The Effects of Inflation Uncertainty on Firms and the Macroeconomy*

Carola Binder† Ezgi Ozturk‡ Xuguang Simon Sheng§

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Abstract

We construct measures of inflation uncertainty for 33 countries using data from professional forecasters. Inflation uncertainty, as proxied by inflation forecast disagreement, rose substantially in most, but not all, countries following the pandemic. Using panel local projections, we show that inflation uncertainty reduces real economic activity. This holds true at the country level, where higher inflation uncertainty leads to lower industrial production, and at the firm level, where it results in lower real sales and employment. Global openness amplifies this negative impact, with the amplification effect being more pronounced for financial openness than for trade openness. Higher inflation uncertainty also leads to higher inflation.

Keywords: Firms; Forecast Disagreement; Inflation uncertainty; Local Projections

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†University of Texas at Austin, E-mail: carola.binder@austin.utexas.edu

‡International Monetary Fund, E-mail: EOzturk@imf.org.

§American University, Email: sheng@american.edu.

1 Introduction

Inflation rose dramatically around the globe in 2021 and 2022. The rise in inflation was accompanied by an increase in macroeconomic uncertainty, including uncertainty about inflation. Inflation uncertainty became the dominant source of macroeconomic uncertainty after 2021, especially following the Russian invasion of Ukraine (Londono et al., 2023). Around the same time, global trade growth declined, and trade as a share of GDP fell in major economies including China and India (Goldberg and Reed, 2023).

In this paper, we study the impacts of inflation uncertainty on macroeconomic and firm outcomes in 33 countries, many of which experienced a large increase in inflation uncertainty during or soon after the onset of the pandemic. We also study how globalization, including both financial and trade openness, can moderate or amplify the effects of inflation uncertainty. We proxy for uncertainty, which is difficult to measure, using inflation disagreement, defined as the interquartile range of one-year-ahead inflation forecasts from professional forecasters provided by Consensus Economics. After the early work of Zarnowitz and Lambros (1987) and Giordani and Soderlind (2003), researchers have carefully examined the theoretical and empirical link between disagreement and uncertainty (Dovern et al., 2012). The nature of this link depends on the forecasting context (Glas, 2021). Disagreement tends to be a strong proxy for aggregate uncertainty at relatively short forecast horizons, like the one-year horizon we consider, and in unstable forecasting environments, like the COVID-19 period that is part of our study (Lahiri and Sheng, 2010).[1] Another advantage of the disagreement measure is that it is available in real time and thus provides an *ex ante* proxy for uncertainty. That is, it does not require knowledge of *ex post* forecast errors.

We use panel local projection methods to trace the dynamic response of industrial production and inflation to inflation uncertainty at the country level. We find that on average,

[1] Lahiri and Sheng (2010) show that aggregate forecast uncertainty can be expressed as the sum of forecast disagreement and the perceived variability of future aggregate shocks; the highly unusual COVID-19 period makes it difficult to estimate the variance of future aggregate shocks with a GARCH or stochastic volatility model, as is the common approach.

industrial production declines and inflation rises in response to a shock to inflation uncertainty, with the largest effects occurring after about a year. The industrial production results are consistent with the theoretical and empirical literature on the real economic effects of inflation uncertainty, which mostly finds negative effects (Evans and Wachtel, 1993; Grier and Perry, 2000; Choi et al., 2022). Theoretically, higher inflation uncertainty affects financial markets by raising long-term interest rates, and can lead businesses and households to spend resources avoiding the risks associated with inflation uncertainty (Kantor, 1983). It also may lead businesses and consumers to delay consumption and investment until uncertainty is resolved (Dotsey and Sarte, 2004; Binder, 2017). Holland (1993) review 18 studies of the relationship between inflation uncertainty and real activity for the United States. Of these, 14 find a negative relationship, three find an insignificant relationship, and one finds a positive relationship. More recently, Londono et al. (2023) find that inflation uncertainty reduces industrial production, consumption, and investment in the US.

Effects of inflation uncertainty on inflation are more ambiguous. Cukierman and Meltzer (1986) show that inflation uncertainty can lead to higher inflation by increasing monetary policymakers' incentive to create surprise inflation to boost employment. But inflation uncertainty might also induce policymakers to reduce inflation to lower the welfare costs associated with uncertainty (Holland, 1993, 1995). Empirical studies are mixed, or find that the relationship between inflation uncertainty and inflation varies across countries or time periods (Maskus and Pourgerami, 1990; Grier and Perry, 2000; Mankiw et al., 2004; Barnett et al., 2020; Ha et al., 2023). Our results are more consistent with the Cukierman and Meltzer (1986) hypothesis. Note that there is also a positive link between inflation and inflation disagreement, which we use as an uncertainty proxy (Mankiw et al., 2004). More recent theoretical work by Falck et al. (2021) uses a structural sticky price model to show how inflation disagreement may affect inflation by changing firms' response to monetary policy. In the model, when disagreement is high, the signaling channel of monetary policy is stronger, so contractionary monetary policy shocks lead firms to raise prices. Empirically, they find

that contractionary monetary policy shocks are inflationary in high-disagreement regimes.

To better understand the macroeconomic effects of inflation uncertainty, we modify our panel local projections to allow for cross-country heterogeneity. In particular, we focus on whether trade or financial openness – two common features associated with globalization – moderate or amplify the effects of uncertainty on industrial production and inflation. Our interest in these country characteristics is motivated by a growing literature on the relationship between globalization, inflation, and inflation uncertainty, which was originally prompted by the rise of globalization in the 1990s and 2000s.

Seminal work by Romer (1993) suggests that greater openness to trade reduces inflation via a terms-of-trade channel. That is, in a more open economy, the real exchange rate depreciation caused by unanticipated monetary expansion is more costly, so monetary policymakers' incentives for expansion are lower. In other words, trade openness steepens the Phillips curve, or reduces the tradeoff between output and inflation, in turn reducing the equilibrium inflation when monetary policymakers have discretion. Consistent with his theory, Romer finds a negative relationship between trade openness and inflation in a large cross-section of countries. Lane (1997) similarly shows that trade openness reduces the output gains from unanticipated inflation, reducing policymakers' incentive to inflate, in a general equilibrium model with nominal price rigidity in the non-traded sector. In addition to reducing monetary policymakers' incentive to inflate, trade openness may reduce inflation by increasing competition and reducing market power, thus lowering firms' markups (Chen et al., 2009).

However, there is some theoretical ambiguity. In micro-founded models, the effects of trade openness on the output and inflation tradeoff can in fact be the opposite of those in Romer (1993). The key insight is that openness increases aggregate price stickiness by exposing firms to international competition that forces firms to be cautious in adjusting prices; as a result, monetary expansion is less able to boost output through unexpected price increases (Daniels et al., 2005; Daniels and Vanhoose, 2006). Cavelaars (2009) suggests that

when import tariffs are high, currency depreciations reduce tariff revenues. This disciplines monetary policymakers and deters monetary expansions. Thus, if trade openness comes through reduced tariffs, it may reduce this source of monetary policy discipline and increase inflation. Indeed, several papers have found a positive or insignificant empirical relationship between openness and the level of inflation (Terra, 1998; Daniels et al., 2005; Ball, 2006).

Other work has considered the effects of trade openness on inflation volatility. Again, theoretical results are ambiguous, as they depend on the effect of openness on the sacrifice ratio between inflation and output and on the extent to which monetary policy is more disciplined as a result; see Bowdler and Malik (2017) for a thorough discussion. Lo et al. (2007) and Bowdler and Malik (2017) find that trade openness reduces inflation volatility.

Financial openness, likewise, may affect both the level and the volatility of inflation through its effects on the sacrifice ratio and on macroeconomic policy (Gruben and McLeod, 2002). For example, Razin and Yuen (2002) note that with greater financial openness, capital mobility improves consumption smoothing, giving central banks less motive to smooth output. Liberalization of international capital markets reduces the inefficiencies associated with output gap fluctuations relative to inflation fluctuations, which can lead monetary authorities to put greater priority on reducing output gap fluctuations (Razin and Loungani, 2007). Thus, financial openness is likely to lead to lower inflation volatility through its effects on macroeconomic policy. Badinger (2009) find that both trade openness and financial openness reduce inflation in a sample of 91 countries.

Our focus is slightly different. We focus not on how trade and financial openness affect the level or volatility of inflation, but rather on how they alter the effects of inflation uncertainty on inflation and output. We find that high financial openness, and, to a lesser extent, high trade openness, *amplify* the positive impact of uncertainty on inflation and the negative effect on industrial production. The previously-discussed effects of openness on the sacrifice ratio and on monetary policy can help explain these results. If openness increases the sacrifice ratio, then uncertainty about future inflation increases uncertainty about future output.

Especially when financial openness is high, policymakers may be more willing to tolerate greater future output gap fluctuations in order to stabilize inflation fluctuations. The terms-of-trade channel also implies that inflation uncertainty increases exchange rate uncertainty in countries with high trade openness. These effects will tend to reduce output through a precautionary channel.

Regarding the amplified effects of openness on inflation, we note that in Cukierman and Meltzer (1986), imperfect monetary control increases policymakers' opportunities for ambiguity, amplifying the effects of inflation uncertainty on inflation (see in particular Section 6 of Cukierman and Meltzer). Increased financial openness, which leads to greater exchange rate volatility, can make it more difficult for central banks to control domestic monetary conditions. Thus the effect of inflation uncertainty on inflation will be larger even as the average level of inflation is lower.

We enhance our country-level analysis using firm-level data from Orbis to analyze the impact of inflation uncertainty on firms' real sales, employment, and profit margins, again using panel local projections. The firm data, which comes from national business registries, covers firms in 20 sectors, excluding the public sector and financial sector. Consistent with the country-level results, we find that inflation uncertainty reduces real sales and employment, with these negative effects amplified especially by financial openness. On average, inflation uncertainty shocks have a small positive effect on firm profits, but a negative effect for firms in highly financially open countries. We also show that our results are similar if we restrict our data to the pre-COVID era or use alternatively-defined measures of openness. Given the important role of financial constraints in firms' responses to high uncertainty episodes (Campello et al., 2010; Choi et al., 2018), we also include a firm-level measure of financial constraint as an additional interaction term in our firm-level analysis. In response to high inflation uncertainty, commercial banks may raise lending rates to hedge against this uncertainty and the possibility of central banks increasing the policy rate. This leads to higher borrowing costs for firms, which are amplified for financially-constrained firms, in

line with our results.

