The Impact of Supply Chain Disruptions on Business Expectations during the Pandemic*

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Abstract

Utilizing the Federal Reserve Bank of Atlanta's Business Inflation Expectations (BIE) survey, which has been continuously collecting subjective probability distributions over own-firm future unit costs since October 2011–we build a measure of firms' aggregated marginal cost expectations (a key determinant in price-setting behavior). We document two facts about firms' marginal cost expectations and risk during the COVID-19 pandemic. First, in the early months of the pandemic, firms, on net, saw COVID-19 largely as a demand shock and lowered their one-year ahead expectations. However, as the pandemic wore on, firms' one-year ahead unit cost expectations rose sharply alongside their views on supply chain and operating capacity disruptions. Second, entering into the pandemic, the balance of unit cost risks were weighted to the downside, as more weight was assigned to the lowest two bins in the five-bin distribution. By December 2022, however, upside cost risks had sharply outweighed the potential for perceived downside risks over the year ahead. We find that both positive demand shocks (e.g. large order backlogs) and negative supply shocks (e.g. long supplier delivery times and labor shortages) have contributed to elevated short-term unit cost expectations and risk.

*This research was initiated while Brian Prescott was in the Research Department at the Federal Reserve Bank of Atlanta. The views expressed here are the authors' and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System.

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1 Introduction

At the onset of the pandemic, Meyer, Prescott and Sheng (2022, MPS hereafter) elicited firms' expected changes in selling prices, realized and anticipated wage growth, and qualitative responses to questions about the level of disruption the onset of the COVID shock was having on business operations, sales activity, and supply chains. Amid a sharp decline in firms' quantitative sales gaps, results to all of these special questions were in line with the notion that firms perceived the onset (and through the first 8 months) of the pandemic as a net *demand* shock.

However, as the pandemic continued, sales revenue, demand, and real output recovered relatively quickly. By the second quarter of 2021, real GDP growth had fully recovered its pre-pandemic level. Amid the resumption in real activity at the beginning of 2021, labor supply remained depressed and it became increasingly clear that supply chain disruption and shipping bottlenecks constrained the ability of firms to meet the rebound in demand. This paper builds on MPS (2022) and extends it along three dimensions.

First, we provide a complete picture of business unit cost expectations over the course of pandemic. In sharp contrast to firms' views early in the crisis, firms' one-year ahead unit cost expectations have risen sharply. Our interpretation is that the dramatic rise in firms' year-ahead unit cost expectations largely reflects the level of supply chain and labor disruption experienced. At the time of this analysis, firms anticipated these disruptions and lack of labor availability to persist well into 2023, a fact not lost on monetary policymakers.

Second, we go beyond simply looking at the first moment (i.e. mean) to explore a higher-moment (i.e. skewness) of survey expectations. Entering into the pandemic, after an extended period of low, stable inflation, these nominal marginal cost risk indicators reveal that balance of risks were weighted to the downside, as more weight was assigned to the lowest two bins in the five-bin distribution. However, firms quickly reversed course, placing more and more weight in the upper two bins. By April 2022, firms were assigning more than one-third of the weight to unit costs persisting above 5 percent increases over the year-head and just 2 percentage points of weight to a sharp decrease in unit costs. These are striking shifts in the balance of risks to firms' unit cost outlook. By the end of our sample, upside (inflationary) risks had far outweighed the potential for perceived downside (deflationary) risks over the year ahead.

Third, we explore the role of supply chain disruptions in driving unit cost expectations and risk. We find that supply chain disruption and bottlenecks (along with labor constraints) imparted significant upward pressure on firms' costs. Moreover, using our unique data on year-ahead business unit cost expectations in conjunction with special question modules that build upon the Census Bureau's Small Business Pulse Survey, we find a meaningful impact of disruption on firms' year-ahead expectations. Supply disruption has impacted goods-producing firms to a greater extent than service-providing firms, and this is reflected in their year-ahead expectations. The effects of supply chain disruptions on firms' unit cost expectations and risk remain significant even after controlling for demand factors (orders backlog, new orders or sales gap).

Our paper is closely related to a large literature on using survey expectations to elicit agents' beliefs. For example, Cavallo et al. [2017] and Afrouzi and Yang [2021] document firms' and households' pervasive inattention to aggregate inflation. Altig et al. [2022] and Meyer and Sheng [2022] elicit business expectations and uncertainty on own-firm quantities (i.e. unit cost, sales revenue and employment growth) to make inferences for the aggregate economy.

Our paper also builds on the burgeoning literature on the impact of the COVID-19 pandemic on economic activity and agents' expectations. Bartik et al. [2020], Balleer et al. [2020], Alekseev et al. [2022], and Hassan et al. [2023] found that firms, on net, viewed the onset of the pandemic as a demand shock, lowering their inflation expectations and selling prices. Yet, by early 2021, broadening and intensifying supply chain disruption was leading to elevated costs and item stockouts Cavallo and Kryvtsov [2021], much higher producer price index Santacreu and LaBelle [2022], accelerated transportation costs Benigno et al. [2022], and a sizable and persistent reduction in labor force participation Rodríguez-Clare et al. [2023].

The rest of the paper proceeds as follows. Section 2 briefly discusses the data set. Section 3 analyzes the dynamics of firms' expectations during the pandemic. Section 4 explores the role of supply and demand factors in driving firms' unit cost expectations and risks. Section 5 concludes. Additional tables and graphs are relegated to the online appendix.

2 Data

The primary data source used is the Federal Reserve Bank of Atlanta's Business Inflation Expectations (BIE) survey. The BIE is a monthly survey of business owners, executives, and managers in the sixth Federal Reserve district that has been fielded continuously since October 2011. During each wave, in addition to two short qualitative introductory questions, firms provide their expectation of year-ahead nominal marginal (unit) cost expectations and perceived year-over-year unit cost growth. Additionally, respondents are asked a set of rotating quarterly questions and a short set of special questions in each wave. The rotating quarterly questions capture information on firms' quantitative sales gaps relative to "normal", drivers of cost and price pressures, and their longer-run (5-10 year ahead) unit cost expectations.

Broadly speaking, the 6$^{\text{th}}$ Federal Reserve District, which spans most of the American Southeast, mirrors the makeup of the US in terms of industry and firm-size breakdown. By design, the panel composition of the BIE roughly reflects the makeup of the national economy at the two-digit NAICS level. The evolution of the BIE's one-year ahead unit costs expectations is of primary interest in this paper. These expectations are elicited probabilistically using a method popularized by Manski [2004]. The choice to elicit firms' forward expectations for unit costs is dually motivated. First, utilizing the long and rich literature on eliciting the inflation expectations of households, we chose to focus on a key determinant of price-setting behavior that is intimately connected to aggregate inflation and is salient in the minds of respondents. Second, as shown in Meyer and Sheng [2022], the term "unit costs" are synonymous with nominal marginal costs – a key driving variable for firms' price-setting behavior in the micro-founded New Keyensian Philips Curve Sbordone [2005]. As Meyer and Sheng [2022] show, firms' unit cost realizations vary meaningfully by industry, but once aggregated covary strongly with aggregate inflation statistics.[1] And, while own-firm unit cost expectations also vary meaningfully by industry, upon aggregation, firms' aggregated unit cost expectations tend to mirror professional forecasters' year-ahead inflation expectations. In this sense, aggregating up firms' own-cost realizations and expectations gives us a useful measure of future price pressures that are salient in the perceptions and expectations of businesses.

Eliciting and tracking own-firm or industry-level expectations that are less likely to suffer from inattention and noisy beliefs about aggregates is becoming more prevalent. Recent work by Afrouzi [2020] argues for aggregating expectations of competitors (industry-level) price expectations due to strategic inattention that creates a wedge between prices firms find relevant and aggregate inflation expectations. Others, such as Verbrugge and Zaman [2021] evaluate the performance of aggregated own-firm expectations and show that the BIE's unit cost expectations perform strongly in both in-sample and pseudo out-of-sample inflation forecasting exercises.

The BIE questionnaire contains space (at the end of every monthly survey) for short,

[1] Additional assurances of response quality and external validity such as survey response rates, the impact of tenure on first and second moment expectations, the impact of question wording, responses to cognitive interviews, and the relationship of BIE responses to other national expectations surveys can be found in Meyer and Sheng [2022].

special question modules. This space allows researchers to ask questions that are policy-relevant, topical, or related to broader academic research. These "special" questions are increasingly being used by researchers across a variety of survey efforts to uncover causal estimates, engage in randomized controlled trials, and test the inclusion of alternative questions for future changes in core questionnaires. In this paper we build on the special questions fielded in the BIE early in the pandemic to gauge how firms were responding to the initial COVID shock (see MPS 2022) to elicit information for how firms' behavior and expectations evolved as the pandemic wore on.

To measure the breadth and severity supply disruptions and crimped labor supply were having on firms' realizations and expectations, we began fielding a repeated module of special questions in March 2021. Specifically, we expanded on a well-designed and tested set of questions fielded in the Census Bureau's Small Business Pulse Survey.[2] In March, June, and August 2021, February 2022, and August 2022, we fielded these questions; see details in Online Appendix A. Rather than just replicating the Census' results – which reflect the share of firms experiencing each aspect of disruption in supply chains and the operating capacity of the firm – we expanded on these questions by asking follow-up questions designed to gauge the intensity of the disruption the firm was experiencing. For example, if a respondent indicated that they were experiencing "supplier delays", we posed a follow-up asking business executives, "How would you describe the impact of each disruption your business encountered?" The response options were "none", "little to none", "mild", "moderate", and "severe".

We cover the results of these questions in the following section. While these results were quite informative on their own merit, especially for policymakers,[3] to make full use of the breadth and scope of these supply-side constraints and relate them to firms' unit-cost expectations, we transformed these responses into firm-level intensity-of-disruption indexes. To create this measure, we first assigned a score from 0 to 4 to each special question response based on whether they responded "None" (0), "Little to none" (1), "Mild" (2), "Moderate" (3), or "Severe"(4). We then add their scores to obtain their disruption index. For example, in March 2021 the mean disruption index value for firms in goods-producing industries was 9.3 and 6.6 for service-providing firms. And, consistent with anecdotes, other research, and news stories, the disruption indexes were the highest in manufacturing industries (9.75) and trade and transportation industries (9.1).

[2] https://www.census.gov/data/experimental-data-products/small-business-pulse-survey.html

[3] https://www.atlantafed.org/news/speeches/2021/10/12/bostic-the-current-inflation-episode

In addition to the BIE microdata and special question results, we utilize other measures of disruption that researchers have leaned on heavily to explore supply and demand factors on firms' behavior and expectations during the pandemic – namely, order backlogs and supplier delivery times for the manufacturing and nonmanufacturing sectors from the Institute of Supply Management. In a regression framework, we also use the Federal Reserve Bank of New York's Global Supply Chain Pressure Index, which is an amalgamation of several different indicators of cross-boarder transportation costs (i.e. the Baltic Dry Index, the Harper Index, PPIs for air transportation costs) and country-level manufacturing PMIs.[4] To relate these supply and demand factors to firms in the BIE panel, especially with regard to foreign supply chain disruption, we use average foreign bottleneck exposure values graciously provided to us by Santacreu and LaBelle [2022].

Next, we evaluate the evolution of survey measures of inflation expectations and compare them to the BIE aggregated unit-cost measure as the pandemic has evolved. Specifically, we compare the aggregate BIE 1-year ahead unit cost expectations to other well-known and often-cited survey measures of household (University of Michigan and FRBNY) and professional (Survey of Professional Forecasters and Blue Chip) inflation expectations.

