). Nevertheless, we use an alternative measure of credit constraints taken from Kroszner et al. (2007), which is derived from the firm-level data outside the United States as a robustness check.[33] Table A.4 in the Appendix shows that our results hold even after using the alternative measure.

Uncertainty in the estimates of the degree of inflation anchoring. A possible limitation of the analysis is that our measure of the degree of inflation anchoring is estimated and not directly

[32] In this case, the correlation of the new anchoring coefficients with the original coefficients is 0.75. For this exercise, we include industries with more than 10, not 15, available observations on value-added growth due to the shorter sample period, which explains the increase in the sample size.

[33] Kroszner et al. (2007) constructed a measure of external financial dependence similar to Rajan and Zingales but using the firm-level data from Worldscope for non-crisis countries during the period 1990–1999. The median value across the countries is used.

observable, implying that the uncertainty about the inflation anchoring estimates is not properly considered. This is a crucial problem because some of the inflation anchoring coefficients are statistically insignificant, implying that they cannot be distinguished from zero. To address this concern, (i) we re-estimate Equation (1) using weighted least squares (WLS), with weights given by the reciprocal of the standard error of the estimated sensitivity coefficients; (ii) assigning a value of zero to the insignificant estimates (at the 10 percent significance level); (iii) dropping the insignificant estimates. The results of this exercise are reported in Table 7. The estimated parameters are similar to those in Table 4 with the exception of asset tangibility for case (i), suggesting that the inference in baseline results is not contaminated using a generated regressor.

Confounding factors and omitted variable bias. A possible remaining concern in estimating Equation (1) is that the results could be biased due to the omission of macroeconomic variables affecting industry growth through the credit constraint that is, at the same time, correlated with our measure of inflation anchoring. Thus, we augment Equation (1) by interacting each of the country-specific confounding factors $other_c$ with our credit constraint measures to check whether the inclusion of these confounding factors alters the effect of inflation anchoring on industry growth. The parameter θ in Equation (3) aims to capture this additional interaction effect.

$$g_{i,c} = \alpha_i + \alpha_c + \delta const_i \times inf_c + \theta const_i \times other_c + \mu y_{i,c}^0 + \varepsilon_{i,c}. \tag{3}$$

The first obvious consideration is the level of financial development. To the extent that the lack of developed financial markets weakens the transmission channel of monetary policy, our measure of inflation anchoring might simply capture financial development. Acemoglu and Zilibotti (1997) also claim that low financial development could reduce long-run growth and increase the volatility of the economy. Following much of the literature, we use the average of bank credit to the private sector to GDP (the main variable used in Rajan and Zingales, 1998) between 1990 and 2014 as a measure of financial development.

A second potential variable is the level of inflation. Adding to the earlier literature on the negative relationship between inflation and growth, Evers et al. (2020) recently showed that inflation increases the cost faced by firms holding liquid assets to hedge risky production against expenditure shocks. They argued that inflation tilts firms' technology choice away from innovative activities toward safer but return-dominated ones and therefore reduces long-run growth. To the extent to which high inflation can be both a source and an outcome of failed inflation anchoring (Ball, 1992), disentangling the effect of inflation anchoring from the effect of the level of inflation provides further insight on the underlying mechanism. Thus, we explicitly control for the interaction between the level of inflation (the average of the annual CPI inflation between 1990 and 2014) and credit constraint measures.

Third, we control for the size of government, known to be positively correlated with the countercyclicality of fiscal policy (Aghion et al., 2014; Choi et al., 2020), and govern the relationship between output volatility and growth (Fátas and Mihov, 2001; Debrun et al., 2008; Afonso and Furceri, 2010). We measure the government size by the average of government expenditure to GDP between 1990 and 2014.

The fourth candidate we consider is economy-wide growth. If countries with a better monetary policy framework achieve faster economic growth overall, the interaction effect we found earlier might simply pick up different elasticities of industry growth to aggregate growth. To control for the effect of overall growth, we allow the interaction of the average of the annual real GDP growth between 1990 and 2014 with credit constraint measures.

Fifth, we control for output volatility, measured by the volatility of real GDP growth during the sample period. Given the well-known negative relationship between volatility and growth (Ramey and Ramey, 1995), controlling for output volatility is particularly important in identifying the effect of inflation anchoring through the credit constraint channel. Output uncertainty and inflation uncertainty could be systematically related via the Taylor rule. For example, suppose that a central bank is committed to keeping inflation at the target at the expense of any other objective. Then inflation expectations may well be perfectly anchored, but the real output would be more volatile. Such output uncertainty would reduce productive investment, especially in credit-constrained industries, through the mechanism described by Aghion et al. (2010), Aghion et al. (2014), and Choi et al. (2018).

Sixth, monetary policy stance—measured by the cyclicality of the real short-term interest rates—might also capture the stabilizing effect of monetary policy, similar to inflation anchoring. Using industry-level value-added growth from 15 OECD countries over the period 1995–2005, Aghion et al. (2015) found that industries relying heavily on external financing tend to grow faster in countries with a more procyclical real short-term interest rate (i.e., a countercyclical monetary policy). Following Aghion et al. (2015), we measure the cyclicality by the sensitivity of the real short-term interest rate to real GDP growth, controlling for the one-quarter-lagged real short-term interest rate.[34] Among the 36 countries in our sample, we obtain the cyclicality of the real short-term interest rates from 28 countries.

Figure 4 provides correlations between the degree of inflation anchoring and macroeconomic variables that may affect industry growth. Indeed, the level of financial development, the level of inflation, the size of government expenditure, overall growth, output volatility, and the cyclicality of the real short-term interest rates are correlated with the degree of inflation anchoring with the expected signs. A country with well-anchored inflation expectations, on average, tends to have a deeper credit market, a lower level of inflation, a larger government, higher overall growth, lower output volatility, and a more countercyclical monetary policy. The correlations between these six variables and the sensitivity of inflation expectations are -0.19 (0.26), 0.59 (0.01), -0.15 (0.38), -0.16 (0.34), 0.29 (0.09), -0.11 (0.63), respectively. The numbers in parentheses are the associated p-values. As expected, since the correlation is statistically significant for the level of inflation, we pay special attention to whether the inclusion of this confounding factor affects our findings.

Table 8 shows that the significant interaction effects of inflation anchoring and credit constraint measures remain significant in all cases.[35] While the coefficient of the interaction term between the average level of inflation and credit constraint measures is statistically significant with a correct sign for liquidity needs and R&D intensity, its presence hardly

---

[34] We measure the short-term interest rate by the money market rate. Real interest rates are calculated by subtracting the annualized CPI inflation from nominal interest rates. To be comparable to our measure of inflation anchoring, we run the estimation over the period 1990–2014. For euro-zone countries with a common monetary policy since the introduction of the euro, the estimation is only conducted for the pre-euro period.

[35] Table A.5 summarizes the interaction effects of each confounding factor and credit constraint measures without the inflation anchoring variable.

changes our key findings. This result is consistent with the theoretical prediction by Ball (1992) that the increased uncertainty in nominal contracts can be more costly than higher inflation itself. We take this as supporting evidence to distinguish the inflation anchoring channel from the traditional inflation channel.

Lastly, all the aforementioned factors are likely driven by whether a country is an emerging market or advanced economy, as emerging market economies are characterized by faster but more volatile growth, underdeveloped financial markets, higher inflation, and more procyclical policies. As shown in Figure A.1 in the Appendix, it is not surprising that the inflation anchoring coefficients are larger in emerging economies than in advanced economies. Thus, the role of inflation anchoring in explaining growth differentials when interacting with credit constraints might simply capture some inherent characteristics of such economies. To guard against this possibility, we include an interaction variable of credit constraints and an indicator variable denoting whether a country belongs to emerging market economies. Although the statistical significance is somewhat reduced, the results in Column (VII) of Table 8 confirm that our key findings still hold in this case.

Instrumental variables. We further address endogeneity concerns using an IV approach. Specifically, we use the following set of indicators regarding the institutional quality of central banks as instruments: (i) the central bank governor turnover index; (ii) the central bank independence index; and (iii) the central bank transparency index. These indicators are largely exogenous to our dependent variable of industry-level value-added growth, but they are likely correlated with the degree of inflation anchoring since inflation expectations tend to be better anchored in a country with an independent and transparent central bank (Loungani and Sheets, 1997; Crowe and Meade, 2007; Carlstrom and Fuerst, 2009; Park, 2018).