In addition to the literature already discussed, we also contribute to a large literature on the drivers and effects of macroeconomic uncertainty and disagreement (Bernanke, 1983; Mankiw et al., 2004; Bloom, 2009; Baum et al., 2009; Capistran and Timmermann, 2013; Leduc and Liu, 2016; Baker et al., 2016; Bloom, 2014; Istrefi and Mouabbi, 2018; Ozturk and Sheng, 2018; Beckmann et al., 2023; Binder et al., 2022; Cuaresma et al., 2020; Caggiano and Castelnuovo, 2023). More recently, some of this literature has focused on the effects of macroeconomic uncertainty on firms. While we focus on inflation uncertainty, others consider uncertainty about interest rates or growth. For example, Kumar et al. (2023) use a survey experiment to study the effects of GDP growth uncertainty on New Zealand firms, and find that higher uncertainty leads to lower prices, employment, investment, sales, and technological development. Duquerroy et al. (2024) study the effects of interest rate uncertainty on European firms and find similarly negative effects: in response to higher uncertainty about interest rates, firms reduce investment, sales, hiring, and divident payouts. Other research instead focuses on firms' idiosyncratic uncertainty, which tends to reduce investment (Bloom et al., 2007), or on uncertainty about economic policy or trade policy, which likewise reduces investment (Baker et al., 2024; Caldara et al., 2020).

The remainder of the paper proceeds as follows. Section 2 describes the survey data and measurement of inflation uncertainty. Section 3 explores the impact of inflation uncertainty on industrial production and inflation. Section 4 studies the effects of uncertainty on firms, and section 5 concludes. Additional tables and graphs are relegated to the appendix.

2 Measuring Inflation Uncertainty

This section describes our data sources and the construction of inflation uncertainty used in our analysis. We use survey data of inflation forecasts to compute inflation forecast uncertainty. As in Ozturk and Sheng (2018), the forecast data are from the *Consensus*

Forecasts, published by Consensus Economics, Inc., a private macroeconomic survey firm. The survey covers a wide range of advanced and emerging market economies. The number of forecasters contributing to the Consensus Forecasts changes over time and varies across different countries. Our data begins in October 1989 and ends in December 2022, with varying start dates for each of the 33 countries included in our sample (see Appendix Table A.1).[2]

On a monthly basis, the survey reaches out to approximately 10-30 professional forecasters residing in each country, requesting their macroeconomic forecasts for the current and next calendar year. As a result, the survey delivers monthly forecasts for specific events, with forecast horizons that differ in length. The accuracy of these predictions tends to increase as the forecast horizon shortens and approaches the actual value. Following Dovern et al. (2012) and Ozturk and Sheng (2018), we transform the fixed-event CPI inflation forecasts into fixed-horizon forecasts with the following adjustment:

$$I_{t+12|t} = \frac{k}{12} I_{t+k|t} + \frac{12-k}{12} I_{t+12+k|t} \tag{1}$$

where $I_{t+k|t}$ and $I_{t+12+k|t}$ are the two inflation forecasts with horizons $k \in \{0, 1, ..., 12\}$ and $k+12$ months, respectively. The average of two fixed-event forecasts weighted by their share in the forecasting horizon approximates the fixed-horizon forecast, $I_{t+12|t}$, for the next 12 months.

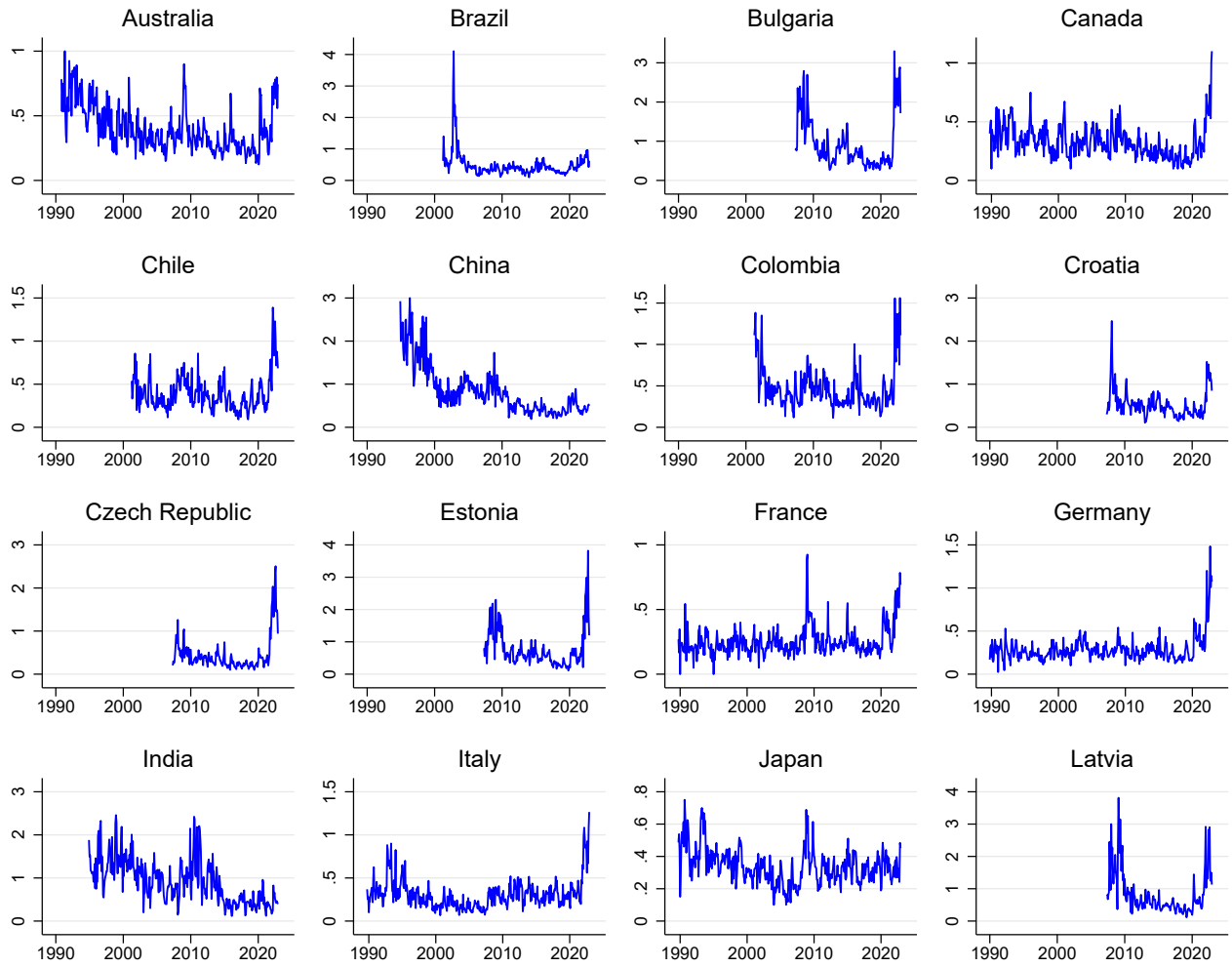
Lahiri and Sheng (2010) show that forecast disagreement – that is, the variance of forecasts across forecasters at time t – corresponds to the idiosyncratic component of uncertainty. Therefore, inflation forecast disagreement is an important component of overall inflation uncertainty. However, the cross-forecaster variance is susceptible to the influence of outliers. If a single forecaster's prediction is significantly higher or lower than all other forecasts, it can heavily skew the variance. To mitigate this issue, we use the interquartile range as a

[2]We omit from our analysis four countries that experienced hyperinflation during the time period for which forecast data is available: Argentina, Indonesia, Turkiye, and Ukraine.

measure of forecast disagreement. The interquartile range is a widely used measure of forecast disagreement in the literature (Mankiw et al., 2004; Capistran and Timmermann, 2013). As the calculation of the forecast disagreement does not require the use of actual values of inflation, it is a pure *ex-ante* measure.