3 Evolution of Firms' Expectations during the Pandemic

3.1 At the Onset: March 2020–December 2020

At the onset of the pandemic, firms, on net, viewed the COVID-19 shock as a demand shock (MPS 2022). Amid the sharpest decline in economic activity in the post-WWII era, firms, en masse, lowered their year-ahead unit cost expectations, lowered current and expected sales prices, and, especially for firms that were experiencing significant COVID-related disruption, lowered nominal wages for many high- and low-skill workers. Moreover, in response to special questions regarding the severity of the impact COVID was having on firms' sales activity, supply chains, and business operations, the majority of firms indicated that the disruption to sales activity was far more severe than the attendant supply chain disruption. Interestingly, MPS (2022) also found that, in April 2020, even firms that were experiencing significant or severe supply disruption anticipated lowering sales prices over a 6-month ahead period. In sum, while elements of both a supply shock

[4] https://libertystreeteconomics.newyorkfed.org/2022/01/a-new-barometer-of-global-supply-chain-pressures/

and a demand shock were present at the onset of the pandemic, firms, on net, viewed the initial months of the pandemic as a demand shock.

However, as the pandemic wore on into 2021, even amid a very large reallocation shock and a dramatic amount of dispersion across firm sales revenue Barrero et al. [2020], demand rebounded sharply. By the second quarter of 2021, real GDP had regained its pre-pandemic levels. And, firms clearly felt the return of demand. Figure 1 plots firms' quantitative sales gap measure from the BIE for all firms and by firm size classes. Firms of all sizes experienced the sharpest decline in sales levels relative to "normal" in the short (decade long) history of the BIE. Prior to the pandemic, this survey-based measure of a sales gap carried a very high correlation with the CBO's output gap measure. Consistent with Bartik et al. [2020], the smallest firms reported a much larger hit to sales levels than firms with more than 100 employees. Moreover, these patterns are also consistent with other business survey findings that elicited the anticipated impact of COVID on sales levels in 2020 Bloom et al. [2021].

3.2 As the Pandemic Wore On

"*As the reopening continues, shifts in demand can be large and rapid, and bottlenecks, hiring difficulties, and other constraints could continue to limit how quickly supply can adjust...*"

— Chair Powell. June 16, 2021[5]

Since the resumption from the severe and short recession in April and May 2020, economic activity rebounded quickly. Within 4 quarters after the onset of the pandemic, firms' quantitative sales gaps had turned positive for all but the smallest firms in the panel. And, by early 2022, firms' quantitative sales gaps had turned sharply positive. As was the case early in the pandemic, there was a dramatic amount of dispersion in firm-level expectations and realized sales revenues as the economy recovered Meyer et al. [2022a]. Goods-producing firms and many service-providing firms, especially those connected to the resumption of travel, experienced a huge pick-up in demand.

Firms in the BIE panel clearly felt the attendant increase in cost pressure brought on by disruption. Figure 2 plots firms' unit cost realizations over the past year alongside the year-over-year growth rate in the GDP deflator. The correlation is quite astounding and provides some further support for the role that unit costs play in inflation determination as well as support for the external validity of our survey instrument.[6] Despite the sharp

[5] https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20210616.pdf

[6] Some will note that the sharp increase in both unit cost realizations and the GDP deflator starting in late 2020 is contributing to the tight comovement in both series (as we show is the case between household and

decline at the onset of the pandemic, and consistent with Santacreu and LaBelle [2022], firms' unit costs rose sharply starting in the fourth quarter of 2020. By late 2021, the series had reached its highest levels on record (dating back to 2011). At the same time, we also saw a surge in firms' aggregated unit cost expectations, peaking at levels roughly double its pre-pandemic average.

One additional (and unprecedented in our decade-long timeseries) aspect of firms' unit cost expectations during the COVID pandemic has been the evolution in firm-level probability distributions. As we mentioned at the outset of this paper, we elicit firm-level subjective probability distributions for year-ahead unit costs by utilizing a fixed-bin approach popularized by Manski [2004]. We can track the evolution of how much weight firms are assigning to each bin. Figure C.1 plots the distribution of firm-level probabilistic unit cost expectations over a year-ahead horizon. The center of this distribution moved lower and more responses accumulated on the left side after the onset of the pandemic in March 2020. Yet by the fourth quarter of 2020, the distribution of year-ahead unit cost expectations began to move sharply to the right. Firms' year-ahead unit cost expectations peaked in April 2022 and have come down modestly concurrent with the improvement in supply chain disruption indicated by all the indexes we utilize in this paper. However, as of December 2022, firm's year-ahead unit cost expectations were still about 50 percent higher than their pre-pandemic norms.

Figure 3 plots three simple measures of skewness, averaging across firms in the panel. The first is simply the weight assigned to the highest bin (unit costs up greater than 5%) minus unit costs decreasing more than a percentage point. The second is the difference between the highest two bins and the lowest two bins. And, the third is simply the average weight assigned to the highest bin. In essence, these measures are indicators of unit cost risk, with the last measure just tracking upside risks as opposed to the balance of risks. And, while a fulsome investigation of how unit cost risk relates to the anchoring of expectations is outside the scope of this paper, Figure 3 elucidates how the typical firm's projections for future unit cost have evolved over the course of the pandemic. Entering into the pandemic, after years of low, stable inflation (below the FOMC's price stability target), these unit cost risk indicators reveal that balance of risks were weighted to the downside (as more weight was assigned to the lowest two bins in the five-bin distribution). In April and May of 2020, the typical firm had assigned a nearly 15 percent likelihood that their costs were going to decline by more than 1 percent over the year ahead and just an 8 percent likelihood of unit costs increasing greater than 5 percent. However, firms quickly reversed course, placing

firm inflation expectations in the next section). However, the pre-COVID correlation coefficient is 0.88.

more and more weight in the upper two bins. By April 2022, firms were assigning more than one-third of the weight to unit costs persisting above 5 percent increases over the year head and just 2 percentage points of weight to a sharp decrease in unit costs. These are striking shifts in the balance of risks to firms' unit cost outlook. By the end of our sample, upside risks had far outweighed the potential for perceived downside risks over the year ahead. These risk measures also help provide context for the BIE's unit cost uncertainty metrics, which have fallen during the course of the pandemic. Essentially, firms, en masse, have reacted strongly to the persistent disruption and elevated cost environment over the past two years.

3.3 Comparison to Other Survey-based Inflation Expectations

Much attention has been paid to household-based measures of inflation expectations at the outset of the pandemic, the University of Michigan's Survey of Consumers (MSC) and the New York Fed's Survey of Consumer Expectations (SCE). Figure 4 clearly shows that over the early months of the pandemic in 2020, household expectations increased sharply. For example, the MSC measure increased by 1.1 percentage points to 3.2 percent over the course of a single month – from April 2020 to May 2020. The increase in the NY Fed's SCE measure wasn't quite as sharp, rising 0.4 percentage points in May 2020.[7] While some may be tempted to view this divergence as households held an initial view that the COVID shock was a supply-side shock, as shown in Meyer et al. [2022b], grocery store prices comprised nearly the entirety of the upper tail of the price change distribution for the consumers' market-basket. Moreover, as forwarded by Cavallo et al. [2017], households form beliefs about aggregate price movements based on salient items that they frequently observe – namely food and energy prices. That these price changes for grocery store items and gasoline impart a disproportionate impact on households' year-ahead expectations, combined with a sharp increase in these relative prices at the onset of the pandemic likely led to the divergence.[8]

As the pandemic wore on, amid burgeoning and (eventually) seemingly persistent supply chain disruption and labor constraints, retail price pressure broadened out significantly.

[7] Interestingly, the NY Fed's questionnaire elicits both point estimates and expected values from probabilistic distributions. And, in May 2020, the median point prediction rose by roughly 1 percentage point to 4.1 percent. See Engelberg et al. [2009] for discussions on the divergence between point and probabilistic expectations.

[8] An alternative explanation, forwarded by Afrouzi and Yang [2021] argues that, as inflation rose sharply and became more volatile during the pandemic, inflation expectations have become more sensitive to news about relevant price pressures.

Figure C.2 plots the expenditure-weighted share of the CPI rising at rates greater than 3 percent and 5 percent, respectively. At the onset of the pandemic, these shares fell modestly, but remained within their typical, pre-pandemic relevant ranges, an indicator that much of the price movement in the overall CPI (and core CPI) was driven by swings in a few relative price changes rather than a fulsome shift in underlying inflation. However, as we moved through 2021 that changed swiftly. By May 2021, two-thirds of the CPI price-change distribution was rising at rates greater than 3 percent. And, by June 2022, almost 80 percent of the retail market-basket was rising at rates greater than 5 percent – a clear signal that inflationary pressures had become quite widespread and very intense (rising to its highest level since early 1981). In fact, the U.S. has not witnessed an inflationary period like the current episode since the Great Inflation period of the 1970s and early 1980s, so long ago that the majority of the prime-age working population hasn't had prior first-hand experience with a high inflation environment.

Amid these widespread price pressures, all survey-based measures of year-ahead inflation expectations increased sharply. While there is disagreement across all measures in terms of the level of expected inflation, directionally all measures are converging. Figure 5 plots recursive/rolling 5-year correlation coefficient between the year-ahead expectations from the BIE panel and the Blue Chip Panel of Economic forecasters' year-ahead expectations, and the MSC and SCE household measures of inflation expectations. As discussed at length in Meyer and Sheng [2022], over the pre-pandemic period, firms' and professional forecasters' expectations comove strongly but are nearly uncorrelated with MSC household expectations and are only weakly correlated with the SCE's median probabilistic year-ahead aggregate inflation expectations.[9] However, by the end of our sample period, nearly all measures carry the same high correlation.

One interpretation of this, at least directional, convergence is that due to the overwhelmingly widespread and elevated inflationary environment, the influence of salient food and energy prices in the minds of households when forming aggregate inflation expectations has been essentially washed out, in that the majority of all prices in the economy are rising at elevated rates. That said, should the relative prices of gasoline and at grocery stores begin to diverge from price pressures elsewhere in the economy, we would anticipate

[9]BIE 1-year ahead unit cost expectations are most highly correlated with 1-year ahead GDP Price Index expectations from the Philadelphia Fed's Survey of Professional Forecasters (SPF). Given that the BIE is eliciting unit cost expectations from a panel of businesses comprising firms across all broad industry and firm-size cuts, the most apt aggregate inflation statistic for comparison is the GDP Deflator – which is a much broader measure of inflationary pressures than aggregate statistics based on retail prices alone. Hence, the very high correlation with the SPF's 1-year ahead GDP Deflator expectations is unsurprising to us (especially given that unit cost realizations track the GDP deflator very closely as well).

the correlation between firms' and households' inflation expectations to revert to their pre-COVID averages.

4 Firms' Unit Cost Expectations and Disruptions

4.1 The Effect of Supply Chain Disruptions

On the supply side, supply chain disruption and shipping bottlenecks were evident in the Institute for Supply Management (ISM)'s supplier deliveries indexes for both goods-producers and service-providers; see Figure 6. Outside of a sharp spike at the onset of pandemic, these measures rose sharply, again with strains appearing first and more severely in the manufacturing sector and then becoming quite evident in the services sector as well. A broader measure of supply chain disruption, the Global Supply Chain Pressure Index (GSCPI) from the NY Fed, which captures global crimps in supply chains and shipping bottlenecks showed a very similar surge, peaking at 4 standard deviations above its average value in December 2021. These indexes began to re-trace their upside movements starting in early 2022. As of December 2022, the GSCPI was back down to just 2 standard deviations about its average value and the ISM supplier deliveries indexes (especially for the manufacturing sector) had ebbed appreciably.

Consistent with both the ISM data and the NY Fed's GSCPI, in March 2021 we found that more than half of the firms in our panel felt some form of supplier delay; see Table I. The prevalence of this disruption is particularly striking for a few reasons. First, the BIE panel, like the nation, is disproportionally weighted toward service-providing firms. Second, three months prior, in a separate special question, "supply chain concerns" ranked eighth out of their top 10 concerns for the year-ahead.[10] In addition to issues receiving raw materials and intermediate inputs from suppliers, a little more than one in three firms in the BIE panel also indicated they were experiencing delays in fulfillment and roughly a third indicated they were having difficulties with their employees' availability to work.

Even more striking, back in March 2021, was that conditional on experiencing "supplier delays," the majority indicated they were already experiencing moderate-to-severe disruption. In fact, nearly 40 percent of the overall panel indicated the presence of "moderate to severe" delays in supplier deliveries as of March 2021.