We take the indicators from the dataset constructed by Crowe and Meade (2007), which extends the database of Cukierman et al. (1992). Seeking further exogeneity of our instrumental variables, we use the values of the central bank governor turnover index and the central bank independence index constructed from the institutional data between 1980 and 1989 only, which does not overlap with our main sample period of 1990–2014. Among the 36 countries in our sample, these indicators are jointly available for 25 countries.

Figure 5 plots the correlation between our inflation anchoring coefficients and these measures of central bank institutional quality. Since the adoption of inflation targeting can enhance inflation anchoring, we also include a dummy variable indicating whether a country adopted an inflation-targeting framework by 2000. While the first three variables are strongly correlated with the anchoring coefficients, the inflation targeting dummy is not.[36] Thus, we use the first three variables as an exogenous instrument.

Each of the instruments that vary over countries also interacts with industry credit constraints before entering estimation. This interaction variable is the relevant instrument because the independent variables are themselves interaction variables (Wooldrige, 2010). We proceed with a two-stage least squares (2SLS) approach. We proceed in two steps. In the first step, we regress the degree of inflation anchoring on the three instrumental variables, controlling for the industry- and country-fixed effects.

The results of the first stage in Table 9 confirm that these three instruments can be considered as "strong instruments"—that is, the Cragg-Donald Wald F-statistics are well above the Stock and Yogo (2005) critical values for weak instruments in all cases. Hansen's J statistics for valid instruments are also reported in Table 9. In the second step, we re-estimate Equation (1) using the exogenous part of the degree of inflation anchoring driven by these three instruments—that is, the fitted value of the first step. The results reported in Table 9 confirm that inflation anchoring enhances growth more for industries with heavier external financial dependence and higher R&D intensity, albeit with smaller effects than in the OLS case.

V. CONCLUSIONS

Long-standing literature has sought a causal relationship between inflation and growth. By applying a DID approach to large industry-level panel data for both advanced and emerging

[36] We thank an anonymous referee for considering this possibility. Perhaps these countries adopted inflation targeting because of poor inflation anchoring performance in the past. This possibility will weaken the causal channel from inflation targeting to inflation anchoring in the data. Even if inflation targeting improved inflation anchoring, it would be difficult to observe such a relationship during the sample period in our dataset because we took an average of the data for analysis.

market economies, this paper has examined how the effect of inflation anchoring on growth depends on the industry's intrinsic characteristics capturing credit constraints. Consistent with the theoretical prediction of our model, we find that inflation anchoring fosters industry growth through the credit constraint channel.

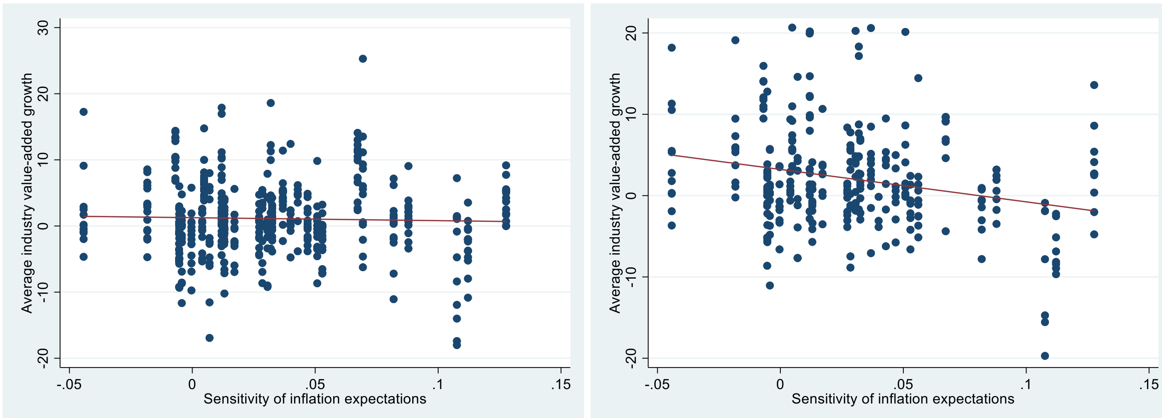
Our results are robust in controlling for the interaction between credit constraints and a broad set of macroeconomic variables, such as financial development, the level of inflation, the size of government, overall economic growth, output volatility, and monetary policy stance. This provides reassurance that the credit constraint channel of inflation anchoring identified in the paper is unlikely to be confounded by other factors found to explain growth differentials in the literature.

Since our findings can answer which kind of industries are expected to benefit more by anchoring inflation expectations, it also sheds light on economy-wide gains from an improved monetary policy framework. For example, improving a monetary policy framework to anchor inflation expectations is expected to be more growth-friendly in an economy with a larger share of credit-constrained industries.

Figures and Tables

Figure 1. Inflation anchoring and industry growth: the role of credit constraints

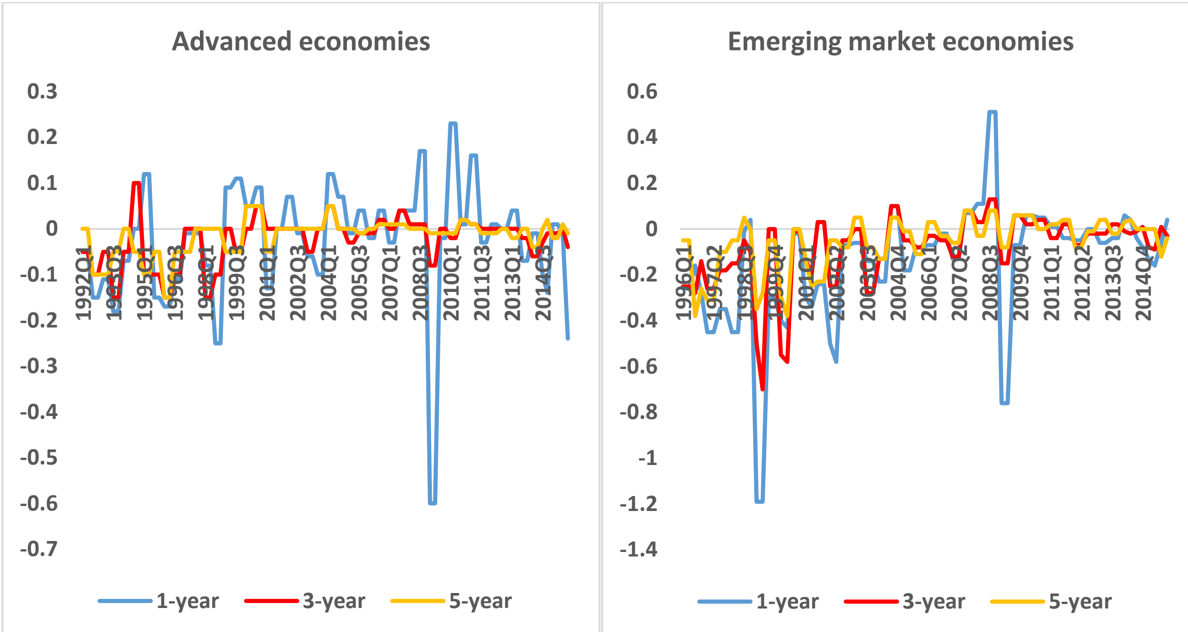
Below-median external financial dependence Above-median external financial dependence