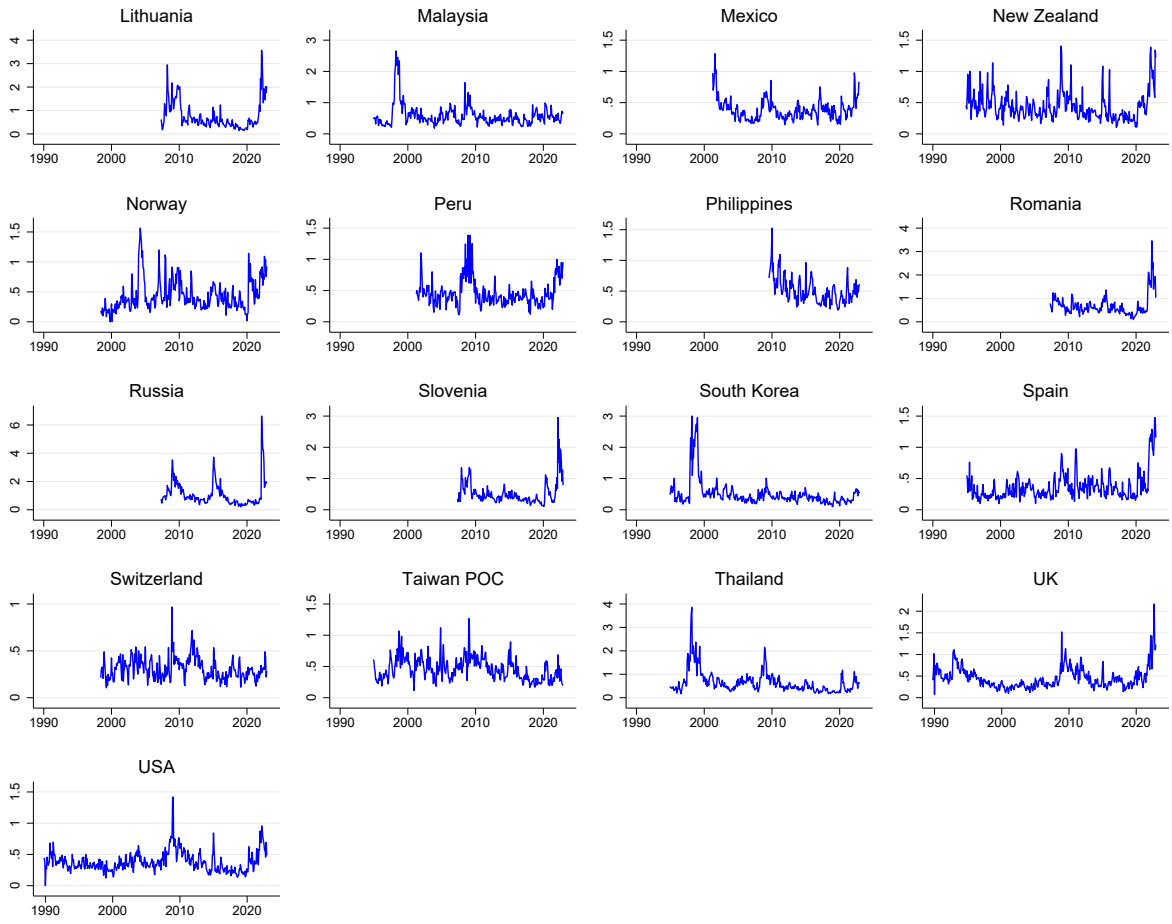
Figure 1 shows our inflation uncertainty measure for each country, while Appendix Figure A.1 shows the mean forecast for inflation for each country. A few important features stand out from the graphs. Note that the axis scales differ by country, since there is substantial variation across countries in the level of uncertainty. For many (but not all) countries, inflation uncertainty increases at the end of our sample with the global pandemic and rise in inflation. Likewise, inflation uncertainty rises in the Great Recession only in a subset of our sample. In some cases, the recent rise is greater than the Great Recession rise, while in others, the reverse is true. Appendix Table A.2 summarizes uncertainty overall and in the pre- and post- COVID-19 periods for each country by reporting the average interquartile range in each period. On average, the difference between inflation uncertainty in January 2020 (pre-pandemic) and peak inflation uncertainty is 1.4 percentage points, with the peak occurring about two years into the pandemic. Finally, we note that in nearly all countries, inflation uncertainty is positively correlated with the real economic uncertainty measure of Londono et al. (2024) and with the economic policy uncertainty index of Baker et al. (2016). Yet these three concepts are distinct, as the correlation coefficients are typically small; see Appendix Table A.3.

Figure 1: One-Year-Ahead Inflation Uncertainty



Notes: Figure continues on next page. See notes below continued figure.

Figure 1: One-Year-Ahead Inflation Uncertainty (continued)



Notes: Figure displays one-year-ahead inflation forecast disagreement for each country in our sample. Data from Consensus Forecasts.

3 Macroeconomic Impact of Inflation Uncertainty

To examine the dynamic relationship between inflation uncertainty and two macroeconomic indicators – industrial production growth and inflation – we employ the local projection method (Jorda, 2005). Our benchmark model is specified as follows:

$$Y_{c,t+h} - Y_{c,t-1} = \alpha_c^h + \beta_1^h \Delta U_{c,t}^{inf} + \theta^h M_{c,t} + \epsilon_{ct} \tag{2}$$

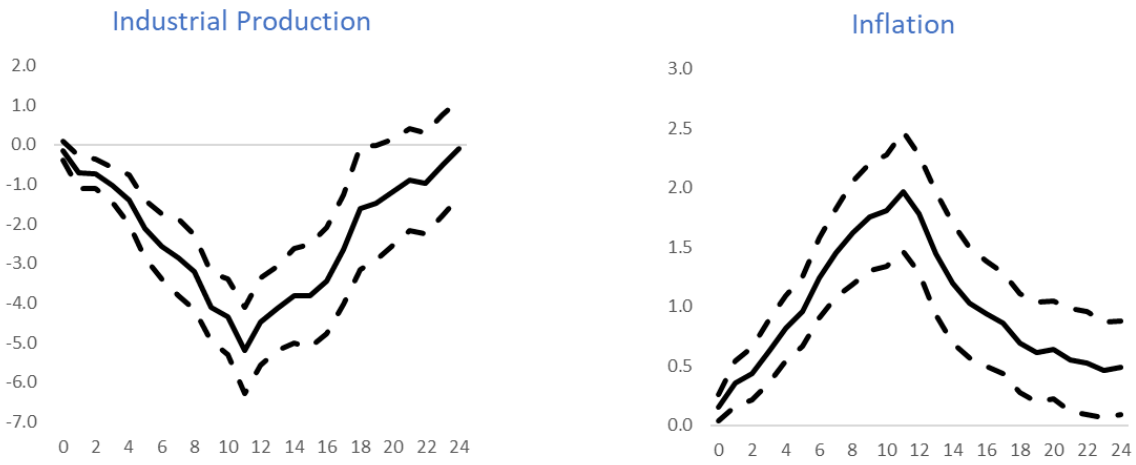
where $Y_{c,t}$ is either the industrial production growth or inflation for country c and time t. Monthly industrial production growth is defined as the year-over-year change in industrial production, from the International Monetary Fund (IMF). Monthly inflation is the year-over-year change in the consumer price index (CPI), also from the IMF. On the right hand side, $\Delta U_{c,t}^{inf}$ is the month-over-month change in inflation uncertainty for country c. The vector of control variables $M_{c,t}$ includes one lag of the month-over-month change in the industrial production growth and inflation, the current value and six lags of the volatility index (VIX),[3] and changes in inflation uncertainty between period $t-2$ and $t-1$ and all monthly changes between period t and $t+h-1$. The model includes country fixed effects, and standard errors are clustered at the country-year level. Summary statistics for the country-level variables are included in Appendix Table A.4.

Figure 2 shows the estimated response of industrial production and inflation to one-year-ahead inflation uncertainty. Higher inflation uncertainty leads to lower industrial production and higher inflation. These results are consistent with theoretical predictions in the literature, e.g. Kantor (1983) and Cukierman and Meltzer (1986). These impacts are also economically meaningful. In particular, a one percentage point increase in inflation uncertainty leads to more than a five percentage point reduction in industrial production growth and a nearly two percentage point increase in inflation after 12 months.

We extend the benchmark analysis by studying how globalization, including both finan-

[3]The Chicago Board Options Exchange (CBOE) VIX, an indicator of market sentiment, is attained from the Federal Reserve Bank of St Louis.

Figure 2: Impact of Inflation Uncertainty: Benchmark Results



Notes: Figure shows the estimated response of industrial production growth and inflation to one-year-ahead inflation uncertainty, with 68 percent confidence intervals.

cial and trade openness, can moderate or amplify the effects of inflation uncertainty. As a measure of financial openness, we use the Chinn and Ito (2006) index, which measures a country's degree of capital account openness, based on restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. For trade openness, we use the sum of exports and imports as a percent of GDP, from the World Bank World Development Indicators. A country is classified as having high trade openness if its average trade openness measure over the sample period is larger than the median of the averages of all countries in the sample, and it is assigned a value of 1 as a trade openness indicator. Otherwise, the country is categorized as having low trade openness, with a corresponding value of 0 as a trade openness indicator. The financial openness indicator is defined analogously. We use the average openness over the entire sample to define this dummy to reduce endogeneity due to the potential time-varying response of financial or trade openness to inflation uncertainty.

The extended analysis takes the following form:

$$Y_{c,t+h} - Y_{c,t-1} = \alpha_c^h + \beta_1^h \Delta U_{c,t}^{inf} + \beta_2^h \Delta U_{c,t}^{inf} * I_c + \theta^h M_{c,t} + \epsilon_{ct} \tag{3}$$

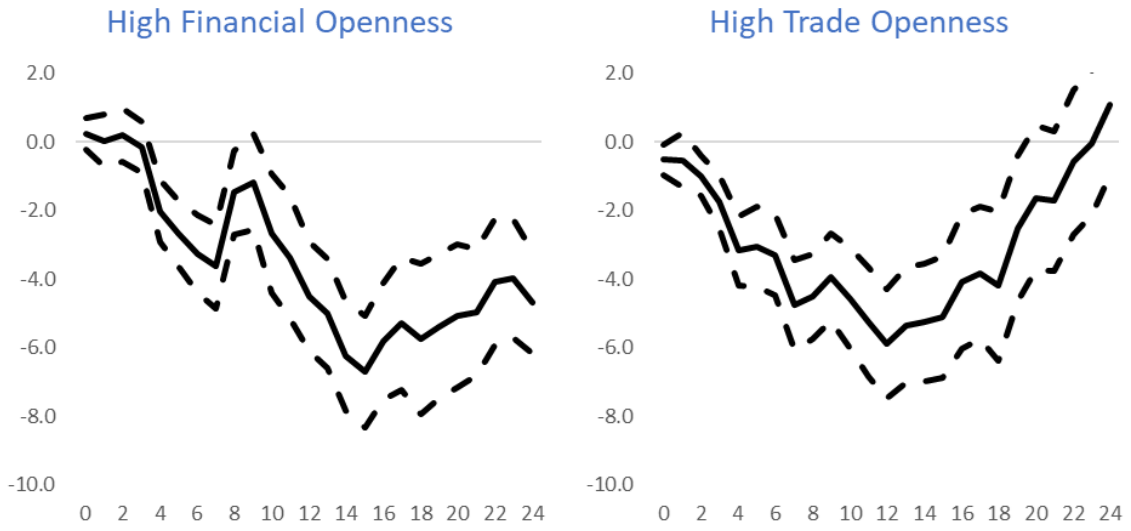
where the indicator I_c is equal to one if the country is classified as high financial openness or high trade openness. M_{ct} is the same set of control variables used in the benchmark analysis.

Figure 3 illustrates the differential responses (i.e. β_2^h) of industrial production and inflation to one-year-ahead inflation uncertainty for countries with high financial or trade openness compared to those with lower openness. Both financial and trade openness amplify the negative impact of inflation uncertainty on industrial production while also enhancing its positive impact on inflation.