The breadth and intensity of supply disruption only grew more severe throughout 2021

[10] https://www.atlantafed.org/research/inflationproject/bie/special-questions.aspx?pub_year=2020

and into early 2022. Figure C.3 plots the evolution of the "moderate to severe" intensity for the most frequently experienced responses to this special module on supply chain disruption and operational capacity. By February 2022, nearly 60 percent of firms in the BIE panel indicated "moderate to severe" supply chain disruption and 36 percent indicated delays in delivery of their product or service (roughly corresponding with the peak in the NY Fed's GSCPI). Moreover, by early 2021, nearly half of the firms in the BIE panel indicated "moderate to severe" issues with employee availability and 44 percent indicated that the availability of supplies or inputs was impacting their ability to meet demand.

In August 2022, there was some indications of supply chain "thawing" (again, consistent with the ISM and GSCPI), as the share of firms experiencing supplier delays edged down to 60 percent and only half of the panel indicated that supplier delays were "moderate to severe." However, firms continued to indicate growing and intensifying pressures in the availability of labor.

Comparing these responses to the Census Bureau's Small Business Pulse Survey, we find that the relative rankings of sources of disruption are quite similar – supplier delays far outweighed other supply chain disruptions, and the "availability of employees for work" was the most frequently cited sources of disrupted operations. Yet we find a greater incidence of disruption (even if we restrict our sample only to small firms).[11]

There is one other important aspect of relating firm-level survey evidence to macroeconomic data on supply chain disruption and shipping bottlenecks, and this has to do with the endogenous impacts of supply and demand. Series from the ISM's PMI, such as order backlogs and delivery times are not entirely "clean" measures of demand and supply shocks. For example, order backlogs can represent both increased demand, but also could reflect delays in firms receiving intermediate inputs that would allow them to fulfill demand. Conversely, increased delivery times, while likely reflecting shipping bottlenecks and other supply-side constraints, could also be polluted by surging demand at the same time. Here, survey evidence may be helpful in disentangling firms' perceptions of whether supply or demand factors dominate. For example, in MPS (2022), firms clearly saw the impact the onset of the pandemic was having on supply and demand, and judged, in the

[11]For example, 40 percent of firms surveyed by the Census Bureau indicated supplier delays, which slightly more than half of firms indicated to us. Such a discrepancy is unlike previous comparisons to other Census Bureau work (which match quite closely) and could be the result of a number of survey-specific factors. For instance, the types of respondents differ markedly – whereas the BIE elicits responses mainly from those in the C-suite and business owners, the census typically aims for lower-level accounting and finance employees in a given organization. Additionally, the number of response options also differs slightly, and census respondents have seen these questions on disruption to supply chains and operating capacity numerous times over the pandemic.

balance, that the shortfall in demand was outweighing supply constraints. And, carefully constructed modules like the Census' Small Business Pulse (and our extension of their questions) allow researchers a more granular look into how firm managers are perceiving specific aspects of these supply and operational constraints. However, shortcomings in this approach are clearly felt in timeseries and panel regression methods. In order to disentangle supply and demand shocks using timeseries methods, researchers need a long timeseries of survey responses to these questions. Unfortunately, for business surveys like the BIE, question space is limited and special modules that we employ in this paper are clearly in response to policy-relevant, salient shifts in macroeconomic conditions. Further research on this topic is warranted, but outside the scope of this paper.

To relate our findings on supply chain disruption and crimped operational capacity to firms' year-ahead unit-cost expectations, we create a summary "Disruption Index" based on the special question modules detailed above. The firm-level disruption index is additive and GDP-weighted averages report the disruption index for the overall BIE Panel during each survey wave (see Figure 7).

A few aspects of Figure 7 standout. First, the mean level of disruption increases from a mean of 7 in March 2021 throughout the next year, peaking at nearly 11 by February 2022. Second, consistent with the broadening prevalence of supply chain disruption measured by the ISM's diffusion index, the mean and median converge over time. Also, there is a tremendous amount of heterogeneity in disruption. The spread of the interquartile range remains wide in each successive fielding wave.

Figure C.4 digs further into the nature of the supply disruption, by separating the disruption index by goods-producing and service-providing sectors. Given the relatively heavy reliance on physical inputs and materials in the production process, it should come as no surprise that the intensity of disruption is more highly felt by the typical goods-producing firm. In March 2021, the mean disruption index value for firms in goods-producing industries was 9.3 and 6.6 for service-providing firms. Yet, there is heterogeneity within these very broad industry breakdowns. Disruption was highest in manufacturing industries (9.75 in March 2021) and trade and transportation services industries (9.1). Also of note, the average disruption index value in goods-producing industries leveled out between August 2021 and February 2022, while it continued to increase in service-providing industries, reaching an average value of roughly 9 by February 2022. This, again, is consistent with the growing prevalence of labor constraints, as the demand for labor continued to increase alongside the swift resumption of economic activity, but the labor force participation rate remained depressed relative to its pre-pandemic levels throughout this time period.

In Figures 8, 9, and C.6, we relate firm-level year-ahead unit cost expectations, risk, and balance of risk to their own-firm disruption indexes. The binscatters show a meaningful relationship between disruption and unit cost expectations and risk. Although supply chain disruption and operational difficulties are not the only factor influencing year-ahead unit-cost expectations, we can clearly see that firms experiencing the largest levels of disruption tend to be those that hold higher expectations for future unit cost and higher upside risk.[12] The slope of and fit of these regressions are consistent across all waves where we collect disruption information and when pooling across all waves.

The persistence of these supply shocks in the minds of business executives is one very interesting aspect of this relationship. While the binscatters in Figure 8 show a fairly consistent relationship between disruption and unit cost expectations over each successive wave, the relationship between disruption and average selling prices was much stronger in early 2022 than it was in mid-2021. One potential explanation for this is that firms, much like policymakers in early 2021, thought that these supply bottlenecks would be transitory, dissipating within a short enough period to allow firms to vary their markup and leave prices unchanged. We posed a follow-up question after the special question module on supply disruptions and operational constraints in June 2021, August 2021, February 2022, and August 2022, asking the following question to firms that indicated the presence of specific disruptive factor regardless of how intense: How long do you anticipate these disruptions will continue to impact your business? The response options were: "up to 3 months," "3-6 months," "6-12 months" and "longer than 12 months."[13] In June 2021, very few firms experiencing supplier delays anticipated them lasting longer than 12 months and the modal expectation was between 6-12 months. And, perhaps as interestingly, firms anticipated a rather quick resumption in their employees' availability to work. The majority of respondents experiencing labor disruption saw an end to these disruptions within 6 months.

However, by August 2022 – fourteen months after we first asked that question – nearly 40 percent of firms anticipated that supplier delays would continue for longer than 12 months, and almost half of respondents saw labor constraints binding for longer than a year. Thus, accumulated duration and the perceived persistence of these disruptive supply factors could account for the steepening in the slope in the relationship between selling

[12]In Figure C.5, we also relate firm-level disruption indexes to year-ahead price expectations. The results are similar.

[13]These results are posted on the Business Inflation Expectations Special Question repository, here: `https://www.atlantafed.org/research/inflationproject/bie/special-questions.aspx?pub_year=2021`

prices and firm-level disruption indexes.

In sum, like Santacreu and LaBelle [2022], we find that supply chain disruption and bottlenecks (along with labor constraints) imparted significant upward pressure on firms' costs. Moreover, using our unique data on year-ahead business unit cost expectations in conjunction with special question modules that build upon the Census Bureau's Small Business Pulse Survey, we find a meaningful impact of disruption on firms' year-ahead expectations and risk. Supply disruption has impacted goods-producing firms to a greater extent than service-providing firms.

4.2 Controlling for Demand Shocks

The empirical analysis above focuses on the impact of supply chain disruptions on unit cost expectations and risk. Amid constrained and disrupted supply chains, however, demand surged as well, as shown in Figure 6. The ISM's new orders and order backlog indexes for the manufacturing and services sectors show the breadth of the surge in demand. New orders diffusion indexes for both manufacturing and services sectors, which plummeted to their lowest levels since 2008 in April 2020, quickly rebounded with the manufacturing orders index peaking in late 2020. The new orders index for services also rebounded quickly, but peaked about a year later (presumably as vaccination became available to many and households were eager to resume life outside their home after the Delta wave of COVID). Moreover, order backlogs in the manufacturing sector rose almost continually throughout the late 2020 through early 2021 period, peaking in May 2021. The jump in services backlogs was more discrete, rising sharply in mid-2021 (shortly after the 3rd fiscal transfer in March 2021), peaking in October 2021.

To explore the joint effects of supply and demand factors on unit cost expectations, we consider the following regression:

$$Y_{it} = \beta^d D_t + \beta^s S_t + \gamma_i + \eta_t + u_{it}, \tag{1}$$

where Y_{it} is either year-ahead unit cost expectations or risk of sector i at time t, D_t is a measure of aggregate demand, and S_t a measure of aggregate supply. We also include sectoral fixed effect γ_i and time fixed effect η_t.

We use three proxies for demand shocks: ISM orders backlog index, ISM new orders index, and BIE sales gap. The two ISM indices are available at a monthly frequency while the BIE data is only available on a quarterly basis. We use ISM supplier delivery times index and FRBNY Global supply chain pressure index to proxy supply shocks. To make our regression results comparable, we normalize all of our variables, including unit cost expectations, risk, and balance of risk taken from the BIE, by the following transformation: $f(z) = z_{max}^{-1}(z - z_{min})$. Unit cost risk is the average probability assigned to year-ahead unit cost greater than 5 percent by firms. Balance of unit cost risk is defined as the average difference between the probabilities assigned to year-ahead unit cost greater than 5 percent and year-ahead unit cost lower than -1 percent.

Table II presents the regression results. Regardless of which proxies used, the demand shock is always statistically significant. Furthermore, after controlling for the impact of demand factors, supply disruptions, including both supplier delivery times and global supply chain pressure, contribute positively and significantly to elevated unit cost expectations (panel A), risk (panel B), and balance of risk (panel C). These results are comparable to a variety of other recent papers on pandemic-related disruption. Cavallo and Kryvtsov [2021] find that stockout hikes are associated with a significant inflationary effect that peaks within a couple of months. For the United States, a 10 percentage point increase in stockout rates raises monthly inflation by about 0.1 percentage point. But, the effect is also transitory. The invasion of Ukraine has resulted in a new set of supply shocks, increasing the world prices of energy and certain foodstuffs, metals, and other commodities and disrupting trade patterns. The Organization for Economic Cooperation and Development projects that if these supply shocks last for one year, they will reduce U.S. growth by almost one percentage point and raise U.S. inflation by almost 1.5 percentage points in the first full year (see Labonte and Weinstock [2022]). And, exposure to foreign bottlenecks, both in terms of supplier delivery times and backlogs, has a statistically significant effect on US PPI inflation. For backlogs, increasing the month-over-month backlogs by 1 percent increases the industry inflation rate by 0.24 percentage points, while the same increase for delivery times causes an increase of about 0.26 percentage points (see Santacreu and LaBelle [2022]).

Next, we expand the basic regression by interacting the supply and demand proxies with our measure of sectoral exposure to disruptions, E_i. We construct the exposure measure as follows. Let S_i be the set of firms in sector i, then $E_i = \frac{1}{44}\sum_{f \in S_i} d_f$ where d_f is the disruption index value of firm f. These specifications test whether unit cost expectations (Table III) and risk (Table B.2) at industries with greater exposure to disruptions covary more strongly with supply and demand factors. We find very strong evidence for this. However, it is difficult to disentangle the demand and supply effects because of the strong correlation between them. For example, the pileup of backorders reflects not only strong demand, but also signals shortage of products due to supply chain disruptions.