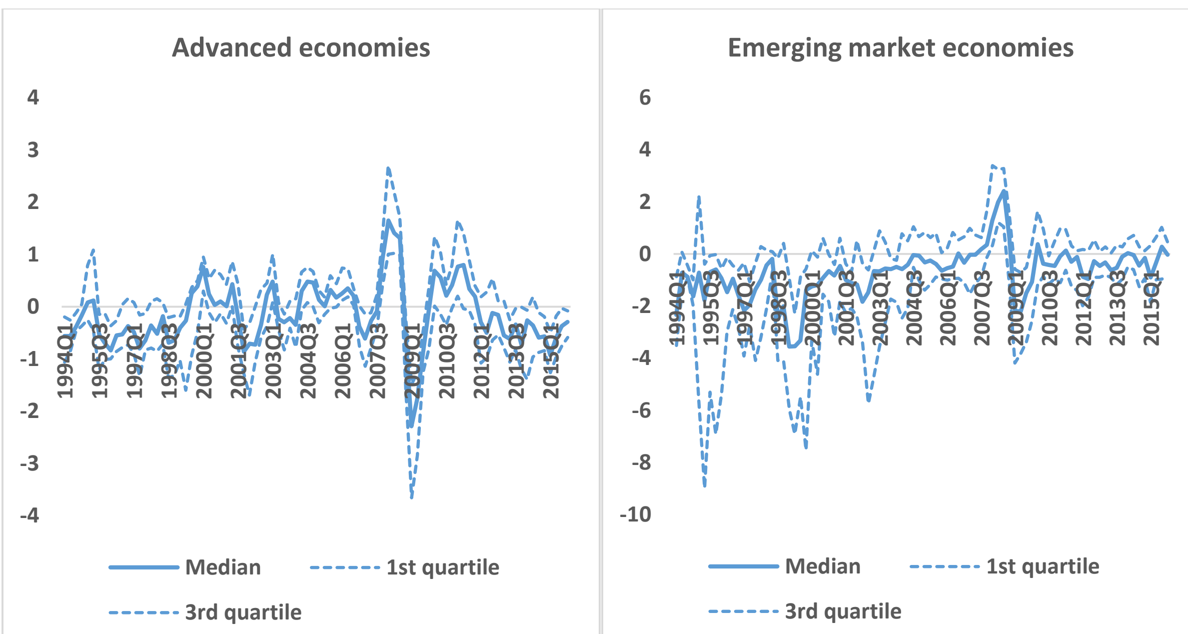
Note: The left (right) panel is the scatter plot of the average real value-added growth for industries with below (above) median external financial dependence against the sensitivity of the medium-term (five-year) inflation expectations in response to inflation surprises, controlling for the initial share of each industry and industry-fixed effects. The slope coefficients of the left (right) panel are -4.49 and -39.66, and the associated t-statistics using robust standard errors are -0.67 and -3.04, respectively.

Figure 2. Changes in inflation expectations and inflation surprises (percentage points)