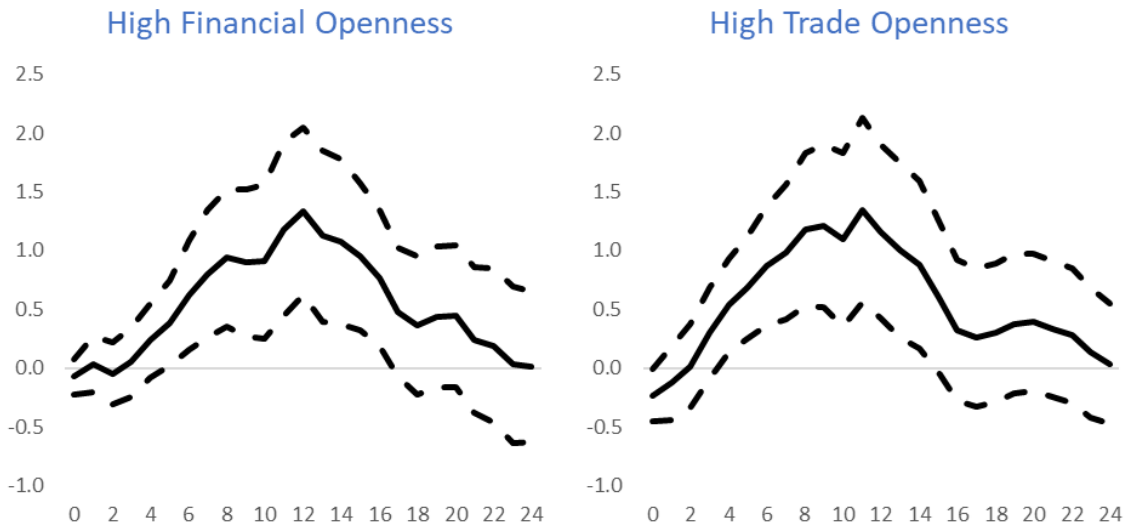
We conduct a number of robustness checks. First, we perform the analysis for the period before the pandemic (i.e., before January 2020) and present the results in Figure A.2. As shown, the impact of inflation uncertainty on industrial production remains similar, while its effect on inflation is somewhat muted compared to the benchmark results. Second, we focus on countries with both high financial and trade openness. Third, we define trade openness as imports as a percentage of GDP. The results, presented in Figure A.3, confirm our benchmark finding that inflation uncertainty reduces real economic activity, with global openness – including both financial and trade openness – amplifying this negative impact. Additionally, higher inflation uncertainty leads to higher inflation in these alternative specifications.

Figure 3: Differential Impacts of Inflation Uncertainty: High vs. Low Globalization

(a) Impact on Industrial Production



(b) Impact on Inflation



Notes: Figure shows the differential responses of industrial production growth and inflation to one-year-ahead inflation uncertainty for countries of high financial and trade openness relative to low openness, with 68 percent confidence intervals.

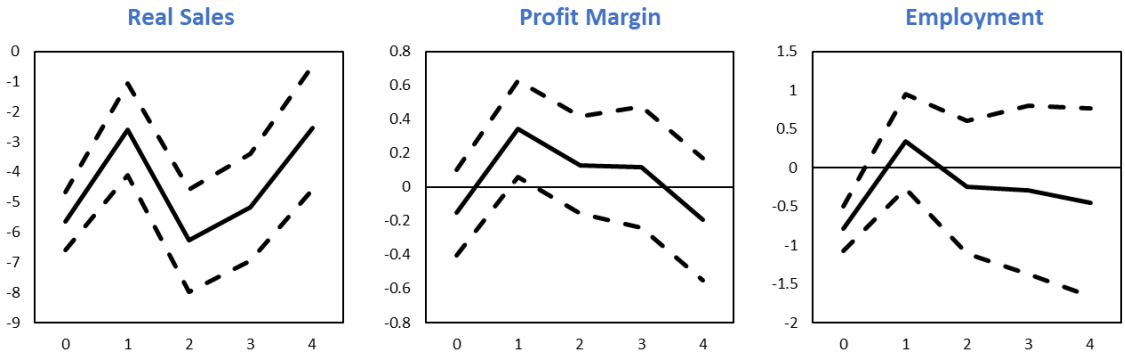
4 Inflation Uncertainty and Firms

The theoretical literature highlights how inflation uncertainty impacts firms, affecting their sales and investment via the real options channel, as well as their profit by influencing firms' borrowing costs. In this section, we study the responses of firms' real sales, profit margin, and number of employees to inflation uncertainty.

Our firm-level data come from the Orbis database provided by Bureau Van Dijk, which collects information from national business registries. The filing requirements for national business registers differ from country to country. While in some countries every firm is required to file to the national business register, in others only large firms are required to file their financial statements (Kalemli-Ozcan et al., 2024). Therefore, the representativeness of the data varies across countries. Comparing the coverage of Orbis database with OECD MultiProd and STAN databases, Bajgar et al. (2020) find that Orbis data covers around 60 percent of aggregate employment and output and around 40 percent of aggregate value added for many of the European countries they consider. Coverage is lower, around 30 to 40 percent of aggregate output, in Austria, Norway, Japan, Korea, and the US.

Our dataset includes 33 countries and 20 sectors, excluding public sector and financial companies. Linear interpolation is employed to fill in missing data between values. Appendix Table A.5 summarizes the share of observations that are imputed this way. Note that imputed data shares are highest for employment in Brazil, Malaysia, and Norway, but as we later show, results without imputed data remain similar. We drop duplicated observations, and those lacking information on sales, number of employees, and profit margin at the same time. Additionally, observations with negative values for cost of employees, operating revenues, total assets, or number of employees were excluded. The total number of observations is around 15.3 million for about 1.2 million companies. If observations for a firm are unavailable for at least 5 consecutive years, then the firm is excluded. Outliers above the 99th and below the 1st percentile of real sales are trimmed.

Figure 4: Impact of Inflation Uncertainty on Firms: Benchmark Results



Notes: Figure shows the estimated response of real sales (in log), profit margin, and the number of employees (in log) to one-year-ahead inflation uncertainty, with 68 percent confidence intervals.

Our benchmark model at the firm level is specified as:

$$Y_{ijc,t+h} - Y_{ijc,t-1} = \alpha^h_{cjt} + \beta^h_1 \Delta U^{inf}_{c,t} + \theta^h_1 M_{c,t-1} + \theta^h_2 X_{ijct} + \theta^h_3 \Delta Y_{ijc,t-1} + \epsilon_{ijct} \qquad (4)$$

where Y_{ijct} is the firm-level dependent variable, including log of real sales, profit margin, or log of number of employees, for firm i, sector j, country c and time t. The independent variable $\Delta U^{inf}_{c,t}$ is the 12-month average of the year-over-year change in inflation uncertainty for country c. $M_{c,t-1}$ is the set of country-level control variables consisting of lagged inflation and lagged industrial production growth, and X_{ijct} is the set of firm-level control variables consisting of log of total assets, and the ratio of current liabilities over current assets. Summary statistics are provided in Appendix Table A.6. The model includes country, sector, and year fixed effects, and standard errors are clustered at the country-sector-year level.

Figure 4 presents the results from the benchmark model. After a one percentage point increase in inflation uncertainty, real sales decline immediately by about six percentage points, and remain depressed for several years, and employment also declines on impact, though the effect is shorter-lasting. The effect on profits is much smaller, with only a small positive effect occurring one year after the shock. These estimates are economically

meaningful. Recall that inflation uncertainty took two years to reach its peak after the onset of the pandemic, increasing by about 1.4 percentage points on average. This, in turn, implies that real sales would decline by approximately 8.4 percentage points (1.4*6=8.4) on average in the two years following inflation uncertainty's peak. These results are broadly consistent with our country-level findings, and suggest that the rise in inflation that follows a shock to inflation uncertainty is not primarily attributable to rising profits, but rather to higher input costs.

As shown in Appendix Figure A.4, results are robust to the inclusion of firm fixed effects. Results are also similar in the pre-COVID era, as shown in Appendix Figure A.5. Finally, we re-estimate our results excluding the imputed data (Figure A.6), and continue to find similar results.

As with our country-level analysis, we consider how trade and financial openness modify the response to inflation uncertainty by including interaction terms in the local projections model. In particular, we estimate the following specification:

$$Y_{ijc,t+h} - Y_{ijc,t-1} = \alpha^h_{cjt} + \beta^h_1 \Delta U^{inf}_{c,t} + \beta^h_2 \Delta U^{inf}_{c,t} * I_c + \theta^h_1 M_{c,t-1} + \theta^h_2 X_{ijct} + \theta^h_3 \Delta Y_{ijc,t-1} + \epsilon_{ijct} \quad (5)$$

where the indicator I_c is equal to one if the country is classified as high financial openness or high trade openness. We use the same set of control variables as in the benchmark analysis.

Figure 5(a) plots the differential responses (i.e. β^h_2) of real sales, profit margin, and employment to one-year-ahead inflation uncertainty for firms in countries with high financial openness compared to those with low financial openness. Similarly, Figure 5(b) presents the same analysis for high versus low trade openness. Again, results are largely consistent with the results in the previous section. Financial openness amplifies the adverse effects on real outcomes (sales and employment). Firms in highly financially-open countries, where inflation increases more in response to inflation uncertainty, also experience a decline in profits, suggesting that the input price inflation cuts into their profits. Trade openness plays

a smaller role, with no detectable differential effect on real sales or profits, and a small amplifying effect on employment.