5 Conclusion

Firms, grappled in real-time to adjust to the unusual and evolving aspects of the COVID pandemic. We find that firms, on net, saw the first eight months of the pandemic as a demand shock. But, as the pandemic unfolded and the economy began to recover from the imposed lockdowns, supply chain disruption, shipping bottlenecks, and labor constraints grew in breadth and intensity, impacting the ability of firms to meet the strong, stimulus-fueled, surge in demand. Against this swift change current, firms rapidly ratcheted up their year-ahead expectations for pricing pressures, particularly those that were impacted by supply disruption and operating constraints. Moreover, the balance of risks, which were initially weighted to the downside, shifted markedly to the upside. Moreover, as discussed in Section 4, both positive demand shocks (increased new orders) and negative supply shocks (longer supplier delivery times and greater supply chain pressure) contributed to the elevated short-term unit cost expectations and risks.

We also view the findings in this paper as relevant to the current monetary policy discussions. Policymakers have begun raising interest rates swiftly in an effort to curb inflationary pressures and prevent elevated short-run inflation expectations from spilling over into the longer run. Chair Powell, in his press conference following the July FOMC meeting, noted that "if you have a sustained period of supply shocks, those can actually start to undermine or to work on de-anchoring inflation expectations".

This high-inflation environment is not lost on businesses. In fact, firms' perceptions (unit-cost realizations) have been highly correlated with the evolution of overall inflation over the course of the pandemic. When general prices increase, businesses' input costs also increase, and as higher costs squeeze margins, many firms will pass some or all of those costs on to their customers in the form of higher prices. Survey evidence we presented suggests a correlation between supply chain disruptions and higher year-ahead unit cost expectations. And, while supply chain disruptions aren't the only factor influencing expectations, firms with the largest levels of disruption tend to hold higher expectations for price pressures in the year ahead. So what are firms telling us about their expectations for the evolution of unit cost over the year ahead and beyond?

Perhaps the easiest way to see how much both short-run and five-year-ahead (long-run) unit cost expectations have moved over the past two years is to index them to their pre-pandemic growth rates. Firms' year-ahead expectations peaked at about twice their pre-pandemic period early in 2022 and, as of December 2022 are still about 1.5 times higher than their pre-pandemic averages. Firms' longer-run expectations peaked about 25 percent higher than the expectations we saw in late 2019 and, while ebbing modestly, remain above their pre-pandemic levels.

We can dig a bit deeper into firms' longer-run expectations by examining the average probability weights that firms assign to the potential outcomes for longer-run unit costs at different periods, as Figure C.7 shows. In this case, we look at the fourth quarter of 2019 and the second quarters of 2020, 2021, and 2022. These histograms illustrate the degree to which firms' longer-run unit cost expectations have shifted over the course of the pandemic. Here, two aspects of this shift are worth noting. First, through the middle of 2021, even as inflation metrics were beginning to heat up, the distribution of firms' longer-run expectations had not moved much. Second, during the past year, the average probability distribution shifted starkly. The typical panelist assigned more than 50 percent probability to longer-run unit cost increases of at least 3 percent per year through the end of 2022. And, while the modal expectation is for longer-run unit costs rose to 5 percent or more in mid-2022, the distribution of firms' longer-run unit cost expectations (while still right-skewed) started resembling its pre-pandemic averages by December 2022.

A couple of caveats are worth mentioning here. First, this is the first sizable "inflation shock" we've been able to examine in the BIE survey, we do not have a long enough time series to compare the current era to the Great Inflation period (1965-1982). At best, we can suggest that – given the high correlation between firms' unit cost expectations and professional forecasters' expectations – our measures would have performed similarly in the '70s and '80s. Also, as the extensive literature on consumer expectations documents, the possibility exists for business executives to base their projections for future unit costs largely on current conditions. Still, that last point cuts two ways. First, it's possible that, should inflation ebb meaningfully in the coming quarters, these longer-term expectations might follow suit. Conversely, persistently high inflation could further cement such expectations for the longer run, making it more challenging for policymakers to bring inflation back to their price-stability goals.

Said another way, the current bout of high inflation is unusual in many different ways, and how it will play out remains fraught with uncertainty. Firms' short- and long-run expectations have risen sharply, and longer-run expectations became more responsive to realized and short-run movements in expectations, so much so that the modal expectation in the second quarter of 2022 was on anticipated cost increases greater than 5 percent. While it's too early to declare that firms' longer-run unit cost expectations have become unanchored, the events of the past two years may have left longer-run unit cost expectations unsettled.

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Tables

Table I: Type and intensity of supply chain disruptions experienced by firms

In the last week, did your business have any of the following?	Share of firms					Moderate to severe disruption				
	Mar 21	Jun 21	Aug 21	Feb 22	Aug 22	Mar 21	Jun 21	Aug 21	Feb 22	Aug 22
Supplier delays	55.1	64.1	62	71	60	37.9	49.4	52	57	54
Difficulty locating alternate suppliers	23.7	34.7	41	40	36	16.7	27.1	36	33	47
Production delays	24.7	30	29	32	25	15.2	21.8	21	22	34
Delivery/shipping delays	37.4	41.8	41	45	34	22.2	30.6	34	36	40
None	35.9	31.2	31	24	30	–	–	–	–	–
In the last week, was your business's operating capacity affected by any of the following?	Share of firms					Moderate to severe disruption				
	Mar 21	Jun 21	Aug 21	Feb 22	Aug 22	Mar 21	Jun 21	Aug 21	Feb 22	Aug 22
Ability to re-hire laid off employees	13.1	22.4	21	21	14	9.1	17.1	18	18	25
Availability of employees to work	32.8	52.9	55	62	45	21.2	40.6	41	46	50
Ability of employees to work from home	11.1	7.1	5	11	5	5.6	3.5	3	7	9
Physical distancing of employees	15.2	4.1	14	6	6	8.6	1.8	6	2	9
Physical distancing of customers	17.2	6.5	10	9	6	8.6	3.5	6	4	12
Availability of PPE	2.5	1.2	1	2	1	1.5	0.6	0	0	2
Availability of other supplies or inputs	30.8	40	49	50	40	21.2	34.7	41	44	64
None	34.3	29.4	20	19	29	–	–	–	–	–

Notes: The columns March 2021, June 2021, August 2021, February 2022, and August 2022 correspond to the survey waves when the questions were asked.
Source: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.

Table II: Relationship between supply factors, demand factors, and unit cost expectations

Panel A: Unit cost expectations

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Backlogs	1.02***			0.697***		
	(0.063)			(0.059)		
Sales gap		0.221***			0.213***	
		(0.048)			(0.047)	
New orders			0.301***			0.237***
			(0.035)			(0.034)
Negative supply shock						
Supplier delivery times	-0.254***	0.265***	0.263***			
	(0.044)	(0.046)	(0.044)			
Global supply chain pressure				0.476***	0.861***	1.05***
				(0.072)	(0.081)	(0.077)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,463	2,459	7,463	7,460	2,458	7,460
R^2	0.12459	0.07575	0.06567	0.12561	0.10582	0.10048

Panel B: Unit cost risk

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Backlogs	0.729***			0.430***		
	(0.066)			(0.060)		
Sales gap		0.111**			0.102**	
		(0.050)			(0.049)	
New orders			0.140***			0.078***
			(0.030)			(0.029)
Negative supply shock						
Supplier delivery times	-0.123***	0.281***	0.256***			
	(0.039)	(0.045)	(0.045)			
Global supply chain pressure				0.633***	0.848***	1.01***
				(0.079)	(0.083)	(0.089)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,463	2,459	7,463	7,460	2,458	7,460
R^2	0.08568	0.05540	0.04784	0.09599	0.08617	0.08296

Panel C: Balance of unit cost risk

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Backlogs	0.996***			0.652***		
	(0.081)			(0.072)		
Sales gap		0.235***			0.229***	
		(0.059)			(0.058)	
New orders			0.299***			0.232***
			(0.041)			(0.039)
Negative supply shock						
Supplier delivery times	-0.257***	0.247***	0.249***			
	(0.051)	(0.054)	(0.052)			
Global supply chain pressure				0.538***	0.870***	1.07***
				(0.095)	(0.101)	(0.103)
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,463	2,459	7,463	7,460	2,458	7,460
R^2	0.09067	0.05703	0.04659	0.09267	0.08224	0.07593

*Significance Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: The variables new orders, backlogs, and supplier delivery times come from ISM. Firms' sales gap, unit cost expectations and risk come from the BIE. The sales gap question is only available on a quarterly basis. Lastly, global supply chain pressure is from the Federal Reserve Bank of New York.

Table III: Interaction of supply and demand factors with the sectoral exposure and their impact on unit cost expectations

Panel A: Demand measure - New orders

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
New orders	1.285***	0.5259	0.4725*	1.072***	0.4816*	0.7408***
	(0.1698)	(0.3270)	(0.2483)	(0.1660)	(0.2555)	(0.2822)
Negative supply shock						
Supplier delivery times	1.240***	1.516***	1.617***			
	(0.2102)	(0.5334)	(0.4286)			
Global supply chain pressure				1.048***	0.7983***	0.9349***
				(0.0757)	(0.2116)	(0.2216)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	7,460	7,460	7,460	7,460	7,460	7,460
R^2	0.06660	0.23802	0.25714	0.10091	0.23906	0.25831

Panel B: Demand measure - Backlogs

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Backlogs	4.190***	0.9101*	0.7167	2.822***	0.9185**	0.9722**
	(0.3114)	(0.4899)	(0.4429)	(0.3052)	(0.3749)	(0.4031)
Negative supply shock						
Supplier delivery times	-0.9810***	1.369**	1.201***			
	(0.2034)	(0.5729)	(0.4414)			
Global supply chain pressure				0.5234***	0.7266***	0.7643***
				(0.0707)	(0.2289)	(0.2066)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	7,460	7,460	7,460	7,460	7,460	7,460
R^2	0.11810	0.23777	0.25717	0.12196	0.23955	0.25857

Panel C: Demand measure - Sales gap

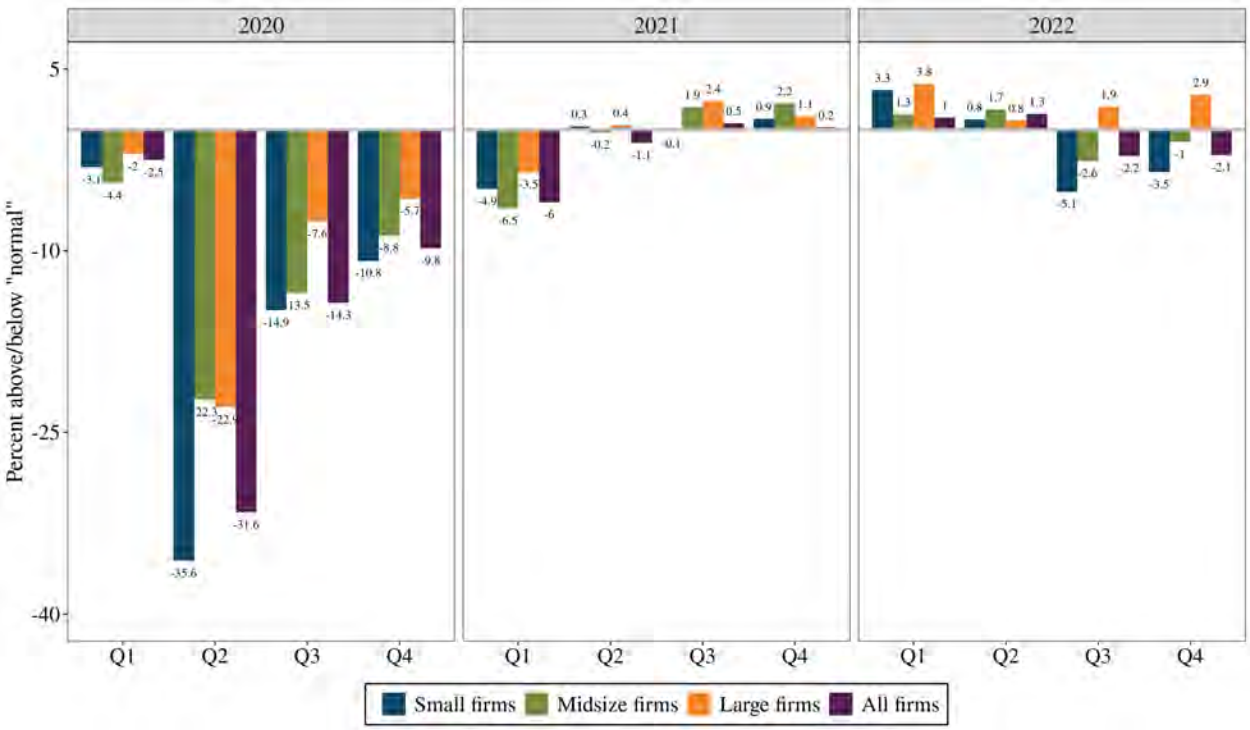
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Sales gap	0.8616***	0.0569	0.0140	0.7564***	-0.0189	-0.0084
	(0.2244)	(0.1500)	(0.2220)	(0.2200)	(0.1510)	(0.2197)
Negative supply shock						
Supplier delivery times	1.395***	2.121***	1.740***			
	(0.2926)	(0.6424)	(0.5652)			
Global supply chain pressure				1.218***	1.161***	1.008***
				(0.1086)	(0.3265)	(0.2723)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	2,214	2,214	2,214	2,214	2,214	2,214
R^2	0.07916	0.27188	0.29396	0.11888	0.27391	0.29480

Clustered (firm-level) standard-errors in parentheses
*Significance Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: The variables new orders, backlogs, and supplier delivery times come from ISM. Firms' sales gap and unit cost expectations come from the BIE. The sales gap question is only available on a quarterly basis. Lastly, global supply chain pressure is from the Federal Reserve Bank of New York. Each variable reported, except unit cost expectations, is interacted with the sectoral exposure measure E_i taken from the BIE.
Source: Federal Reserve Bank of Atlanta, Federal Reserve Bank of New York, and ISM; authors' calculations.