A) Changes in inflation expectations

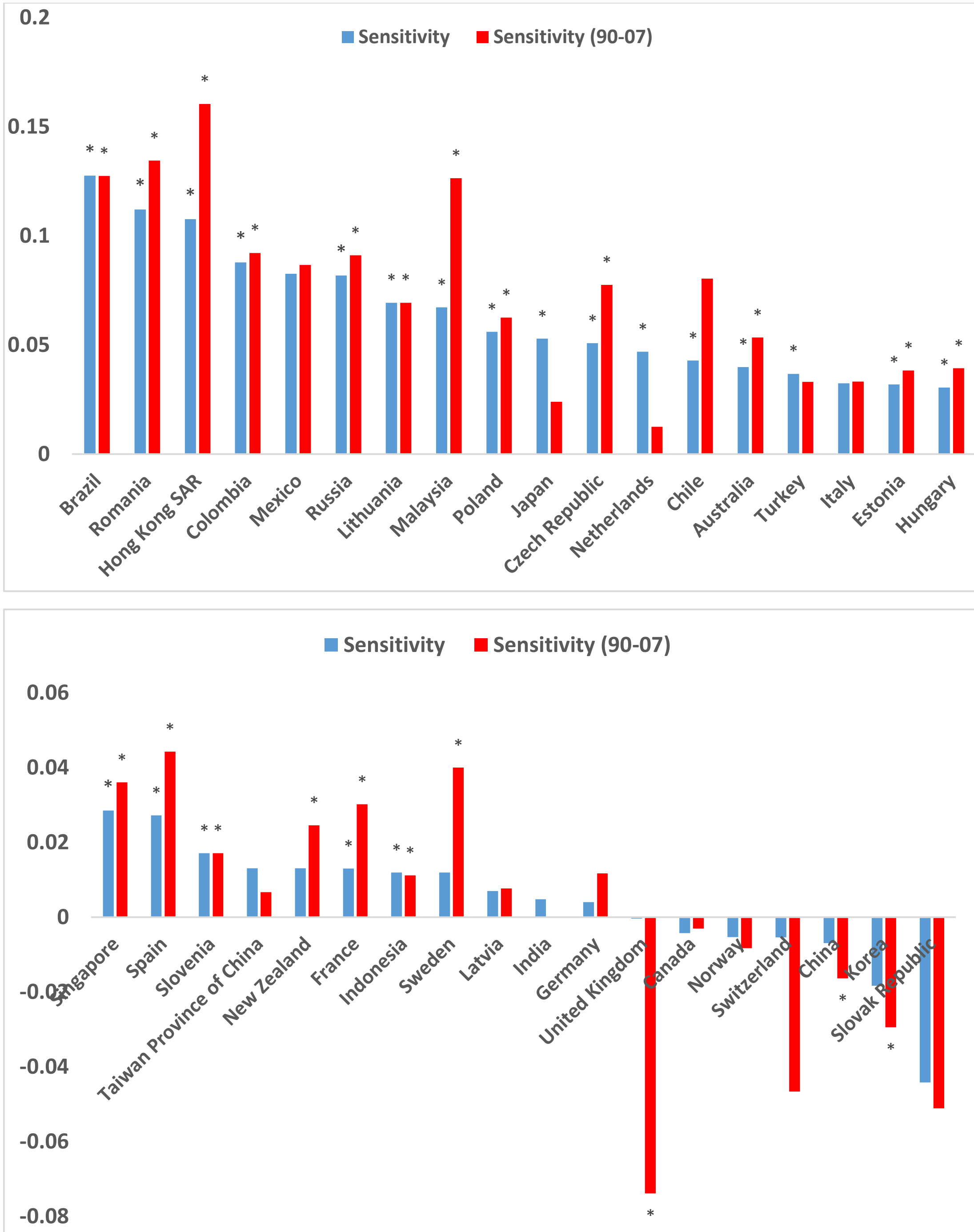


B) Changes in inflation surprises



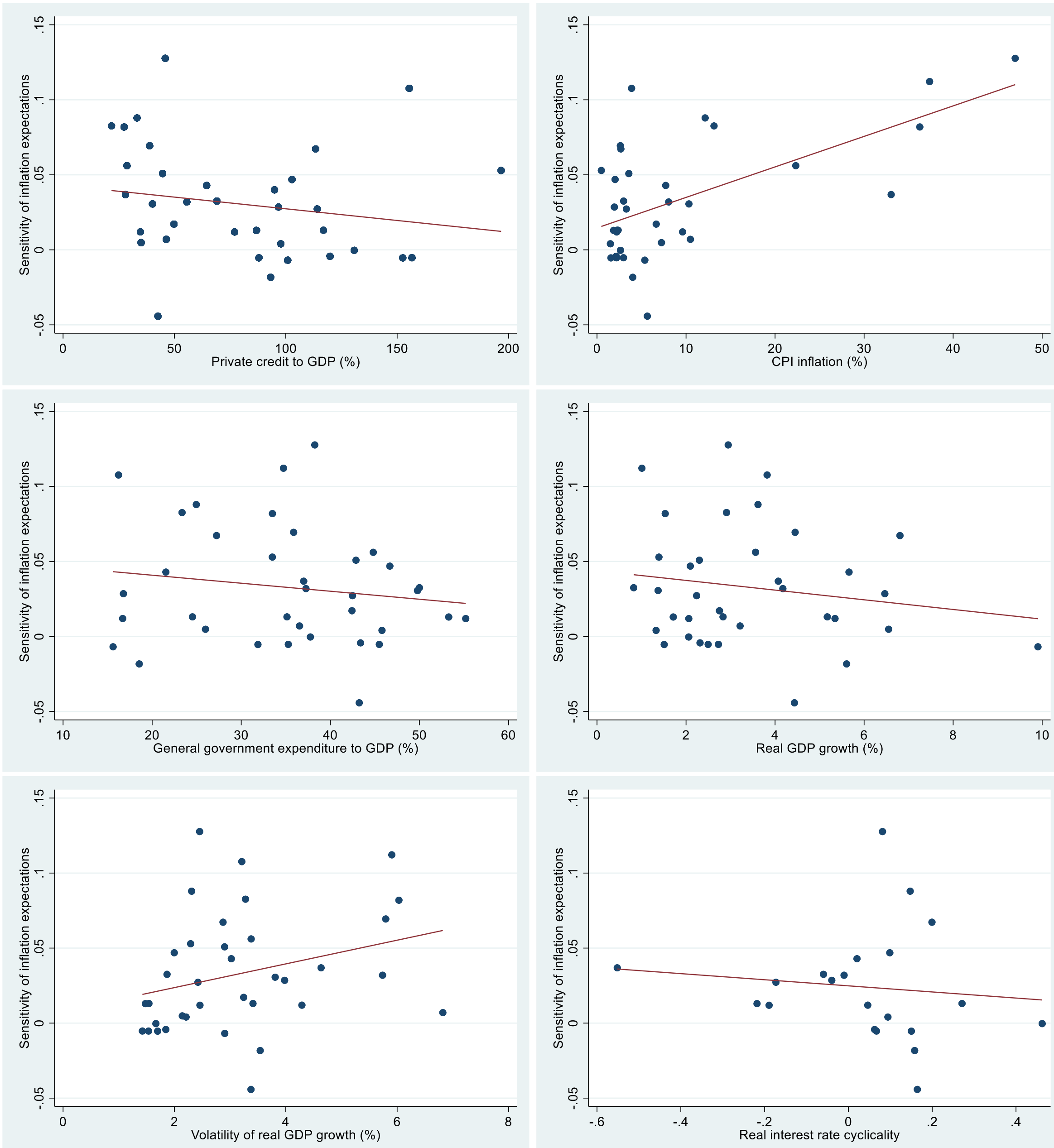
Note: Data used in this figure are quarterly. In the first two panels, the blue, red, and yellow lines denote changes in expectations at 1-, 3-, and 5-year ahead in the future, respectively. In the last two panels, the solid lines denote the median of inflation surprises, and the dotted lines denote their interquartile ranges.

Figure 3. Sensitivity of the medium-term inflation expectations to inflation surprises



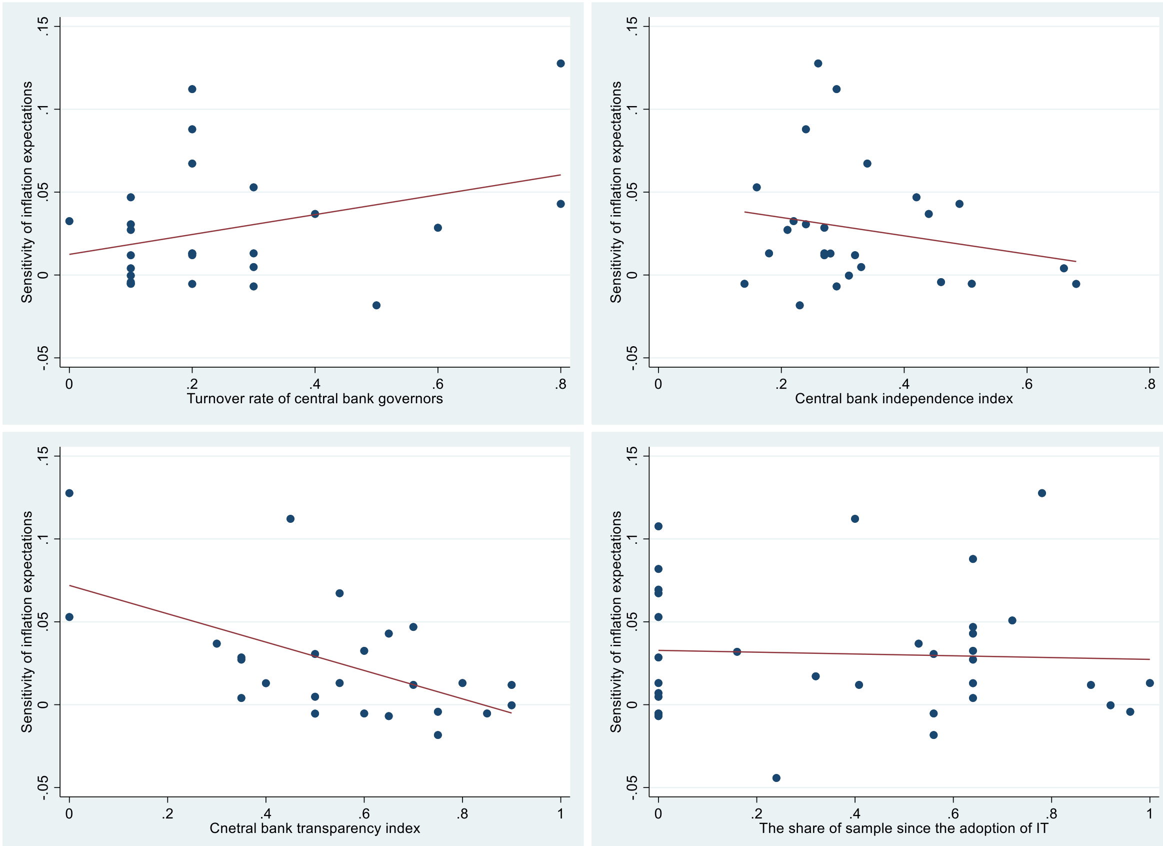
Note: The coefficients from estimating equation (2) using 5-year ahead inflation expectations. * indicates that the estimated coefficient is statistically significant at the 10% level.

Figure 4. Correlations between the sensitivity of inflation expectations and other factors



Note: The correlations between the sensitivity of inflation expectations and the country average of i) private credit to GDP ratio, ii) CPI inflation, iii) general government expenditure to GDP ratio, iv) real GDP growth, v) volatility of real GDP growth, and vi) real interest rate cyclicality are -0.19 (0.26), 0.59 (0.01), -0.15 (0.38), -0.16 (0.34), 0.29 (0.09), -0.11 (0.63), respectively. The numbers in parentheses are the associated p-values.

Figure 5. Correlations between the sensitivity of inflation expectations and other factors



Note: The correlations between the sensitivity of inflation expectations and i) turnover rate of central bank governors, ii) central bank independence index, iii) central bank transparency index, and iv) adoption of inflation targeting are 0.34 (0.08), -0.21 (0.20), -0.57 (0.01), -0.05 (0.78), respectively. The numbers in parentheses are the associated p-values.

Table 1. Country coverage and the number of industries used in the analysis

Country	Number of industries	Inflation targeting adoption	Country	Number of industries	Inflation targeting adoption
Australia	11	1993	Lithuania	18	
Brazil	21	1999	Malaysia	18	
Canada	22	1991	Mexico	16	2001
Chile	12	1999	Netherlands	20	1999
China	18		New Zealand	5	1989
Colombia	18	1999	Norway	21	2001
Czech Republic	18	1997	Poland	22	1998
Estonia	19	2011	Romania	18	2005
France	21	1999	Russia	18	
Germany	20	1999	Singapore	22	
Hong Kong	17		Slovak Republic	20	
Hungary	21	2001	Slovenia	16	2007
India	21		Spain	22	1999
Indonesia	20	2005	Sweden	22	1993
Italy	22	1999	Switzerland	11	
Japan	20		Taiwan	16	
Korea	22	2001	Turkey	22	2006
Latvia	18		United Kingdom	20	1992

Note: Only industries with more than 15 years of data are included in the analysis.