Finally, we further expand equation (5) to test whether the differential impacts of inflation uncertainty on firms in countries of high financial or trade openness depend on certain firm characteristics. In particular, we estimate the following triple interaction specification:

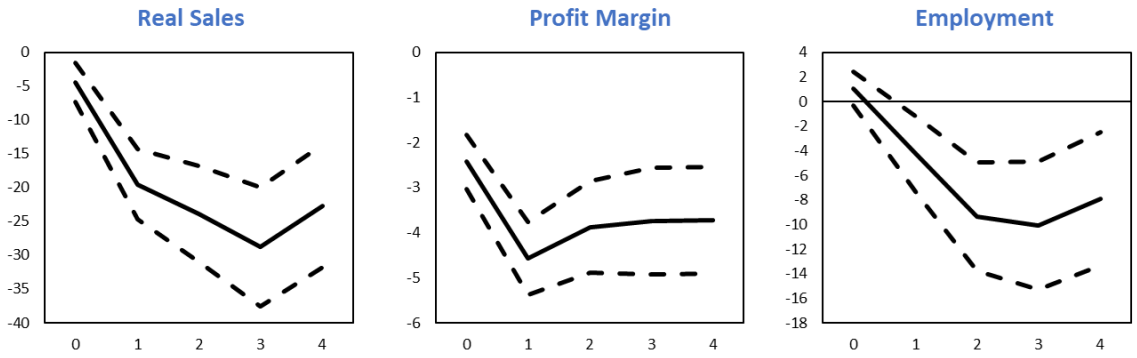
$$Y_{ijc,t+h} - Y_{ijc,t-1} = \alpha^h_{cjt} + \beta^h_1 \Delta U^{inf}_{c,t} + \beta^h_2 \Delta U^{inf}_{c,t} * I_c + \beta^h_3 \Delta U^{inf}_{c,t} * FC_{ijc} + \beta^h_4 \Delta U^{inf}_{c,t} * I_c * FC_{ijc} + \theta^h_1 M_{c,t-1} + \theta^h_2 X_{ijct} + \theta^h_3 \Delta Y_{ijc,t-1} + \epsilon_{ijct} \tag{6}$$

where the indicator FC_{ijc} is equal to one if the firm i is classified as more financially constrained compared to a less financially constrained firm. A firm is considered more financially constrained if its average ratio of current liabilities to current assets over the sample period is larger than the median of the averages of all firms in sector j and country c. We use the average ratio over the entire sample to define this dummy variable in order to reduce endogeneity stemming from the potential time-varying responses of firms' assets and liabilities to inflation uncertainty. We also employ the same set of control variables as in the benchmark analysis.

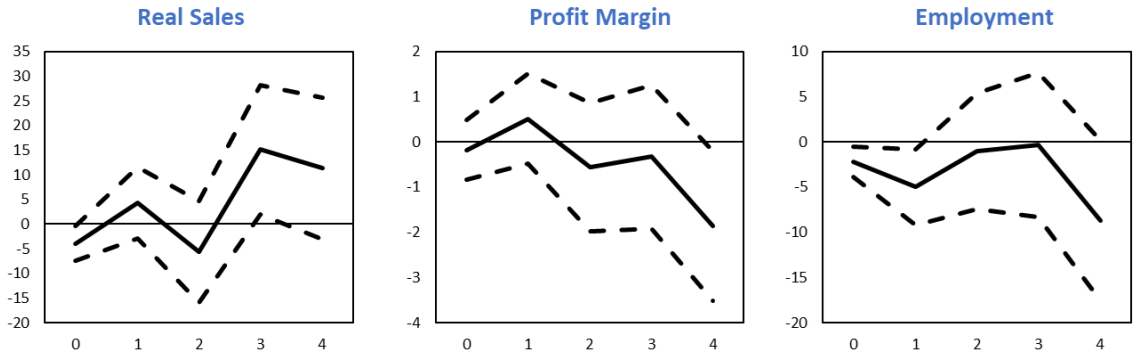
We are interested in the coefficient on the triple interaction term (i.e. β^h_4) in equation (6). As shown in Figure 6(a), the estimated coefficients are negative, indicating that more financially constrained firms in countries with high financial openness experience greater declines in real sales, employment, and, to a lesser extent, profit margins following inflation uncertainty shocks. This may reflect the fact that, in response to high inflation uncertainty, commercial banks raise lending rates to hedge against this uncertainty and the potential for central banks to increase the policy rate. This results in higher borrowing costs for firms, which are particularly amplified for financially constrained firms. However, the differential responses of firms in countries with high trade openness to inflation uncertainty shocks do not appear to depend on firms' financial constraints (see Figure 6(b)).

Figure 5: Differential Impacts of Inflation Uncertainty on Firms: High vs. Low Globalization

(a) Role of Financial Openness



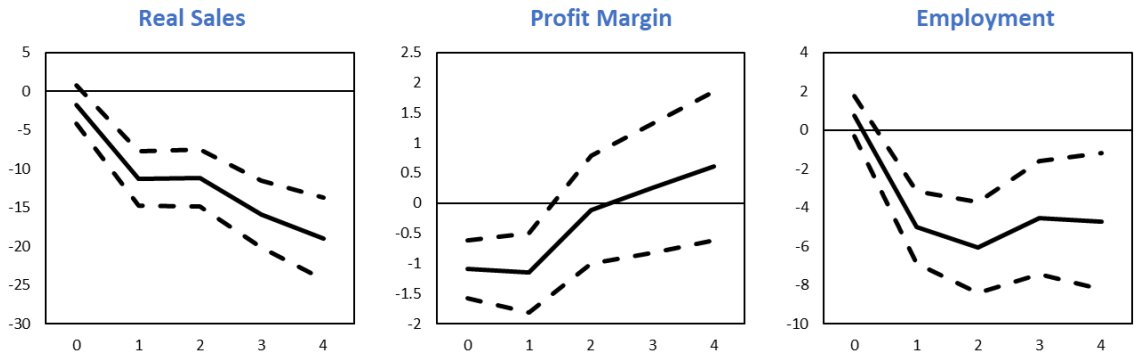
(b) Role of Trade Openness



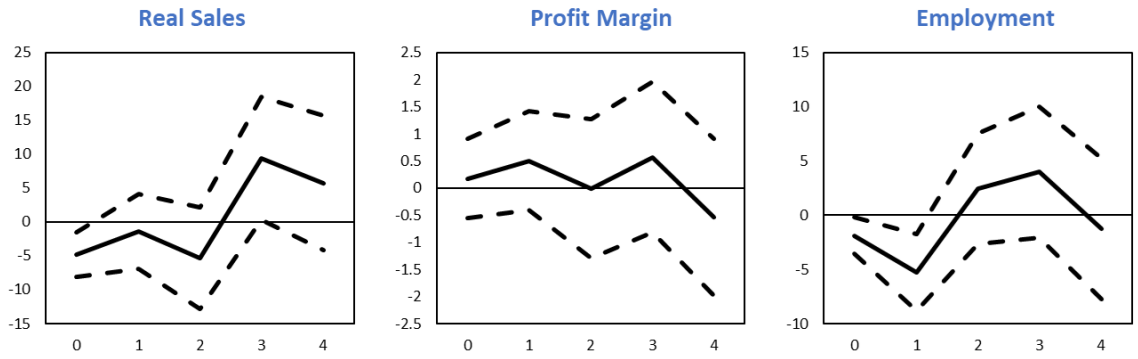
Notes: Figures show differential responses of real sales (in log), profit margin, and the number of employees (in log) to one-year-ahead inflation uncertainty for firms in countries with high financial or trade openness compared to low openness, with 68 percent confidence intervals.

Figure 6: Nonlinear Impact of Inflation Uncertainty on Firms with Triple Interactions

(a) More Financially Constrained Firms in Countries of High Financial Openness



(b) More Financially Constrained Firms in Countries of High Trade Openness



Notes: The solid line shows the point estimate for β_4^h, the coefficient on the triple interaction term in equation (6), across different horizons h, along with 68 percent confidence intervals. These estimates indicate whether and how the differential impacts of inflation uncertainty on firms in countries with high financial or trade openness depend on the firms' financial constraints.

5 Conclusion

This study highlights the significant impact of inflation uncertainty on macroeconomic and firm-level outcomes across 33 countries, particularly in the context of the post-pandemic period marked by increased global tensions and declining trade. Our findings demonstrate that inflation uncertainty, as proxied by the dispersion in professional forecasts, typically leads to a decline in industrial production and a rise in inflation, aligning with existing literature that underscores the adverse effects of uncertainty on economic activity. Moreover, the role of globalization emerges as a crucial factor; both trade and financial openness tend to amplify the negative impacts of inflation uncertainty on industrial production while intensifying its positive effects on inflation.

The analysis of firm-level data further reinforces these conclusions, revealing that inflation uncertainty diminishes real sales and employment, especially in financially open environments. Interestingly, while firms on average experience a slight increase in profits in response to inflation uncertainty, this effect is mitigated for firms in financially open markets, likely due to increased borrowing costs associated with heightened uncertainty. Our results should be interpreted with caution, as we do not claim any causal impact of inflation uncertainty on firms' business decisions. Further research is warranted to study firms' exposure to international trade and financial markets and to examine how this exposure interacts with inflation uncertainty. Additionally, future studies could explore the theoretical channels through which inflation and its associated uncertainty affect firms' business decisions.

Overall, these results suggest that policymakers must navigate the delicate balance between maintaining inflation control and fostering economic stability. For instance, policymakers in financially open economies might place greater emphasis on inflation stabilization over output stabilization, potentially moderating the negative impact of inflation uncertainty on real activity. As inflation uncertainty continues to shape economic landscapes, understanding its dynamics in relation to globalization will be essential for making informed policy decisions moving forward.

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Appendix A Tables and Figures

Table A.1: List of Countries and Sample Period

Country	**Start date**
Australia	November 1990
Brazil	April 2001
Bulgaria	May 2007
Canada	October 1989
Czech Republic	May 2007
Chile	April 2001
China	December 1994
Colombia	April 2001
Croatia	May 2007
Estonia	May 2007
France	October 1989
Germany	October 1989
India	December 1994
Italy	October 1989
Japan	October 1989
Latvia	May 2007
Lithuania	May 2007
Malaysia	December 1994
Mexico	April 2001
New Zealand	December 1994
Norway	June 1998
Peru	April 2001
Philippines	July 2009
Romania	May 2007
Russia	May 2007
Slovenia	May 2007
South Korea	December 1994
Spain	January 1995
Switzerland	June 1998
Taiwan POC	December 1994
Thailand	December 1994
UK	October 1989
USA	October 1989

Notes: Table lists the countries and data availability in our sample. All series end in December 2022. Data from Consensus Forecasts and Global Data Statistics of International Monetary Fund.