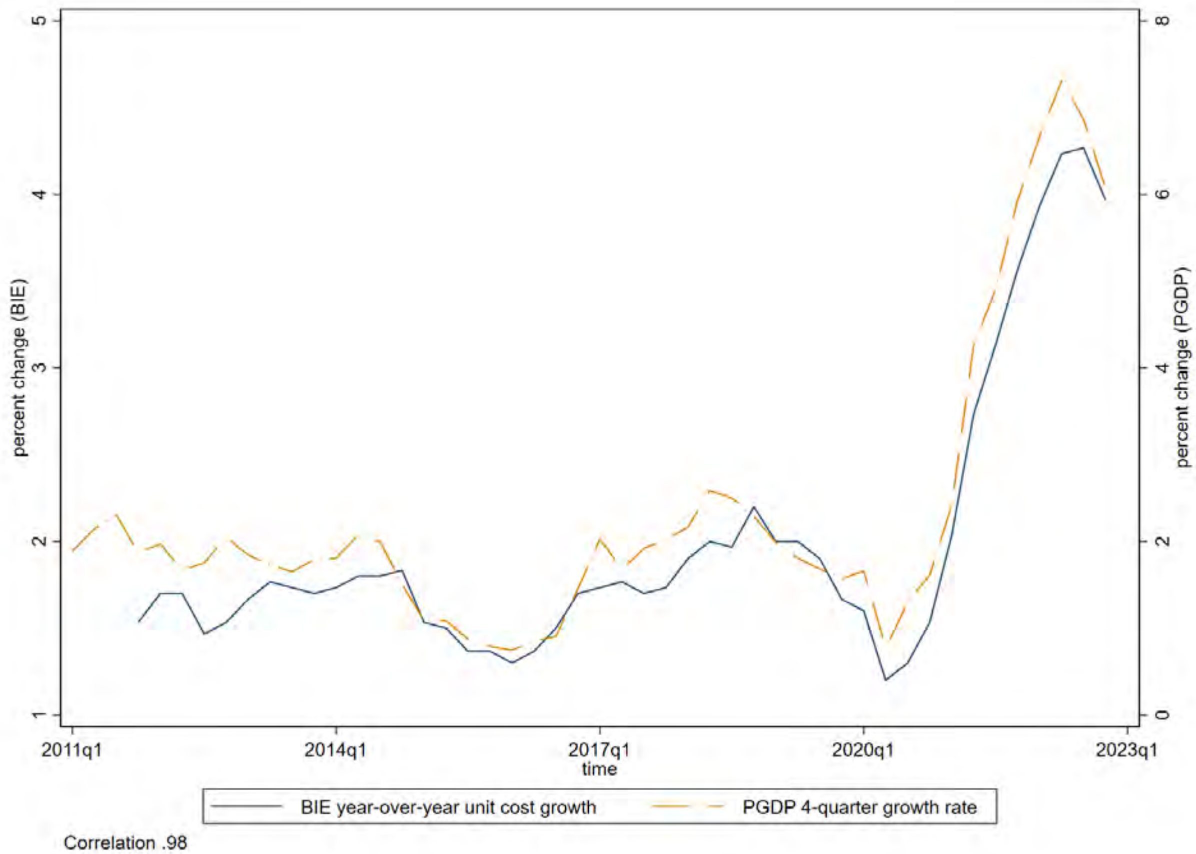
Figures

Figure 1: Distribution of firms' sales gap by size



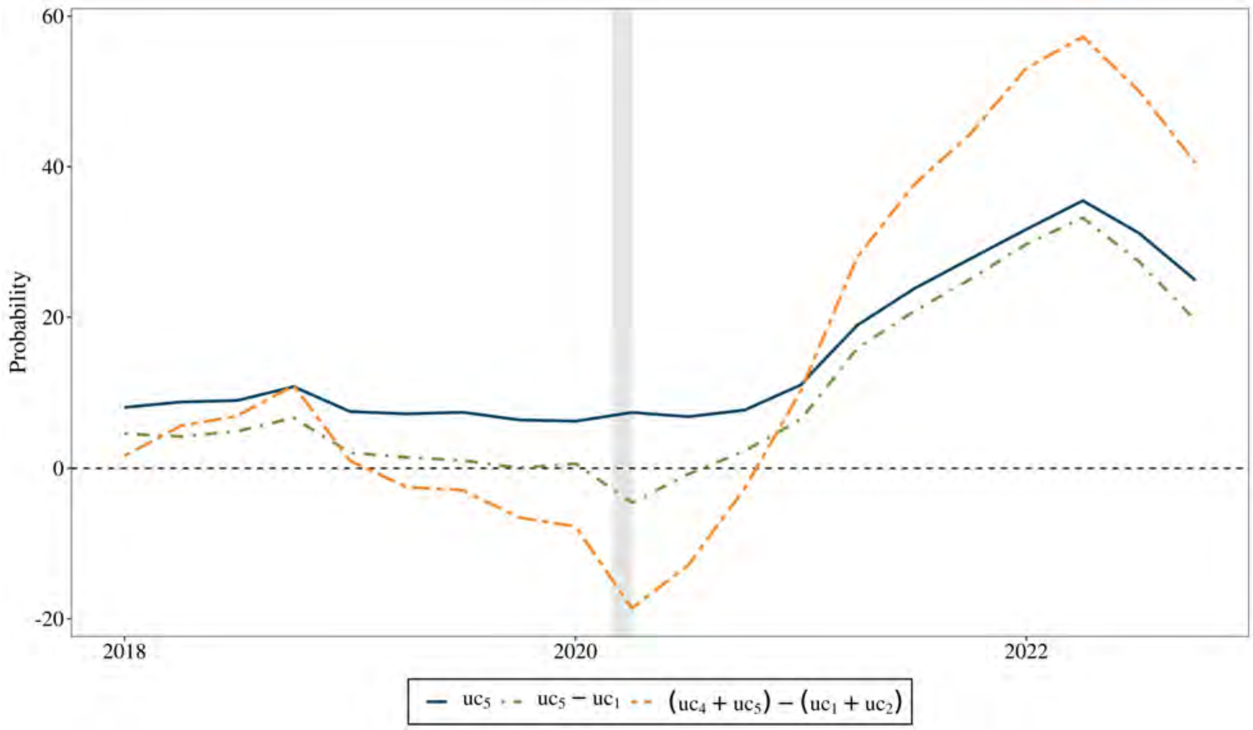
Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey.

Figure 2: Firms' realized unit cost growth vs actual inflation



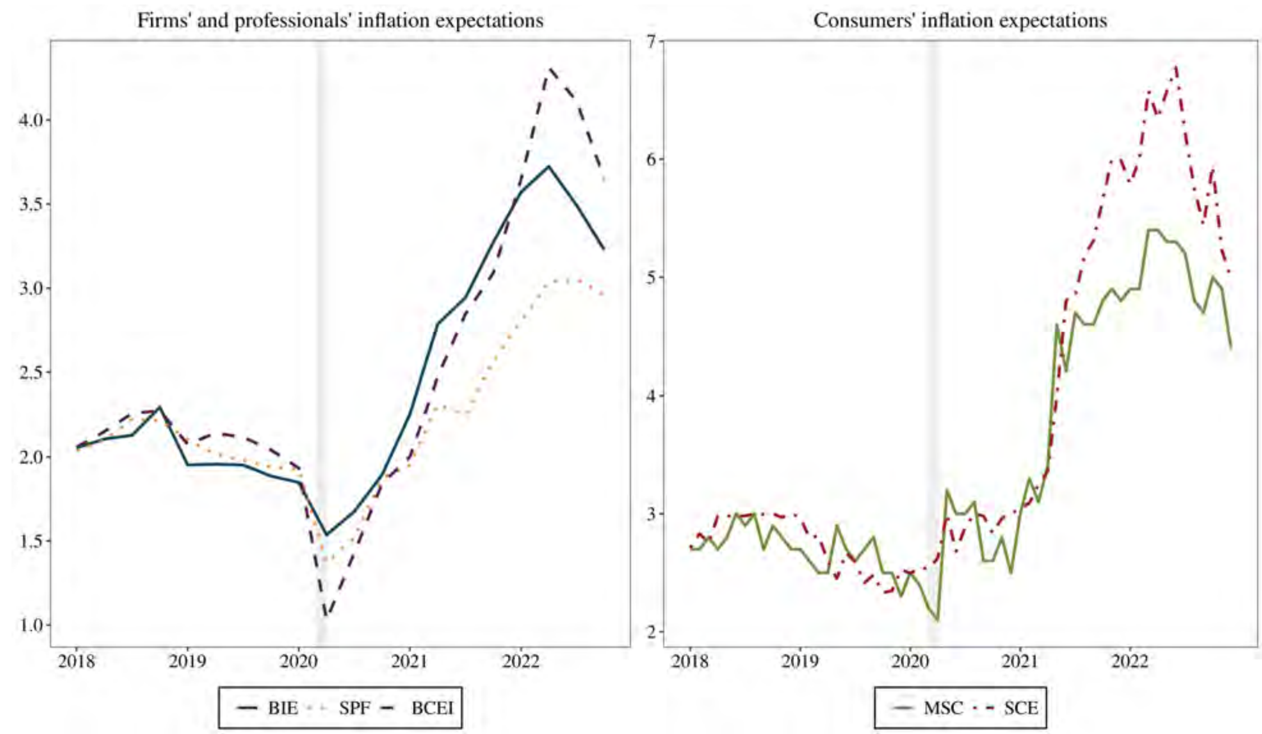
Sources: Bureau of Economic Analysis; Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey.
Notes: The sample period begins in 2011Q3 and ends in 2022Q4. The BIE series are weighted by industry-share of GDP and quarterly averages are plotted. Given the nature of the panel, the most apt comparison is to the broadest notion of overall inflation (i.e. GDP price index). The BIE series is plotted on the left axis and the GDP Price Index is plotted on the right axis.