Table 2. Industry-specific intrinsic characteristics

ISIC code	Industry	External financial dependence	Liquidity needs	Asset tangibility	R&D intensity
15	Food products and beverages	0.11	0.10	0.37	0.07
16	Tobacco products	-0.45	0.28	0.19	0.22
17	Textiles	0.19	0.17	0.35	0.14
18	Wearing apparel; dressing and dyeing of fur	0.03	0.21	0.13	0.02
19	Tanning and dressing of leather	-0.14	0.23	0.14	0.18
20	Wood and of products of wood and cork, except furniture	0.28	0.11	0.31	0.03
21	Paper and paper products	0.17	0.13	0.47	0.08
22	Publishing, printing and reproduction of recorded media	0.20	0.07	0.26	0.10
23	Coke, refined petroleum products and nuclear fuel	0.04	0.08	0.55	0.08
24	Chemicals and chemical products	0.50	0.15	0.29	1.18
25	Rubber and plastics products	0.69	0.14	0.37	0.17
26	Other non-metallic mineral products	0.06	0.13	0.46	0.11
27	Basic metals	0.05	0.15	0.40	0.08
28	Fabricated metal products, except machinery and equipment	0.24	0.16	0.27	0.15
29	Machinery and equipment n.e.c.	0.60	0.17	0.20	0.93
30	Office, accounting and computing machinery	0.96	0.20	0.21	0.81
31	Electrical machinery and apparatus n.e.c.	0.95	0.20	0.21	0.81
32	Radio, television and communication equipment and apparatus	0.96	0.20	0.21	0.81
33	Medical, precision and optical instruments, watches and clocks	0.96	0.21	0.18	1.19
34	Motor vehicles, trailers and semi-trailers	0.36	0.18	0.26	0.32
35	Other transport equipment	0.36	0.18	0.26	0.32
36	Furniture; manufacturing n.e.c.	0.37	0.17	0.25	0.21

Note: The index for external financial dependence is taken from Tong and Wei (2011), the index for liquidity needs is taken from Raddatz (2006), and the indices for asset tangibility and R&D intensity are taken from Samaniego and Sun (2015).

Table 3. Correlation matrix of industry-specific characteristics

	External financial dependence	Liquidity needs	Asset tangibility	R&D intensity
External financial dependence	1			
Liquidity needs	0.04 (0.86)	1		
Asset tangibility	-0.26 (0.24)	-0.68 (0.01)	1	
R&D intensity	0.74 (0.01)	0.33 (0.13)	-0.43 (0.04)	1

Note: The index for external financial dependence is taken from Tong and Wei (2011), the index for liquidity needs is taken from Raddatz (2006), and the indices for asset tangibility and R&D intensity are taken from Samaniego and Sun (2015). The numbers in parentheses are the associated p-values.

Table 4. The effect of inflation anchoring on industry growth: baseline

Explanatory variable	(I)	(II)	(III)	(IV)
Initial share	-0.926***	-0.904***	-0.905***	-0.944***
	(0.287)	(0.297)	(0.297)	(0.291)
External financial dependence *Inflation anchoring	-17.468***			
	(4.357)			
Liquidity needs *Inflation anchoring		-10.399**		
		(3.866)		
Asset tangibility *Inflation anchoring			9.429**	
			(3.502)	
R&D intensity *Inflation anchoring				-13.653***
				(3.783)
Magnitude of differential effects	1.12	0.61	-0.53	1.01
Observations	668	668	668	668
R-squared	0.60	0.60	0.59	0.59

Note: The dependent variable is the average annual growth rate in real value-added from 1990 to 2014 for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively. Differential effects are computed as the change in inflation anchoring from the 75th percentile (i.e., higher sensitivity) to the 25th percentile (i.e., lower sensitivity) of the cross-country distribution between a sector with high external financial dependence (at the 75th percentile of the distribution) and a sector with low external financial dependence (at the 25th percentile of the distribution).

Table 5. The effect of inflation anchoring on industry growth: using alternative measures of inflation anchoring

Explanatory variable	(I) Volatility of five-years-ahead inflation expectations	(II) Using actual changes in inflation	(III) Squared inflation anchoring coefficients	(IV) Using short-term inflation expectations
External financial dependence *Inflation anchoring	-0.140***	-13.228***	-178.59***	-2.256***
	(0.046)	(3.956)	(47.489)	(0.665)
Liquidity needs *Inflation anchoring	-0.019	-7.421**	-95.975**	-1.777***
	(0.042)	(2.828)	(44.864)	(0.339)
Asset tangibility *Inflation anchoring	0.027	6.738**	105.374***	1.806***
	(0.057)	(2.798)	(36.255)	(0.447)
R&D intensity *Inflation anchoring	-0.175***	-10.691***	-151.277***	-1.770***
	(0.046)	(3.378)	(34.950)	(0.860)
Observations	668	668	668	668

Note: The dependent variable is the average annual growth rate in real value-added from 1990 to 2014 for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively.

Table 6. The effect of inflation anchoring on industry growth: subsample analysis

Explanatory variable	(I) Pre-GFC sample only	(II) Post-2000 sample only	(III) EME sample only	(IV) Non-euro area sample only
External financial dependence *Inflation anchoring	-14.530***	-20.759**	-16.640**	-15.949***
	(4.330)	(9.014)	(6.992)	(4.130)
Liquidity needs *Inflation anchoring	-10.917***	-6.544	-11.740**	-9.577**
	(3.494)	(8.328)	(4.801)	(4.005)
Asset tangibility *Inflation anchoring	7.513**	11.922**	12.295***	8.135**
	(3.162)	(6.780)	(3.759)	(3.411)
R&D intensity *Inflation anchoring	-11.775***	-21.445**	-19.075**	-14.994***
	(3.862)	(9.114)	(6.889)	(4.116)
Observations	421	767	266	454

Note: The dependent variable is the average annual growth rate in real value-added during the corresponding subsample for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively.

Table 7. The effect of inflation anchoring on industry growth: accounting for uncertainty in inflation anchoring measures

Explanatory variable	(I) Weighted Least Squares	(II) Assigning zero to insignificant coefficients	(III) Dropping insignificant coefficients
External financial dependence *Inflation anchoring	-10.463**	-18.950***	-29.293***
	(4.853)	(4.708)	(6.634)
Liquidity needs *Inflation anchoring	-9.495**	-9.968**	-16.243**
	(4.605)	(4.125)	(6.555)
Asset tangibility *Inflation anchoring	5.149	10.289***	16.514***
	(5.080)	(3.595)	(4.709)
R&D intensity *Inflation anchoring	-8.609**	-14.873***	-25.050***
	(4.201)	(4.043)	(5.800)
Observations	668	668	408

Note: The dependent variable is the average annual growth rate in real value-added from 1990 to 2014 for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively.

Table 8. The effect of inflation anchoring on industry growth: controlling for confounding factors

Explanatory variable	(I) Financial development	(II) Level of inflation	(III) Government size	(IV) Aggregate growth	(V) Aggregate volatility	(VI) Monetary policy stance	(VII) Emerging markets
External financial dependence *Inflation anchoring	-19.176***	-19.754***	-16.993***	-19.389***	-20.191***	-18.769***	-15.434**
	(4.708)	(7.172)	(3.867)	(4.592)	(4.851)	(4.141)	(6.181)
Liquidity needs *Inflation anchoring	-12.864***	-16.045***	-10.216***	-10.740**	-11.249**	-11.841**	-10.593**
	(4.232)	(4.896)	(3.374)	(4.157)	(4.294)	(5.597)	(4.331)
Asset tangibility *Inflation anchoring	10.306***	13.816**	8.831***	10.003**	10.693***	10.533**	8.586**
	(3.595)	(4.854)	(3.008)	(3.773)	(3.680)	(4.960)	(3.472)
R&D intensity *Inflation anchoring	-10.940***	-9.140**	-13.177***	-14.305***	-14.426***	-15.984***	-10.509***
	(3.520)	(4.277)	(3.955)	(3.727)	(3.723)	(2.990)	(3.974)
External financial dependence *Confounding factor	-0.012*	0.010	0.047**	-0.161**	0.292**	0.519	-0.340
	(0.006)	(0.019)	(0.017)	(0.074)	(0.132)	(0.425)	(0.567)
Liquidity needs * Confounding factor	0.005	0.026*	0.021	-0.027	0.092	-0.168	0.034
	(0.004)	(0.016)	(0.015)	(0.065)	(0.123)	(0.596)	(0.393)
Asset tangibility * Confounding factor	0.007*	-0.022	-0.024*	0.055	-0.147	0.248	0.149
	(0.004)	(0.015)	(0.013)	(0.070)	(0.112)	(0.548)	(0.327)
R&D intensity * Confounding factor	-0.003	-0.022*	0.016	-0.061	0.087	0.589**	-0.545
	(0.004)	(0.013)	(0.015)	(0.077)	(0.096)	(0.253)	(0.398)
Observations	650	668	668	668	668	415	668

Note: The dependent variable is the average annual growth rate in real value-added from 1990 to 2014 for each industry-country pair. Estimates are based on equation (3). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively.