Table A.2: Inflation Uncertainty Pre- and Post-COVID

Country	**All**	**Pre-COVID**	**Post-COVID**
Australia	0.4	0.4	0.5
Brazil	0.5	0.5	0.6
Bulgaria	0.9	0.9	1.2
Canada	0.3	0.3	0.5
Chile	0.4	0.4	0.6
China	0.8	0.9	0.5
Colombia	0.5	0.4	0.6
Croatia	0.5	0.5	0.6
Czech Republic	0.4	0.3	0.9
Estonia	0.8	0.7	1.1
France	0.3	0.2	0.4
Germany	0.3	0.3	0.6
India	0.9	1.0	0.4
Italy	0.3	0.3	0.5
Japan	0.3	0.3	0.3
Latvia	0.8	0.8	1.1
Lithuania	0.8	0.7	1.1
Malaysia	0.6	0.6	0.6
Mexico	0.4	0.4	0.5
New Zealand	0.4	0.4	0.7
Norway	0.4	0.4	0.7
Peru	0.5	0.4	0.6
Philippines	0.5	0.5	0.5
Romania	0.7	0.6	1.1
Russia	1.1	1.0	1.4
Slovenia	0.5	0.5	0.9
South Korea	0.5	0.5	0.4
Spain	0.4	0.3	0.7
Switzerland	0.3	0.3	0.3
Taiwan	0.5	0.5	0.4
Thailand	0.6	0.7	0.5
UK	0.5	0.4	0.8
USA	0.4	0.4	0.5

Notes: Table summarizes inflation uncertainty, measured as the interquartile range of one-year-ahead inflation forecasts, for each country in our sample by time period. Data from Consensus Forecasts. Post-COVID includes January 2020 onward.

Table A.3: Correlation Between Inflation Uncertainty and Other Uncertainty Measures

Country	with REU	with EPU	Country	with REU	with EPU
Australia	0.22	0.13	Latvia	0.44	n.a.
Brazil	0.13	0.30	Lithuania	0.61	n.a.
Canada	-0.06	-0.09	Mexico	0.17	0.37
Czech Republic	0.29	n.a.	New Zealand	-0.04	n.a.
Chile	0.13	0.40	Norway	0.15	n.a.
China	-0.26	-0.44	Slovenia	0.44	n.a.
Colombia	0.00	n.a.	Korea	0.15	-0.15
Estonia	0.30	n.a.	Spain	0.30	0.38
France	0.43	0.25	Switzerland	0.06	n.a.
Germany	0.45	0.69	United Kingdom	0.09	-0.02
Italy	0.23	0.18	United States	0.25	0.16
Japan	-0.02	0.08			

Notes: Table reports correlation coeficients between inflation uncertainty and two different uncertainty measures. REU is the Real Economic Uncertainty measure of Londono et al. (2024) and EPU is the Economic Policy Uncertainty measure compiled at policyuncertainty.com. The n.a. means that a specific uncertainty measure is not available for this country.

Table A.4: Country-Level Summary Statistics

Variable	Obs.	Min.	Max.	Std. Dev.	Average	Median
Inflation Forecast	9622	-2.4	19.6	2.0	2.8	2.4
Inflation Uncertainty	9622	0.0	6.6	0.4	0.5	0.4
Inflation	9607	-4.3	25.6	3.0	2.9	2.3
Industrial Production Growth	9590	-82.1	238.5	9.8	2.6	2.3
Trade Openness	8913	15.8	220.4	39.2	70.5	58.8
Financial Openness	8517	0.2	1.0	0.3	0.8	1.0

Note: Inflation and industrial production growth are calculated year-over-year using monthly data from the IMF. Inflation forecasts are derived from the mean forecast of one-year-ahead CPI inflation, while inflation uncertainty is measured by the interquartile range of professional forecasters' CPI inflation forecasts from Consensus Forecasts. Trade openness is defined as the sum of exports and imports as a percentage of GDP, according to the World Banks World Development Indicators. Financial openness is from Chinn and Ito (2006), which measures a countrys degree of capital account openness according to restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.

Table A.5: Imputation of Firm-Level Data

Country	Employment			Sales			Profit		
	Imputed	Total	Ratio	Imputed	Total	Ratio	Imputed	Total	Ratio
Australia	2406	30251	0.08	370	10252.00	0.04	641	38003	0.02
Brazil	214	883	0.24	2	2433.00	0.00	49	2367	0.02
Bulgaria	941	929102	0.00	0	930381.00	0.00	17182	907029	0.02
Canada	246	1764	0.14	130	9329.00	0.01	514	8137	0.06
Chile	126	1294	0.10	1	1573.00	0.00	25	1546	0.02
China	66	79694	0.00	10	80028.00	0.00	1114	79030	0.01
Colombia	6	106	0.06	0	207.00	0.00	0	207	0.00
Croatia	2	469303	0.00	39	469178.00	0.00	6013	462909	0.01
Czech Republic	41222	503907	0.08	39654	530838.00	0.07	33212	535766	0.06
Estonia	198	385236	0.00	102	385340.00	0.00	5135	380698	0.01
France	564092	3112339	0.18	280	4121867.00	0.00	24960	4082165	0.01
Germany	20685	420002	0.05	24771	390220.00	0.06	29305	388963	0.08
India	572	4239	0.13	486	126165.00	0.00	2518	120964	0.02
Italy	277700	3815480	0.07	193	4130825.00	0.00	30678	4088838	0.01
Japan	0	52898	0.00	3	52896.00	0.00	128	52736	0.00
Latvia	24	499164	0.00	6688	463067.00	0.01	18735	470378	0.04
Lithuania	5	72787	0.00	120	72119.00	0.00	494	71172	0.01
Malaysia	2296	6460	0.36	2	14170.00	0.00	284	13989	0.02
Mexico	5	513	0.01	0	618.00	0.00	8	611	0.01
New Zealand	41	247	0.17	43	8839.00	0.00	66	8766	0.01
Norway	170842	439371	0.39	159	418429.00	0.00	6029	557069	0.01
Peru	6	142	0.04	0	208.00	0.00	2	206	0.01
Philippines	303	2103	0.14	18	4513.00	0.00	115	4352	0.03
Romania	3977	2514105	0.00	321	2517305.00	0.00	49419	2460105	0.02
Russia	83	2676	0.03	0	2906.00	0.00	56	2795	0.02
Slovenia	2187	391609	0.01	196	393087.00	0.00	2074	379927	0.01
South Korea	115314	683930	0.17	1933	1137046.00	0.00	9347	1125323	0.01
Spain	167688	3374698	0.05	89058	3864059.00	0.02	141498	3875293	0.04
Switzerland	216	3856	0.06	3	4201.00	0.00	71	4138	0.02
Taiwan	1407	16956	0.08	7	22533.00	0.00	493	22041	0.02
Thailand	740	4150	0.18	20	15139.00	0.00	235	14835	0.02
UK	5972	750786	0.01	199	18317.00	0.01	28137	723060	0.04
USA	885	99521	0.01	456	102172.00	0.00	3345	90555	0.04

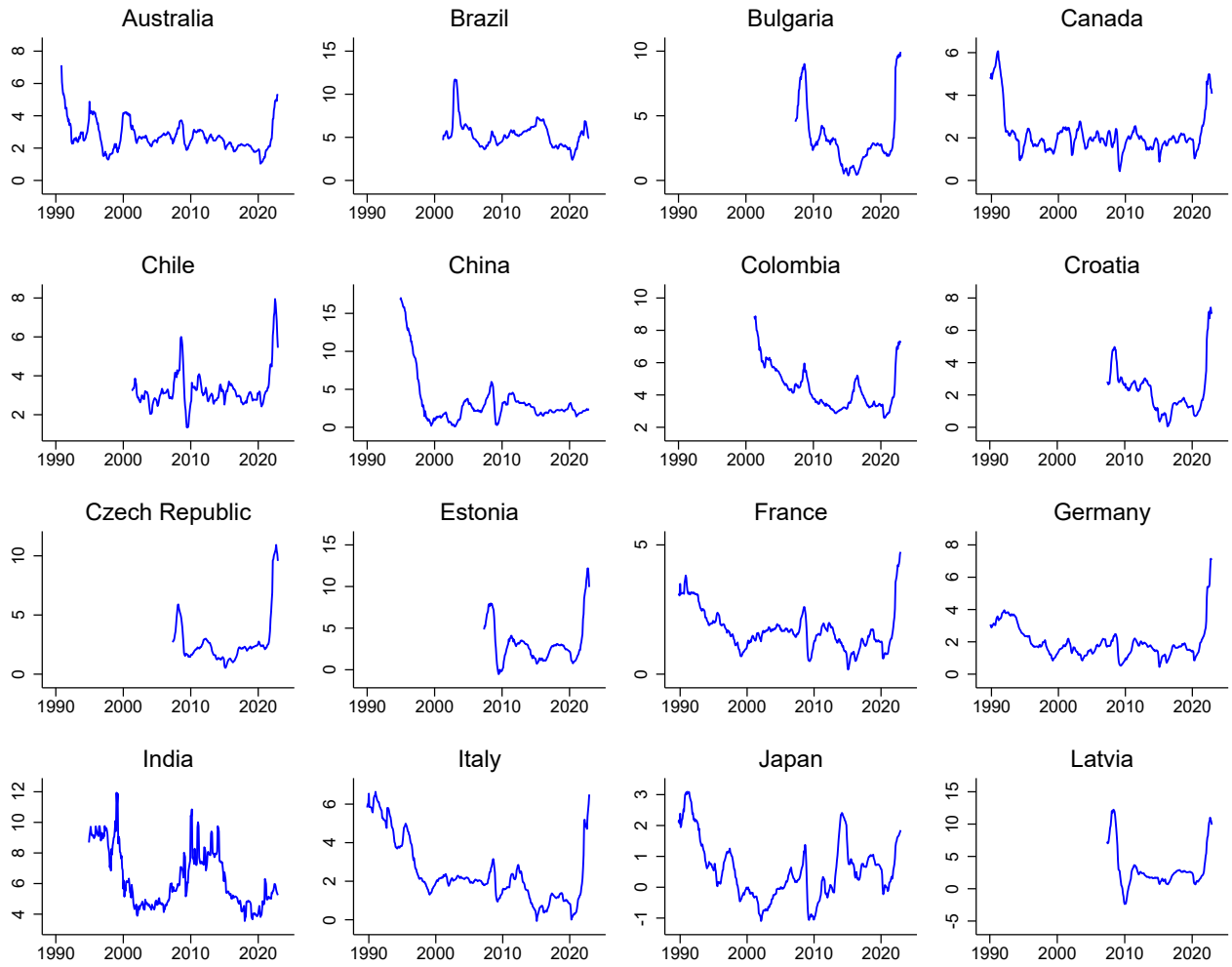
Note: Data from Orbis. Table shows the number of observations for each country and variable that were imputed, the total number of observations, and the ratio of imputed to total observations.