Figure 3: Unit cost risk of firms



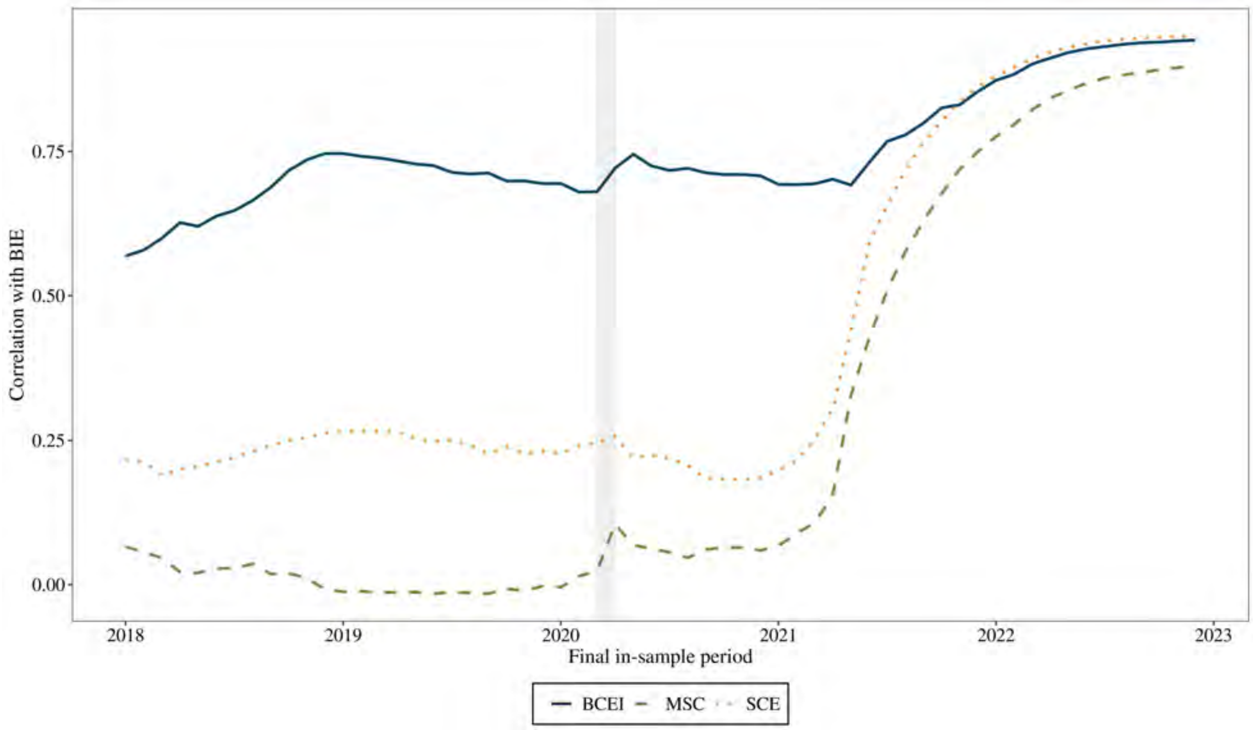
Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.
Notes: The terms uc_1, uc_2, uc_4, and uc_5 correspond to unit cost expectation probabilities for negative, no, significant, and very significant unit cost, respectively. Thus, the figure reads as the difference in probabilities assigned to high and low unit cost states. The shaded region represents the COVID-19 recession as defined by the NBER.

Figure 4: Time-series of inflation expectations by agent type



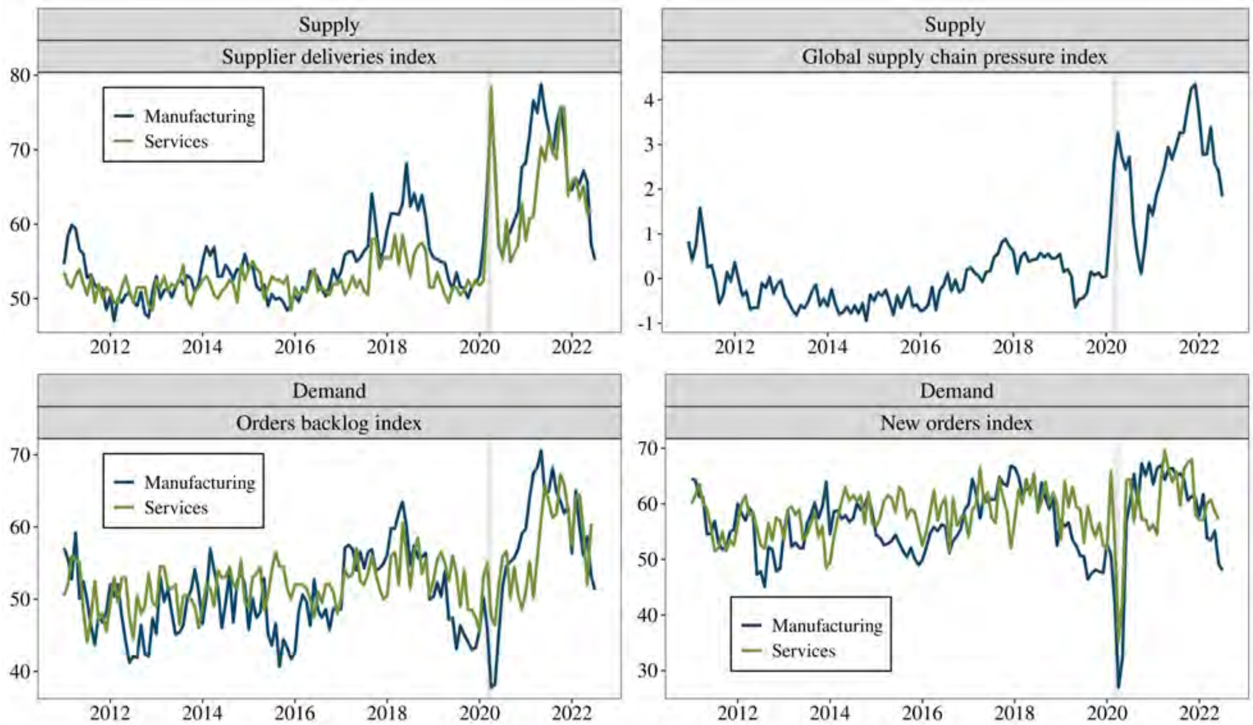
Sources: Federal Reserve Bank of Atlanta, Wolters Kluwer, Federal Reserve Bank of Philadelphia, Federal Reserve Bank of New York, and University of Michigan.
Notes: The surveys in the figure are as follows: Atlanta Fed's *Business Inflation Expectations* survey (BIE), Philly Fed's *Survey of Professional Forecasters* (SPF), Wolters Kluwer's *Blue Chip Economic Indicators* (BCEI), New York Fed's *Survey of Consumer Expectations* (SCE), and Michigan's *Survey of Consumers* (MSC). The BCEI displays year-ahead GDP price index expectations. The shaded region represents the COVID-19 recession as defined by the NBER.

Figure 5: Recursive correlation of monthly measures with BIE



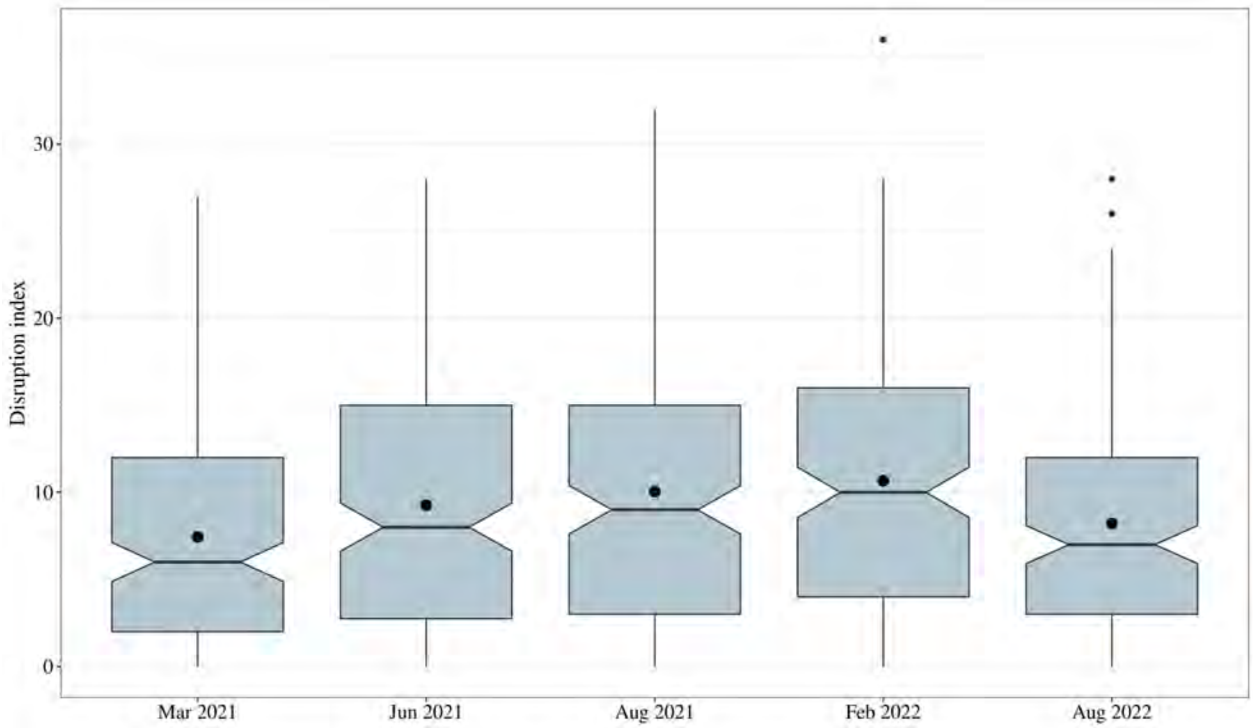
Sources: Federal Reserve Bank of Atlanta, Wolters Kluwer, Federal Reserve Bank of Philadelphia, Federal Reserve Bank of New York, and University of Michigan.
Notes: The surveys in the figure are as follows: Atlanta Fed's *Business Inflation Expectations* survey (BIE), Wolters Kluwer's *Blue Chip Economic Indicators* (BCEI), New York Fed's *Survey of Consumer Expectations* (SCE), and Michigan's *Survey of Consumers* (MSC). The BCEI displays year-ahead GDP price index expectations. The x-axis displays the final in-sample period used to calculate the correlation. The beginning of the sample period is October 2011, i.e. the beginning of the BIE survey. The shaded region represents the COVID-19 recession as defined by the NBER.

Figure 6: Time-series of measures for supply and demand



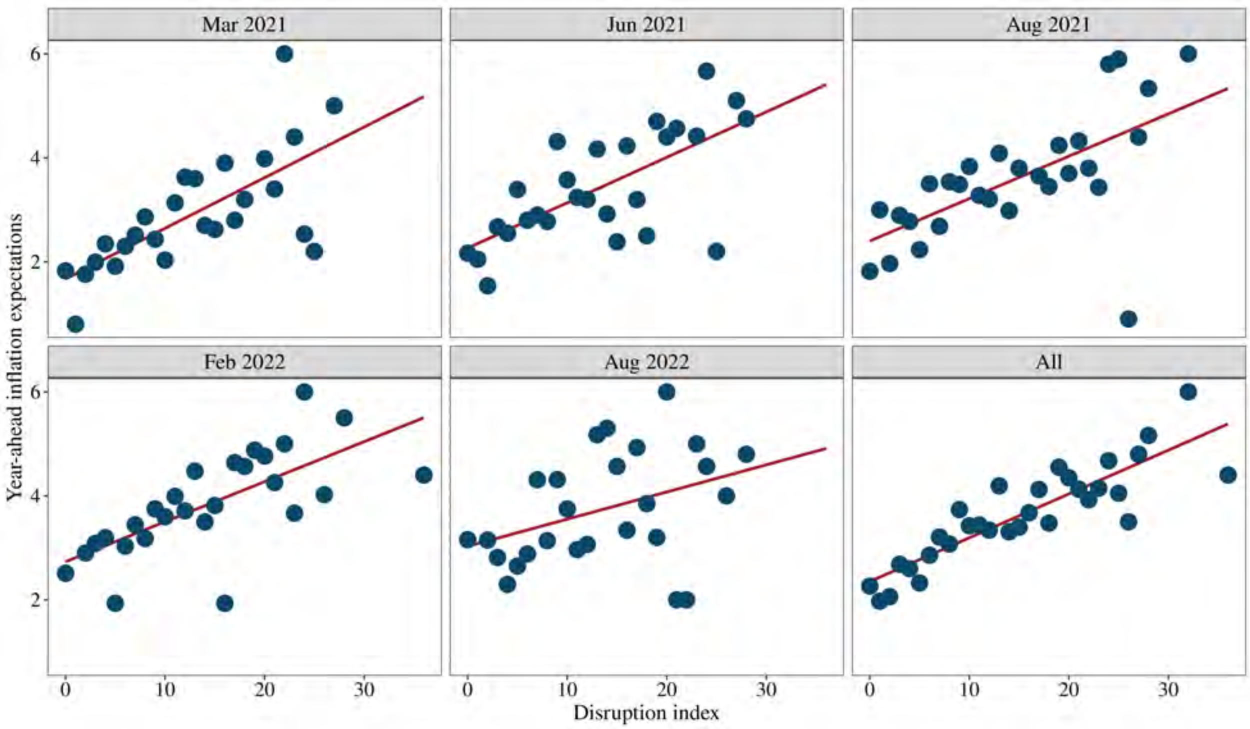
Sources: Federal Reserve Bank of New York, ISM.
Notes: The variables from ISM are new orders, backlogs, and supplier delivery times. Each of these variables is an index with maximum potential value at 100. We use the New York Fed's global supply chain pressure measure which is reported in standard deviations. The shaded region denotes the COVID-19 recession as defined by the NBER.