Table 9. The effect of inflation anchoring on industry growth: IV regression

Explanatory variable	(I)	(II)	(III)	(IV)
Initial share	-0.938***	-0.904***	-0.905***	-0.944***
	(0.228)	(0.297)	(0.297)	(0.291)
External financial dependence *Inflation anchoring	-11.030**			
	(4.712)			
Liquidity needs *Inflation anchoring		2.885		
		(5.266)		
Asset tangibility *Inflation anchoring			-5.918	
			(8.860)	
R&D intensity *Inflation anchoring				-10.719*
				(5.423)
Cragg-Donald Wald F-statistic	105.253	101.591	94.842	97.564
Stock-Yogo weak identification test 5% critical values	13.91	13.91	13.91	13.91
Hansen J-statistic p-value	0.177	0.682	0.757	0.343
Observations	428	428	428	428

Note: The dependent variable is the average annual growth rate in real value-added from 1990 to 2014 for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively. Differential effects are computed as the change in inflation anchoring from the 75th percentile (i.e., higher sensitivity) to the 25th percentile (i.e., lower sensitivity) of the cross-country distribution between a sector with high external financial dependence (at the 75th percentile of the distribution) and a sector with low external financial dependence (at the 25th percentile of the distribution).

References

Acemoglu, Daron, and Fabrizio Zilibotti. "Was Prometheus unbound by chance? Risk, diversification, and growth." Journal of Political Economy 105.4 (1997): 709-751.

Afonso, Antonio, and Davide Furceri. "Government size, composition, volatility and economic growth." European Journal of Political Economy 26.4 (2010): 517-532.

Aghion, Philippe, George-Marios Angeletos, Abhijit Banerjee, and Kalina Manova. "Volatility and growth: Credit constraints and the composition of investment." Journal of Monetary Economics 57, no. 3 (2010): 246-265.

Aghion, Philippe, David Hemous, and Enisse Kharroubi (2014), "Cyclical fiscal policy, credit constraints, and industry growth." Journal of Monetary Economics 62, 41-58.

Aghion, Philippe, Emmanuel Farhi, and Enisse Kharroubi. "Liquidity and growth: the role of counter-cyclical interest rates." Working Paper (2015).

Almeida, Heitor, and Murillo Campello. "Financial constraints, asset tangibility, and corporate investment." Review of Financial Studies 20, no. 5 (2007): 1429-1460.

Arellano, Cristina, Yan Bai, and Patrick J. Kehoe. "Financial frictions and fluctuations in volatility." Journal of Political Economy 127, no. 5 (2019): 2049-2103.

Baldwin, Carliss Y., and Richard S. Ruback. "Inflation, uncertainty, and investment." Journal of Finance 41.3 (1986): 657-668.

Ball, Laurence. "Why does high inflation raise inflation uncertainty?" Journal of Monetary Economics 29, no. 3 (1992): 371-388.

Ball, Laurence M., and Niamh Sheridan. "Does inflation targeting matter?" In The inflation-targeting debate, pp. 249-282. University of Chicago Press, 2004.

Ball, Laurence and Sandeep Mazumder. "Inflation Dynamics and the Great Recession." Brookings Papers on Economic Activity (2011): 337-405.

Barro, Robert J. "Inflation and growth." Review-Federal Reserve Bank of Saint Louis 78 (1996): 153-169.

Berentsen, A., M. Rojas Breu, and S. Shi (2012): "Liquidity, innovation and growth." Journal of Monetary Economics, 59(8), 721-737.

Bernanke, Ben S., Thomas Laubach, Frederic S. Mishkin, and Adam S. Posen. "Inflation targeting: lessons from the international experience" Princeton University Press, 1999.

Bernanke, Ben. "Irreversibility, uncertainty, and cyclical investment." Quarterly Journal of Economics, Vol. 97, No. 1, (1983), pp. 85-106.

Boneva, Lena, James Cloyne, Martin Weale, and Tomasz Wieladek. "The effect of unconventional monetary policy on inflation expectations: evidence from firms in the United Kingdom." International Journal of Central Banking 12, no. 3 (2016): 161-195.

Braun, Matias, and Borja Larrain (2005), "Finance and the business cycle: international, inter-industry evidence." Journal of Finance 60(3), 1097-1128.

Carlstrom, Charles T., and Timothy S. Fuerst. "Central bank independence and inflation: A note." Economic Inquiry 47, no. 1 (2009): 182-186.

Choi, Sangyup, Davide Furceri, and João Tovar Jalles. "Heterogenous Gains from Countercyclical Fiscal Policy: New Evidence from International Industry-level Data." Yonsei University Working Paper. 2020.

Choi, Sangyup, Davide Furceri, Yi Huang, and Prakash Loungani. "Aggregate uncertainty and sectoral productivity growth: The role of credit constraints." Journal of International Money and Finance 88 (2018): 314-330.

Christiano, Lawrence J., Roberto Motto, and Massimo Rostagno. "Risk shocks." American Economic Review 104.1 (2014): 27-65.

Chu, A. C., and G. Cozzi (2014): "R&D and Economic Growth in a Cash-in-Advance Economy," International Economic Review, 55, 507-524.

Coibion, Olivier, Yuriy Gorodnichenko, Saten Kumar, and Mathieu Pedemonte. "Inflation expectations as a policy tool?" Journal of International Economics (2020): 103297.

Crowe, Christopher, and Ellen E. Meade. "The evolution of central bank governance around the world." Journal of Economic Perspectives 21.4 (2007): 69-90.

Cukierman, Alex, Steven B. Web, and Bilin Neyapti. "Measuring the independence of central banks and its effect on policy outcomes." World Bank Economic Review 6, no. 3 (1992): 353-398.

Czarnitzki, Dirk, and Andrew A. Toole (2011), "Patent protection, market uncertainty, and R&D investment." Review of Economics and Statistics 93(1), 147-159.

De Gregorio, Jose. "Inflation, taxation, and long-run growth." Journal of Monetary Economics 31.3 (1993): 271-298.

Debrun, Xavier, Jean Pisani-Ferry, and Andre Sapir. "Government Size and Output Volatility: Should We Forsake Automatic Stabilization?" IMF Working Paper (2008): 1-53.

Dedola, Luca, and Francesco Lippi. "The monetary transmission mechanism: evidence from the industries of five OECD countries." European Economic Review 49.6 (2005): 1543-1569.

Dell'Ariccia, Giovanni, Enrica Detragiache, and Raghuram Rajan. "The real effect of banking crises." Journal of Financial Intermediation 17.1 (2008): 89-112.

Dornbusch, Rudiger, and Jacob A. Frenkel. "Inflation and growth: alternative approaches." Journal of Money, Credit and Banking 5.1 (1973): 141-156.

Dotsey, Michael and Pierre-Daniel Sarte, "Inflation Uncertainty and Growth in a Cash-in-Advance Economy." Journal of Monetary Economics, 2000, 45 (3), 631–655.

Dovern, Jonas, and Geoff Kenny. "Anchoring inflation expectations in unconventional times: Micro evidence for the euro area." International Journal of Central Banking (forthcoming).

Ehrmann, Michael. "Targeting Inflation from Below: How Do Inflation Expectations Behave?" International Journal of Central Banking 11, no. 4 (2015): 213-249.

Evers, Michael, Stefan Niemann, and Marc Schiffbauer. "Inflation, liquidity and innovation." European Economic Review 128 (2020): 103506.

Fatás, Antonio, and Ilian Mihov. "Government size and automatic stabilizers: international and intranational evidence." Journal of International Economics 55.1 (2001): 3-28.