Table A.6: Summary Statistics: Firm-Level

Variable	Obs.	Min.	Max.	Std. Dev.	Average	Median
Real Sales (in logs)	16,219,513	261.23	1484.35	201.45	909.17	906.66
Profit Margin	16,019,311	-100.00	100.00	17.72	4.28	3.15
Employment (in logs)	13,366,054	0.00	2029.49	146.64	207.16	194.59
Liabilities/Assets	15,739,010	0.01	100.00	4.45	1.31	0.72
Total Assets (in logs)	16,134,700	0.00	2540.35	202.76	1365.82	1357.44

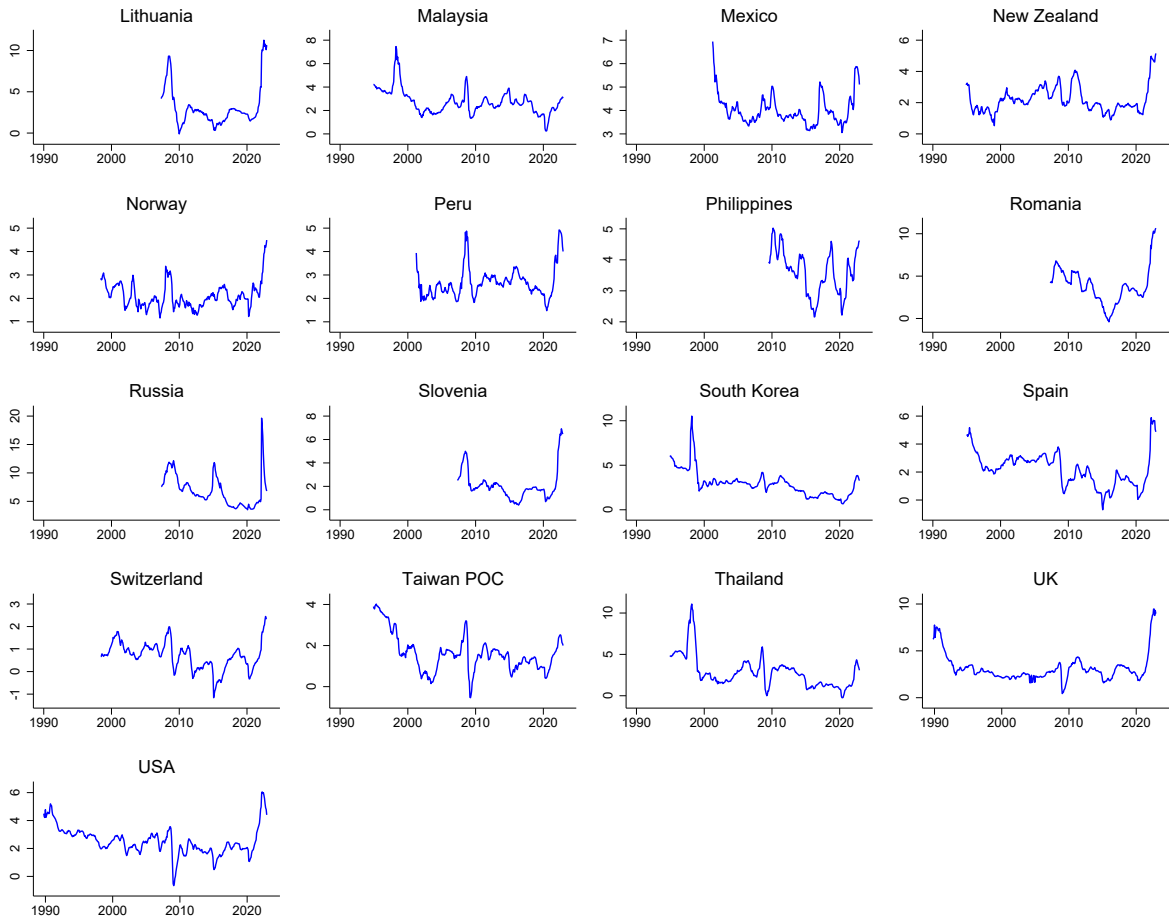
Note: Data from Orbis. Real sales reflect nominal total sales over CPI.

Figure A.1: One-Year-Ahead Consensus (i.e. Mean) Inflation Forecasts



Notes: Figure continues on next page. See notes below continued figure.

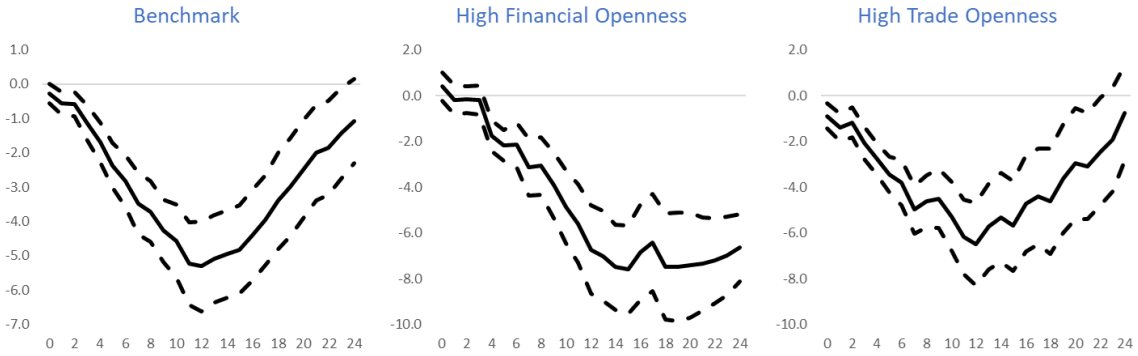
Figure A.1: One-Year-Ahead Consensus (i.e. Mean) Inflation Forecasts (continued)



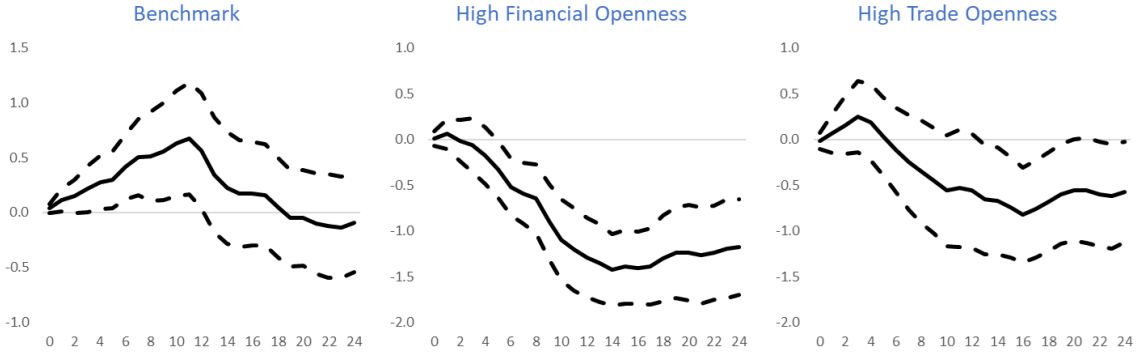
Notes: Figure displays one-year-ahead mean inflation forecasts for each country in our sample. Data from Consensus Forecasts.