Figure 7: Box and whisker plot of supply chain disruptions



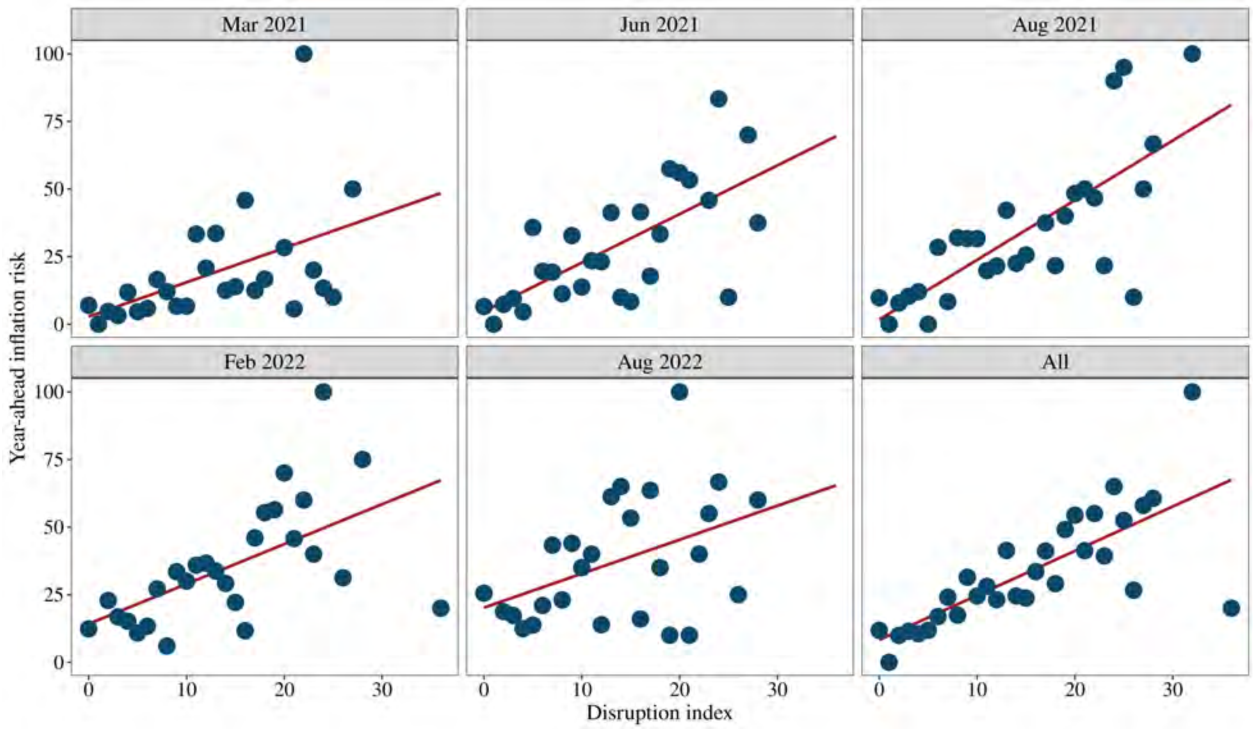
Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey, March 2021, June 2021, August 2021, February 2022, and August 2022; authors' calculations.
Notes: The horizontal rule represents the median disruption index, while the dot inside the boxplot represents the mean.

Figure 8: Business disruptions and short-run unit cost expectations



Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.
Notes: The binscatters are constructed using 30 bins.

Figure 9: Business disruptions and short-run unit cost risk



Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.
Notes: We define unit cost risk as the probability assigned to the largest year-ahead unit cost scenario. The binscatters are constructed using 30 bins.

Online Appendix:
The Impact of Supply Chain Disruptions on Business Expectations during the Pandemic

by Brent H. Meyer, Brian C. Prescott, and Xuguang Simon Sheng

Appendix A Special Questions of Census Bureau's Small Business Pulse Survey

Starting in Phase 2 of the program (beginning on August 8, 2020) the Census asked:[14] In the last week, did this business have any of the following?

- Domestic supplier delays
- Foreign supplier delays
- Difficulty locating alternative domestic suppliers
- Difficulty locating alternative foreign suppliers
- Production delays at this business
- Delays in delivery/shipping to customers
- None of the above.

In the last week, was this business's operating capacity affected by any of the following? Note: Operating capacity is the maximum amount of activity this business could conduct under realistic operating conditions.

- Availability of employees to work
- Ability of employees to work from home
- Availability of COVID-19 tests for employees
- Availability of COVID-19 vaccine for employees
- Physical distancing of employees
- Physical distancing of customers or clients and/or limits on the number of concurrent customers or clients
- Availability of Personal Protective Equipment (PPE) and/or related equipment or supplies
- Availability of other supplies or inputs used to provide good or services
- None of the above

[14] https://portal.census.gov/pulse/data/downloads/small-business-pulse-survey-questionnaire_08_09_2020.pdf

Appendix B Tables

Table B.1: Interaction of supply and demand factors with the sectoral exposure and their impact on unit cost risk

Panel A: Demand measure - New orders

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
New orders	0.6313***	0.3532	0.4170*	0.4402***	0.2314	0.7269***
	(0.1460)	(0.2893)	(0.2155)	(0.1458)	(0.2181)	(0.2564)
Negative supply shock						
Supplier delivery times	1.293***	2.018***	1.951***			
	(0.2109)	(0.4892)	(0.4099)			
Global supply chain pressure				1.002***	1.128***	1.344***
				(0.0881)	(0.2224)	(0.2424)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	7,460	7,460	7,460	7,460	7,460	7,460
R^2	0.05070	0.18564	0.19473	0.08359	0.18869	0.19909

Panel B: Demand measure - Backlogs

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Backlogs	3.156***	1.249***	1.306***	1.963***	1.003***	1.288***
	(0.3069)	(0.4697)	(0.4540)	(0.2943)	(0.3789)	(0.4045)
Negative supply shock						
Supplier delivery times	-0.4375**	1.286***	1.004**			
	(0.1749)	(0.4175)	(0.4214)			
Global supply chain pressure				0.6157***	0.8510***	1.109***
				(0.0762)	(0.2193)	(0.2288)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	7,460	7,460	7,460	7,460	7,460	7,460
R^2	0.08740	0.18690	0.19611	0.09786	0.19046	0.20063

Panel C: Demand measure - Sales gap

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Sales gap	0.4944**	-0.0040	-0.0845	0.3960*	-0.1188	-0.1130
	(0.2123)	(0.1461)	(0.2234)	(0.2082)	(0.1432)	(0.2220)
Negative supply shock						
Supplier delivery times	1.324***	2.588***	2.034***			
	(0.2910)	(0.6679)	(0.5224)			
Global supply chain pressure				1.135***	1.476***	1.433***
				(0.1211)	(0.3418)	(0.2740)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	2,214	2,214	2,214	2,214	2,214	2,214
R^2	0.05968	0.20310	0.21521	0.09682	0.20821	0.21968

Clustered (firm-level) standard-errors in parentheses
*Significance Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: The variables new orders, backlogs, and supplier delivery times come from ISM. Firms' sales gap and unit cost risk come from the BIE. The sales gap question is only available on a quarterly basis. Lastly, global supply chain pressure is from the Federal Reserve Bank of New York. Each variable reported, except unit cost risk, is interacted with the sectoral exposure measure E_i taken from the BIE.
Source: Federal Reserve Bank of Atlanta, Federal Reserve Bank of New York, and ISM; authors' calculations.

Table B.2: Interaction of supply and demand factors with the sectoral exposure and their impact on balance of unit cost risk

Panel A: Demand measure - New orders

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
New orders	1.310***	0.4236	0.5579*	1.088***	0.2664	0.8610***
	(0.1973)	(0.3401)	(0.2912)	(0.1927)	(0.2540)	(0.3254)
Negative supply shock						
Supplier delivery times	1.231***	1.722***	1.912***			
	(0.2523)	(0.6107)	(0.4907)			
Global supply chain pressure				1.068***	1.018***	1.328***
				(0.1019)	(0.2662)	(0.2834)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	7,460	7,460	7,460	7,460	7,460	7,460
R^2	0.04846	0.17575	0.18874	0.07675	0.17789	0.19182

Panel B: Demand measure - Backlogs

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Backlogs	4.263***	1.301**	1.282**	2.841***	0.9559**	1.291***
	(0.3918)	(0.5754)	(0.5802)	(0.3694)	(0.4326)	(0.4844)
Negative supply shock						
Supplier delivery times	-1.027***	1.040*	1.047**			
	(0.2358)	(0.5756)	(0.5320)			
Global supply chain pressure				0.5407***	0.7849***	1.098***
				(0.0907)	(0.2556)	(0.2607)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	7,460	7,460	7,460	7,460	7,460	7,460
R^2	0.09022	0.17658	0.18946	0.09337	0.17896	0.19257

Panel C: Demand measure - Sales gap

Model:	(1)	(2)	(3)	(4)	(5)	(6)
Positive demand shock						
Sales gap	0.8718***	0.0796	0.0740	0.7623***	-0.0225	0.0443
	(0.2643)	(0.1801)	(0.2728)	(0.2596)	(0.1814)	(0.2704)
Negative supply shock						
Supplier delivery times	1.486***	2.155***	2.179***			
	(0.3595)	(0.7677)	(0.6629)			
Global supply chain pressure				1.261***	1.246***	1.437***
				(0.1408)	(0.3938)	(0.3247)
Sector FE	Yes	No	Yes	Yes	No	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Observations	2,214	2,214	2,214	2,214	2,214	2,214
R^2	0.06105	0.20621	0.22199	0.09437	0.20913	0.22471