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Petersen. "Financing Constraints and Corporate Investment." Brookings Papers on Economic Activity 19, no. 1 (1988): 141-206.

Fischer, Stanley. "The role of macroeconomic factors in growth." Journal of Monetary Economics 32.3 (1993): 485-512.

Fischer, Stanley, and Franco Modigliani. "Towards an understanding of the real effects and costs of inflation." Review of World Economics 114.4 (1978): 810-833.

Furceri Davide and Jalles João Tovar (2019). "Fiscal counter-cyclicality and productive investment: evidence from advanced economies." B.E. Journal of Macroeconomics, De Gruyter, vol. 19(1), pages 1-15, January.

Gertler, Mark, and Nobuhiro Kiyotaki. "Banking, liquidity, and bank runs in an infinite horizon economy." American Economic Review 105, no. 7 (2015): 2011-43.

Goel, Rajeev K., and Rati Ram (2001), "Irreversibility of R&D investment and the adverse effect of uncertainty: Evidence from the OECD countries." Economics Letters 71(2), 287-291.

Gonçalves, Carlos Eduardo S., and João M. Salles. "Inflation targeting in emerging economies: What do the data say?" Journal of Development Economics 85.1-2 (2008): 312-318.

Hart, Oliver, and John Moore (1994), "A theory of debt based on the inalienability of human capital." Quarterly Journal of Economics 109(4), 841-879.

Huizinga, John. “Inflation uncertainty, relative price uncertainty, and investment in US manufacturing.” Journal of Money, Credit and Banking 25.3 (1993): 521-549.

Ilyina, Anna, and Roberto Samaniego. “Technology and financial development.” Journal of Money, Credit and Banking 43.5 (2011): 899-921.

Imbs, Jean. “Growth and volatility.” Journal of Monetary Economics 54.7 (2007): 1848-1862.

IMF (2016), “Global Disinflation in an Era of Constrained Monetary Policy”, World Economic Outlook, Chapter 3, October 2016, International Monetary Fund.

Judson, Ruth, and Athanasios Orphanides. “Inflation, volatility and growth.” International Finance 2.1 (1999): 117-138.

Kaplan, Steven N., and Luigi Zingales. “Investment-cash flow sensitivities are not valid measures of financing constraints.” Quarterly Journal of Economics 115, no. 2 (2000): 707-712.

Kroszner, Randall S., Luc Laeven, and Daniela Klingebiel. “Banking crises, financial dependence, and growth.” Journal of Financial Economics 84, no. 1 (2007): 187-228.

Levin, Andrew T., Fabio M. Natalucci, and Jeremy M. Piger. “The macroeconomic effects of inflation targeting.” Review-Federal Reserve Bank of Saint Louis 86.4 (2004): 51-8.

Levine, Ross, and David Renelt. “A sensitivity analysis of cross-country growth regressions.” American Economic Review (1992): 942-963.

López-Villavicencio, Antonia, and Valérie Mignon. “On the impact of inflation on output growth: Does the level of inflation matter?” Journal of Macroeconomics 33.3 (2011): 455-464.

Loungani, Prakash, and Nathan Sheets. “Central bank independence, inflation, and growth in transition economies.” Journal of Money, Credit, and Banking (1997): 381-399.

Mishkin, Frederic S. “Inflation targeting in emerging-market countries.” American Economic Review 90.2 (2000): 105-109.

Park, Kwangyong. “Central bank credibility and monetary policy.” Bank of Korea Working Paper 45 (2018).

Peersman, Gert, and Frank Smets. “The industry effects of monetary policy in the euro area.” Economic Journal 115, no. 503 (2005): 319-342.

Pindyck, Robert S. “Irreversibility, Uncertainty, and Investment.” Journal of Economic Literature 29.3 (1991): 1110-1148.

Raddatz, Claudio. “Liquidity needs and vulnerability to financial underdevelopment.” Journal of Financial Economics 80 (2006): 677-722.

Rajan, Raghuram and Luigi Zingales (1998), “Financial Dependence and Growth.” American Economic Review, 88 (3), 559-86

Ramey, Garey, and Valerie A. Ramey. “Cross-Country Evidence on the Link Between Volatility and Growth.” American Economic Review (1995): 1138-1151.

Rosen, Sherwin. “The economics of superstars.” American Economic Review 71, no. 5 (1981): 845-858.

Samaniego, Roberto M., and Juliana Y. Sun. “Technology and contractions: Evidence from manufacturing.” European Economic Review 79 (2015): 172-195.

Stock, James H., and Motohiro Yogo. “Testing for Weak Instruments in Linear IV Regression.” Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg (2005)

Svensson, Lars EO. “Social value of public information: Comment: Morris and shin (2002) is actually pro-transparency, not con.” American Economic Review 96, no. 1 (2006): 448-452.

Tong, Hui, and Shang-Jin Wei (2011), “The composition matters: capital inflows and liquidity crunch during a global economic crisis.” Review of Financial Studies 24(6), 2023-2052.

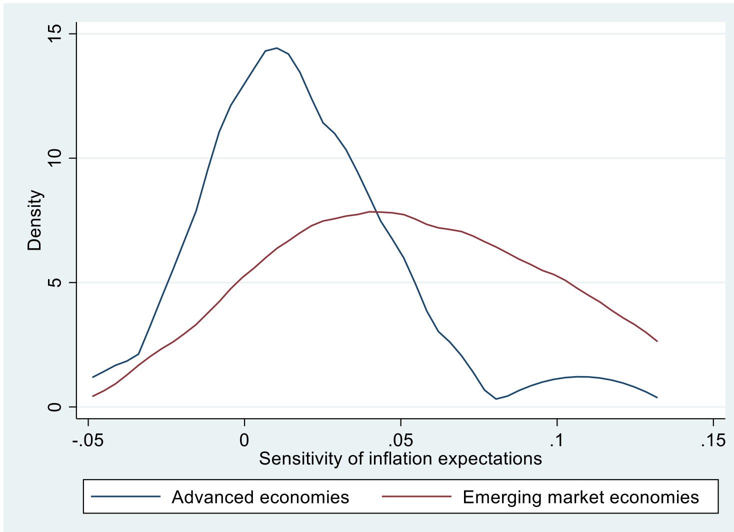
Townsend, Robert M. “Optimal contracts and competitive markets with costly state verification.” Journal of Economic Theory 21, no. 2 (1979): 265-293.

Volcker, P., 1979, Statement before the Joint Economic Committee of the U.S. Congress. October 17, 1979. Reprinted in *Federal Reserve Bulletin* 65 (11): 888–90.

Wooldridge, Jeffrey M. “Econometric analysis of cross section and panel data.” MIT Press, 2010.

Appendix

Figure A.1. Inflation anchoring coefficients: advanced vs. emerging market economies



Note: Distribution of the coefficients estimated from equation (2) using 5-year ahead inflation expectations.