Figure A.2: Impact of Inflation Uncertainty Before the Pandemic

(a) Impact on Industrial Production

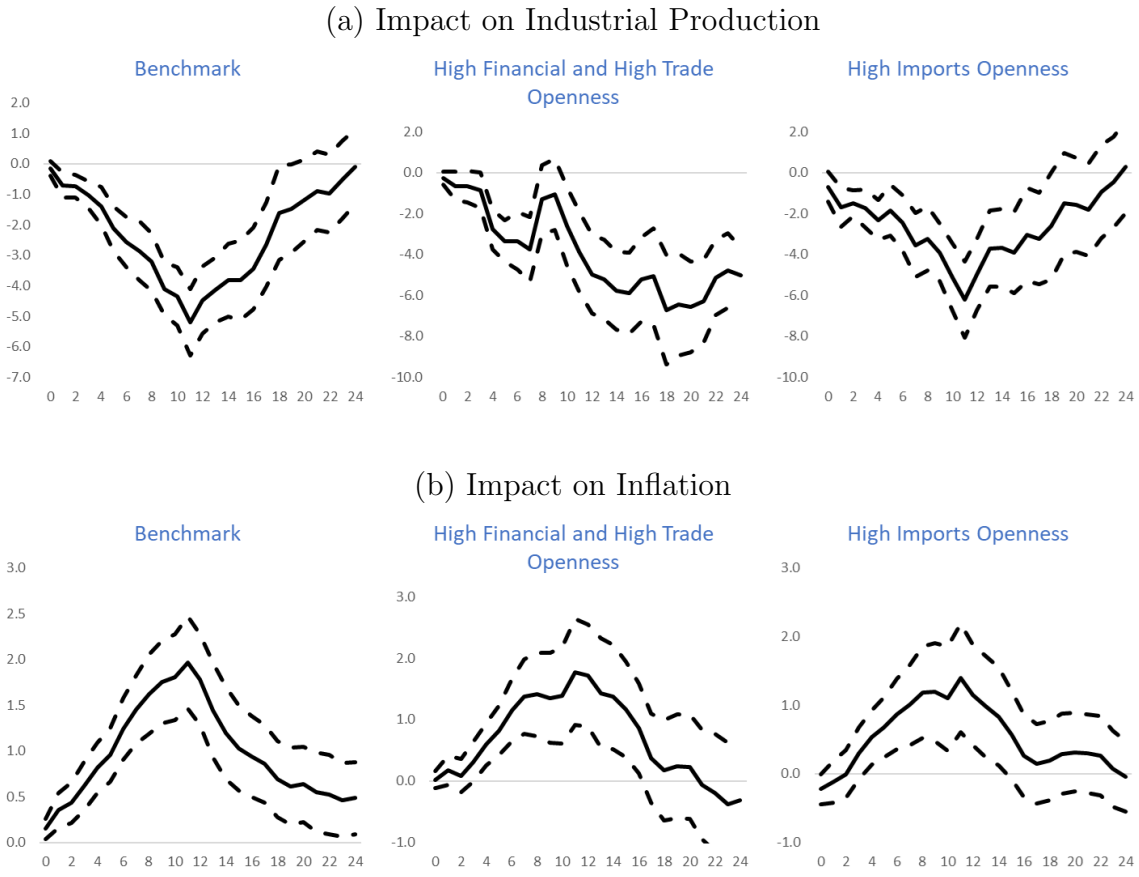


(b) Impact on Inflation



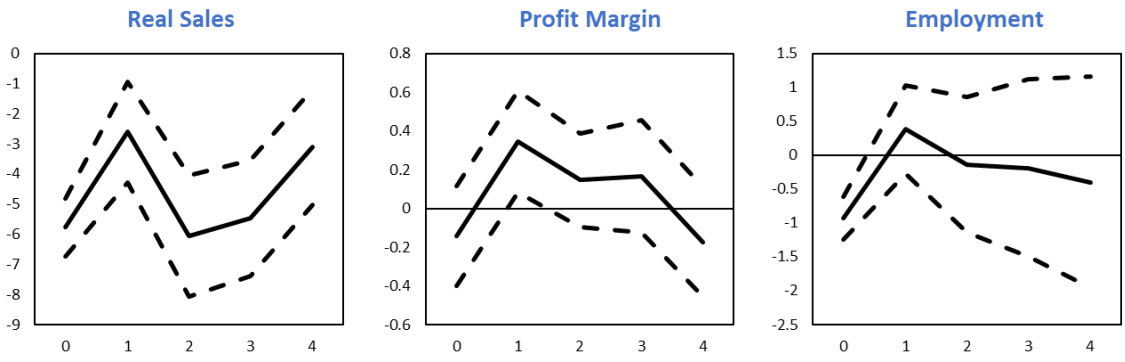
Notes: The figures in the left column show the responses of industrial production and inflation to one-year-ahead inflation uncertainty in the benchmark analysis conducted prior to the COVID-19 pandemic (i.e., before January 2020). The two columns on the right display the differential responses of industrial production and inflation to one-year-ahead inflation uncertainty for countries with high financial and trade openness compared to those with low openness, also prior to the COVID-19 pandemic. The 68 percent confidence intervals are reported.

Figure A.3: Impact of Inflation Uncertainty: Alternative Measures of Openness



Notes: The figures in the left column show the responses of industrial production and inflation to one-year-ahead inflation uncertainty in the benchmark analysis. The middle column displays the differential responses of industrial production and inflation to inflation uncertainty for countries with both high financial and high trade openness compared to others. The right column presents the differential responses of industrial production and inflation to inflation uncertainty for countries with high trade openness compared to those with low trade openness, where trade openness is defined as imports as a percentage of GDP. The 68 percent confidence intervals are reported.

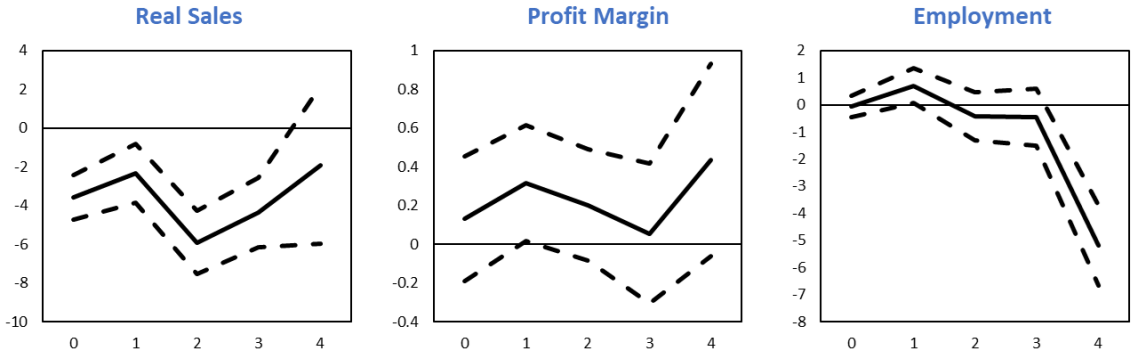
Figure A.4: Impact of Inflation Uncertainty on Firms: Alternative Fixed Effects



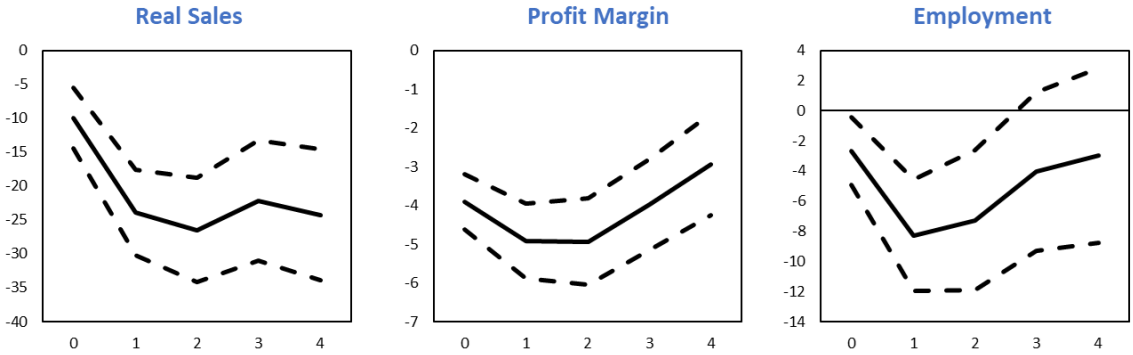
Notes: Figure shows the estimated response of real sales (in log), profit margin, and the number of employees (in log) to one-year-ahead inflation uncertainty, with 68 percent confidence intervals. This specification includes country, sector, firm and time fixed effects.

Figure A.5: Impact of Inflation Uncertainty on Firms Before the Pandemic

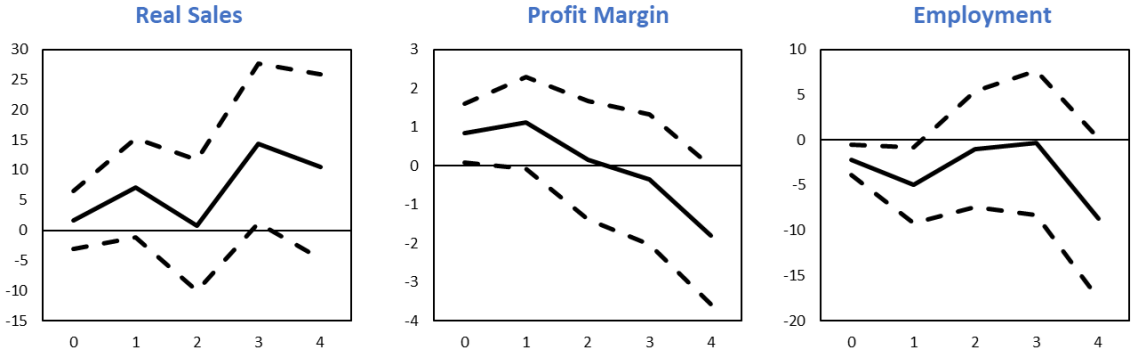
(a) Benchmark results, pre-COVID



(b) Differential impact in high financial openness countries, pre-COVID

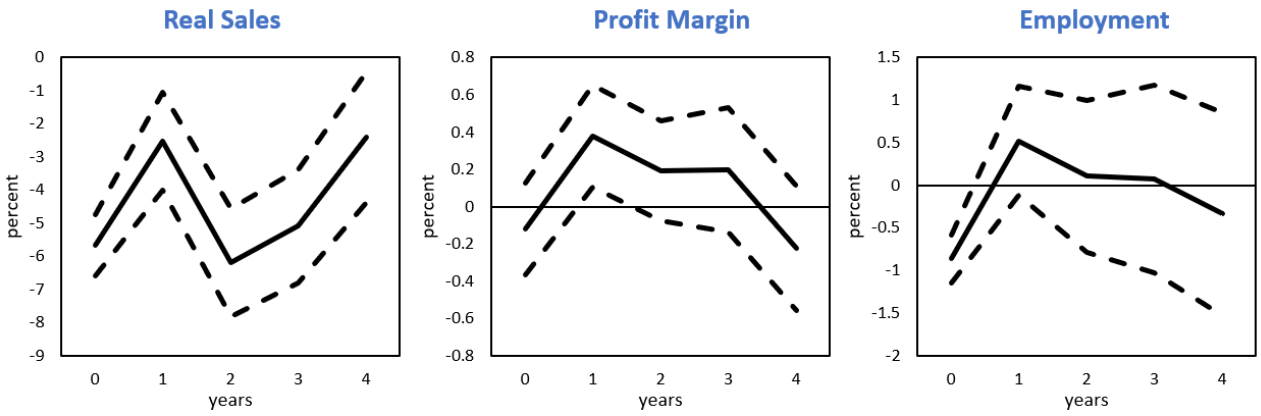


(c) Differential impact in high trade openness countries, pre-COVID



Notes: The first row shows the estimated response of real sales (in log), profit margin, and the number of employees (in log) to one-year-ahead inflation uncertainty, with 68 percent confidence intervals. The second row shows the differential response for firms in high financial openness countries, and the third row shows the differential response for firms in high trade openness countries. All use data prior to the COVID-19 pandemic (i.e., before January 2020).

Figure A.6: Impact of Inflation Uncertainty on Firms: Without Imputed Data



Notes: Figure shows the estimated response of real sales (in log), profit margin, and the number of employees (in log) to one-year-ahead inflation uncertainty, with 68 percent confidence intervals. This specification excludes imputed data.