Table A.1. Degree of inflation anchoring coefficients

Country	(I) 1-year coef	1-year s.e.	(II) 2-year coef	2-year s.e.	(III) 3-year coef	3-year s.e.	(IV) 4-year coef	4-year s.e.	(V) 5-year coef	5-year s.e.
Australia	0.070	0.038	0.022	0.019	0.031	0.015	0.040	0.011	0.040	0.016
Brazil	0.336	0.087	0.287	0.087	0.248	0.091	0.156	0.047	0.128	0.051
Canada	0.063	0.020	0.018	0.007	0.010	0.008	0.005	0.007	-0.004	0.007
Chile	0.125	0.023	0.057	0.016	0.046	0.016	0.046	0.016	0.043	0.020
China	-0.006	0.008	-0.005	0.011	-0.009	0.009	-0.009	0.008	-0.007	0.008
Colombia	0.201	0.020	0.165	0.031	0.119	0.037	0.079	0.039	0.088	0.024
Czech Republic	0.128	0.034	0.068	0.017	0.050	0.015	0.053	0.020	0.051	0.013
Estonia	0.152	0.057	0.041	0.032	0.016	0.019	0.012	0.019	0.032	0.014
France	0.096	0.019	0.037	0.008	0.014	0.007	0.021	0.009	0.013	0.007
Germany	0.124	0.035	0.042	0.020	0.014	0.012	0.018	0.014	0.004	0.012
Hong Kong	0.155	0.060	0.050	0.073	0.043	0.040	0.063	0.024	0.108	0.046
Hungary	0.114	0.072	0.063	0.033	0.048	0.021	0.034	0.015	0.031	0.009
India	0.050	0.014	0.031	0.026	0.024	0.022	0.017	0.025	0.005	0.032
Indonesia	0.216	0.070	0.092	0.017	0.041	0.012	0.020	0.006	0.012	0.006
Italy	0.171	0.023	0.059	0.020	0.018	0.022	0.035	0.019	0.033	0.021
Japan	0.076	0.054	0.110	0.031	0.050	0.030	0.080	0.024	0.053	0.022
Korea	0.123	0.016	0.022	0.022	0.006	0.007	0.015	0.006	-0.018	0.012
Latvia	0.142	0.099	0.068	0.034	0.020	0.017	0.018	0.007	0.007	0.005
Lithuania	0.173	0.074	0.109	0.044	0.080	0.025	0.087	0.044	0.069	0.032
Malaysia	0.163	0.036	0.051	0.015	0.039	0.018	0.033	0.026	0.067	0.032
Mexico	0.243	0.122	0.071	0.088	0.041	0.072	0.045	0.059	0.083	0.054
Netherlands	0.035	0.046	0.041	0.014	0.037	0.016	0.028	0.019	0.047	0.024

New Zealand	-0.005	0.046	-0.015	0.012	-0.002	0.010	0.012	0.007	0.013	0.009
Norway	-0.031	0.023	-0.010	0.007	-0.006	0.006	-0.004	0.005	-0.005	0.005
Poland	0.115	0.032	0.069	0.021	0.061	0.019	0.059	0.023	0.056	0.024
Romania	0.234	0.067	0.172	0.052	0.137	0.037	0.122	0.031	0.112	0.048
Russia	0.900	0.608	0.251	0.121	0.167	0.070	0.139	0.054	0.082	0.040
Singapore	0.140	0.024	0.072	0.015	0.044	0.013	0.027	0.012	0.029	0.012
Slovak Republic	0.063	0.039	-0.033	0.034	-0.043	0.030	-0.042	0.027	-0.044	0.028
Slovenia	0.131	0.030	0.064	0.012	0.041	0.008	0.018	0.007	0.017	0.008
Spain	0.117	0.018	0.049	0.010	0.035	0.009	0.024	0.008	0.027	0.009
Sweden	0.123	0.026	0.045	0.017	0.025	0.012	0.016	0.010	0.012	0.010
Switzerland	0.110	0.025	0.065	0.024	0.012	0.014	0.000	0.016	-0.005	0.017
Taiwan	0.113	0.026	0.035	0.014	0.030	0.013	0.017	0.015	0.013	0.012
Turkey	0.102	0.057	0.058	0.044	0.035	0.051	0.043	0.037	0.037	0.021
United Kingdom	0.179	0.054	0.049	0.022	0.060	0.022	0.009	0.031	0.000	0.035

Note: This table summarizes the results from estimating equation (2) country-by-country using inflation expectations at various horizons.

Table A.2. Industry classification: INDSTAT2 vs. INDSTAT3

INDSTAT2		INDSTAT3	
ISIC	Industry	ISIC	Industry
15	Food products and beverages	311	Food
16	Tobacco products	313	Beverages
17	Textiles	314	Tobacco
18	Wearing apparel; dressing and dyeing of fur	321	Textiles
19	Tanning and dressing of leather	322	Apparel
20	Wood and of products of wood and cork, except furniture	323	Leather
21	Paper and paper products	324	Footwear
22	Publishing, printing and reproduction of recorded media	331	Wood products
23	Coke, refined petroleum products and nuclear fuel	332	Furniture, except metal
24	Chemicals and chemical products	341	Paper and products
25	Rubber and plastics products	342	Printing and publishing
26	Other non-metallic mineral products	351	Industrial chemicals
27	Basic metals	352	Other chemicals
28	Fabricated metal products, except machinery and equipment	353	Petroleum refineries
29	Machinery and equipment n.e.c.	354	Misc. pet. And coal products
30	Office, accounting and computing machinery	355	Rubber products
31	Electrical machinery and apparatus n.e.c.	356	Plastic products
32	Radio, television and communication equipment and apparatus	361	Pottery, china, earthenware
33	Medical, precision and optical instruments, watches and clocks	362	Glass and products
34	Motor vehicles, trailers and semi-trailers	369	Other nonmetallic mineral products
35	Other transport equipment	371	Iron and steel
36	Furniture; manufacturing n.e.c.	372	Nonferrous metals
		381	Fabricated metal products
		382	Machinery, except electrical
		383	Machinery, electric
		384	Transport equipment
		385	Prof. and sci. equip.
		390	Other manufactured products

Table A.3. The effect of inflation anchoring on industry growth: using gross output

Explanatory variable	(I)	(II)	(III)	(IV)
Initial share	-0.767***	-0.756***	-0.758***	-0.785***
	(0.256)	(0.263)	(0.260)	(0.266)
External financial dependence *Inflation anchoring	-18.048***			
	(5.767)			
Liquidity needs *Inflation anchoring		-7.272*		
		(4.090)		
Asset tangibility *Inflation anchoring			6.313	
			(4.408)	
R&D intensity *Inflation anchoring				-13.722***
				(3.217)
Magnitude of differential effects	1.43	0.54	-0.49	1.24
Observations	644	644	644	644
R-squared	0.62	0.61	0.51	0.62

Note: The dependent variable is the average annual growth rate in real gross output from 1990 to 2014 for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively. Differential effects are computed as the change in inflation anchoring from the 75th percentile (i.e., higher sensitivity) to the 25th percentile (i.e., lower sensitivity) of the cross-country distribution between a sector with high external financial dependence (at the 75th percentile of the distribution) and a sector with low external financial dependence (at the 25th percentile of the distribution).

Table A.4. The effect of inflation anchoring on industry growth: using an alternative measure of external financial dependence

Explanatory variable	(I)
Initial share	-0.892***
	(0.293)
External financial dependence *Inflation anchoring	-11.012**
	(5.448)
Magnitude of differential effects	0.46
Observations	668
R-squared	0.59

Note: The dependent variable is the average annual growth rate in real gross output from 1990 to 2014 for each industry-country pair. Estimates are based on equation (1). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively. Differential effects are computed as the change in inflation anchoring from the 75th percentile (i.e., higher sensitivity) to the 25th percentile (i.e., lower sensitivity) of the cross-country distribution between a sector with high external financial dependence (at the 75th percentile of the distribution) and a sector with low external financial dependence (at the 25th percentile of the distribution).

Table A.5. The effect of confounding factors on industry growth

Explanatory variable	(I) Financial development	(II) Level of inflation	(III) Government size	(IV) Aggregate growth	(V) Aggregate volatility	(VI) Monetary policy stance	(VII) Emerging markets
External financial dependence *Confounding factor	-0.009*	-0.031***	0.049**	-0.078	0.141	0.674*	-0.973**
	(0.005)	(0.011)	(0.021)	(0.084)	(0.196)	(0.365)	(0.464)
Liquidity needs * Confounding factor	(-0.003)	-0.006	0.022	0.019	0.009	-0.099	-0.362
	(0.004)	(0.011)	(0.017)	(0.067)	(0.109)	(0.565)	(0.384)
Asset tangibility * Confounding factor	0.006	0.006	-0.027*	0.018	-0.077	0.172	0.468
	(0.004)	(0.013)	(0.015)	(0.072)	(0.130)	(0.516)	(0.344)
R&D intensity * Confounding factor	-0.002	-0.041***	0.021	-0.003	-0.017	0.730***	-0.964**
	(0.004)	(0.011)	(0.017)	(0.089)	(0.146)	(0.200)	(0.393)
Observations	650	668	668	668	668	415	668

Note: The dependent variable is the average annual growth rate in real value-added from 1990 to 2014 for each industry-country pair. Estimates are based on equation (3). t-statistics based on clustered standard errors at the country level are reported in parenthesis. *, **, *** denote significance at 10, 5, and 1 percent, respectively.