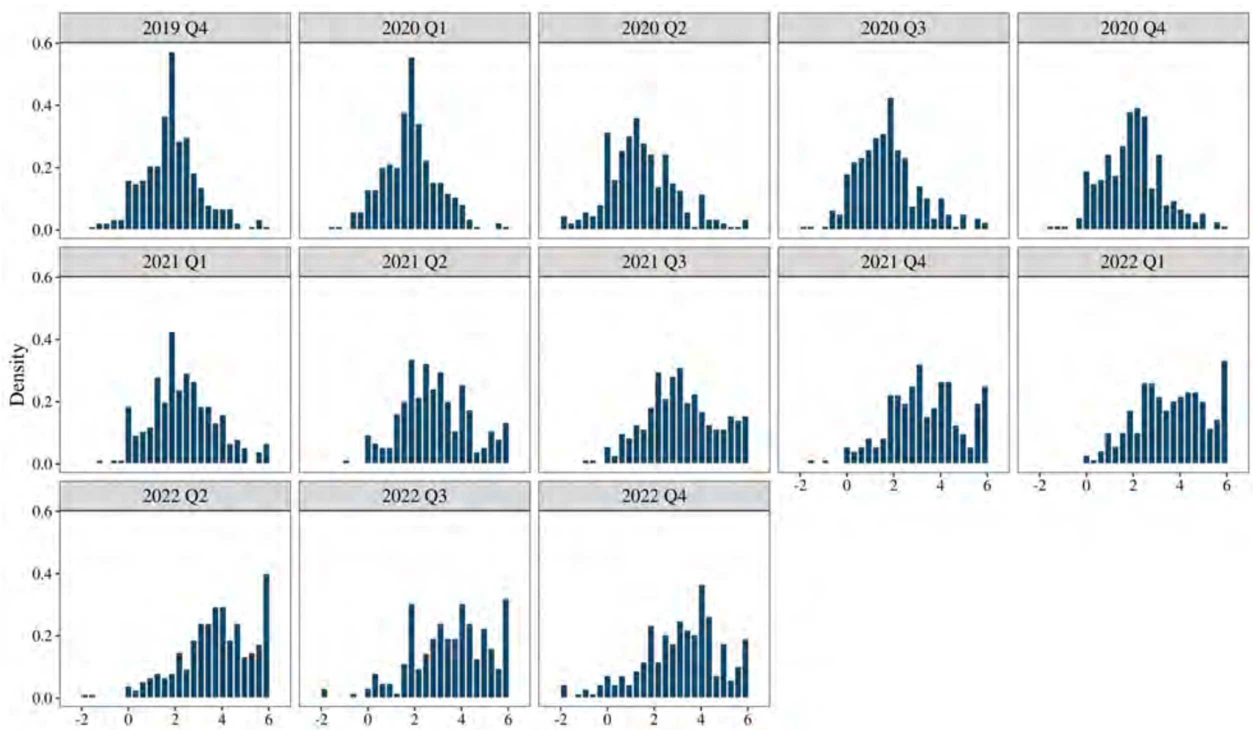
Clustered (firm-level) standard-errors in parentheses
*Significance Codes: ***: 0.01, **: 0.05, *: 0.1*

Notes: The variables new orders, backlogs, and supplier delivery times come from ISM. Firms' sales gap and balance of unit cost risk come from the BIE. The sales gap question is only available on a quarterly basis. Lastly, global supply chain pressure is from the Federal Reserve Bank of New York. Each variable reported, except balance of unit cost risk, is interacted with the sectoral exposure measure E_i taken from the BIE.

Source: Federal Reserve Bank of Atlanta, Federal Reserve Bank of New York, and ISM; authors' calculations.

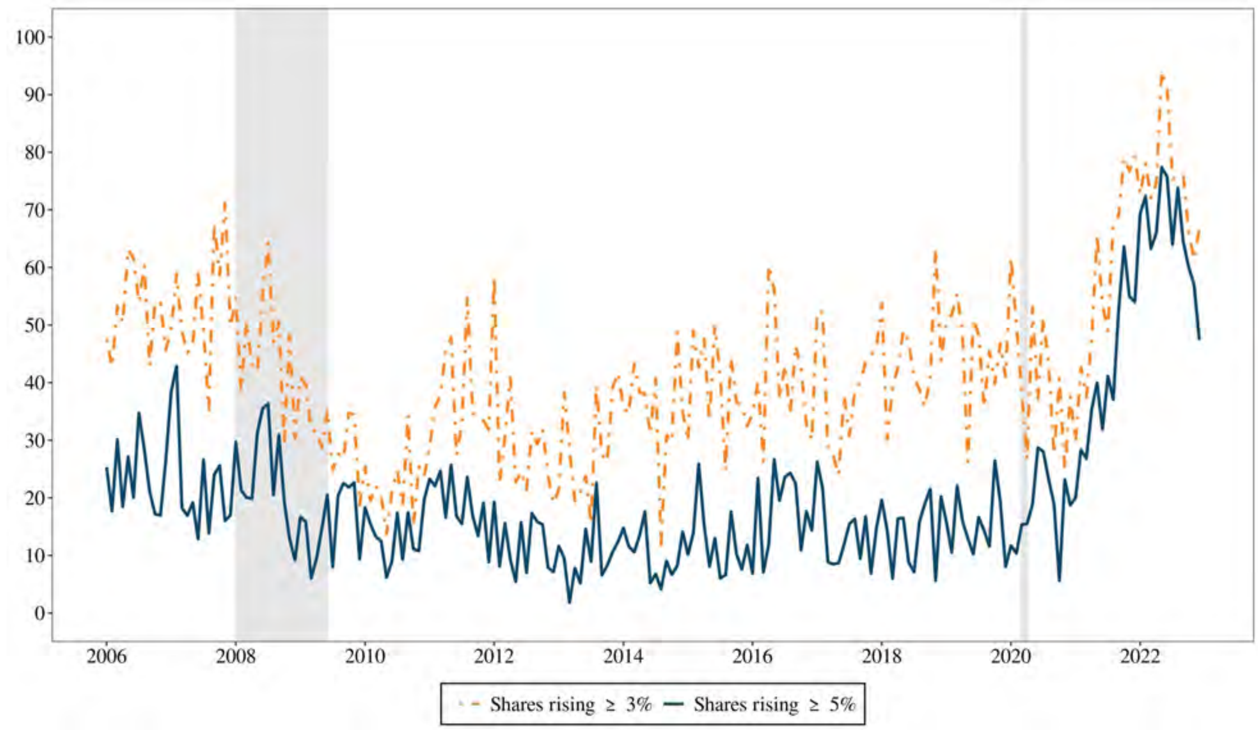
Appendix C Figures

Figure C.1: Distribution of firms' unit cost expectation densities



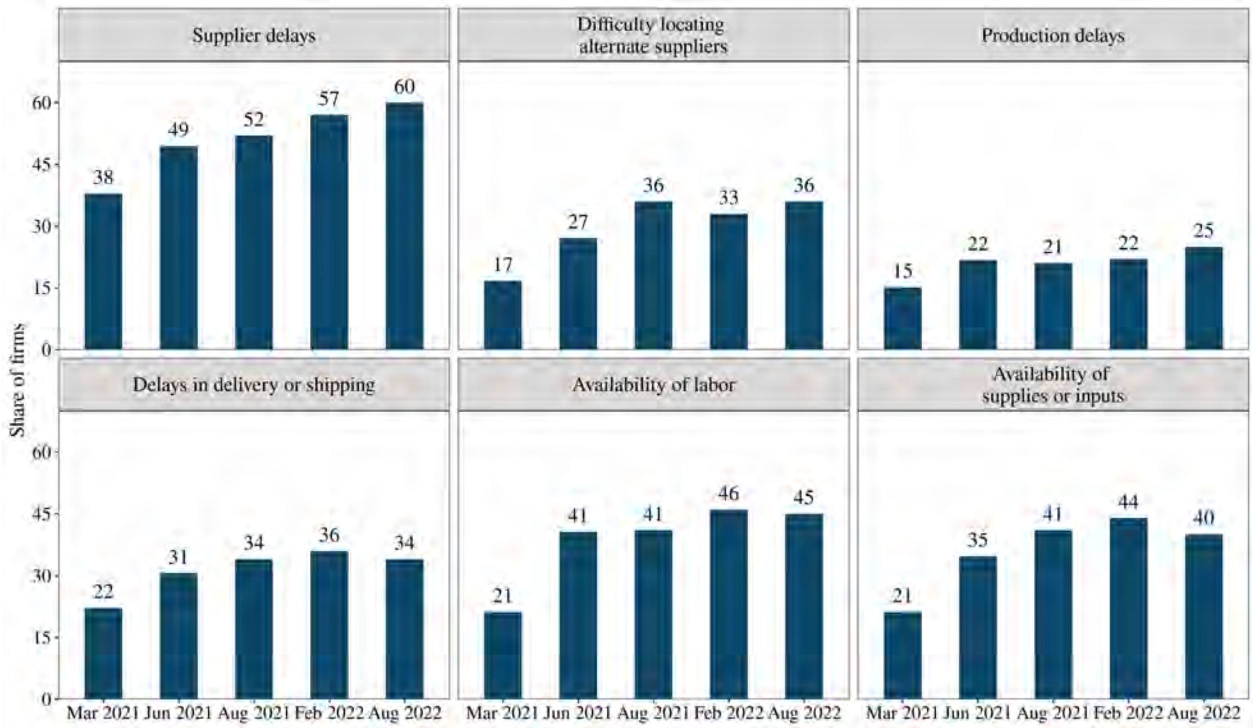
Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.

Figure C.2: Expenditure-weighted CPI price change distribution



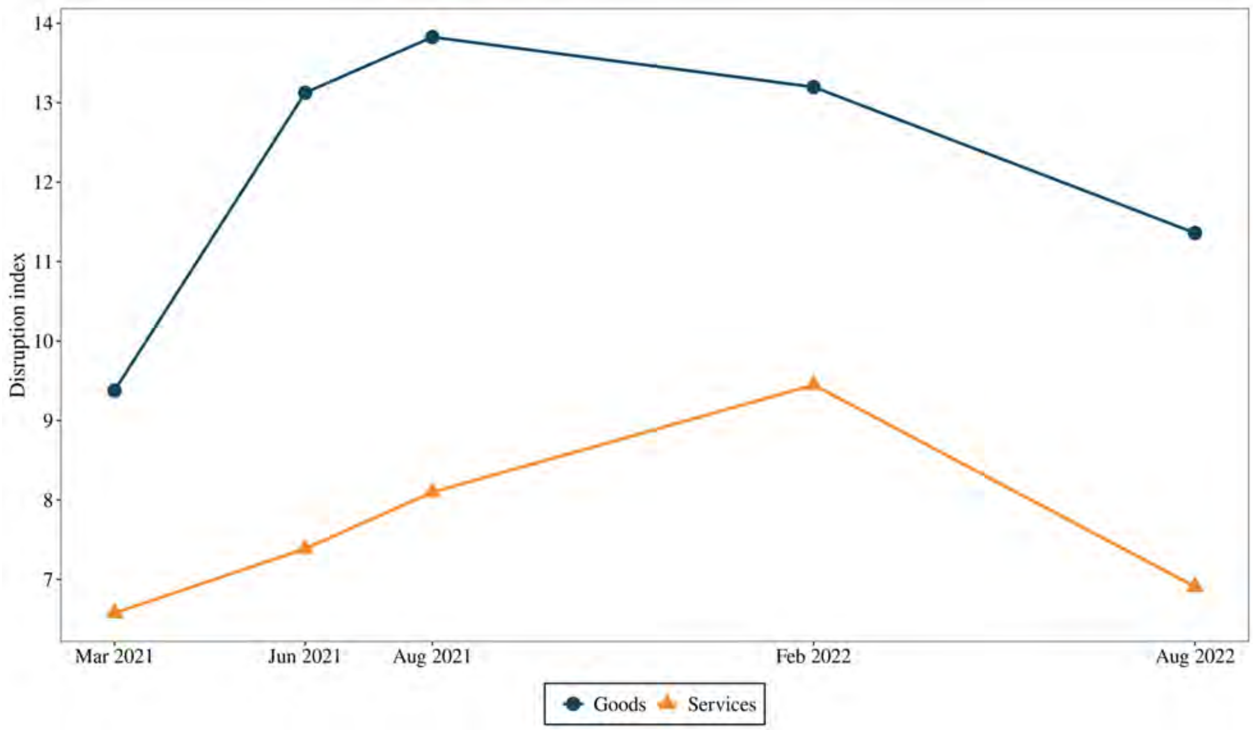
Sources: Bureau of Labor Statistics.
Notes: The shaded regions represent the Great Recession and COVID-19 recessions as defined by the NBER.

Figure C.3: Types of supply chain disruptions experienced by firms throughout the pandemic



Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey, March 2021, June 2021, August 2021, and February 2022; authors' calculations.

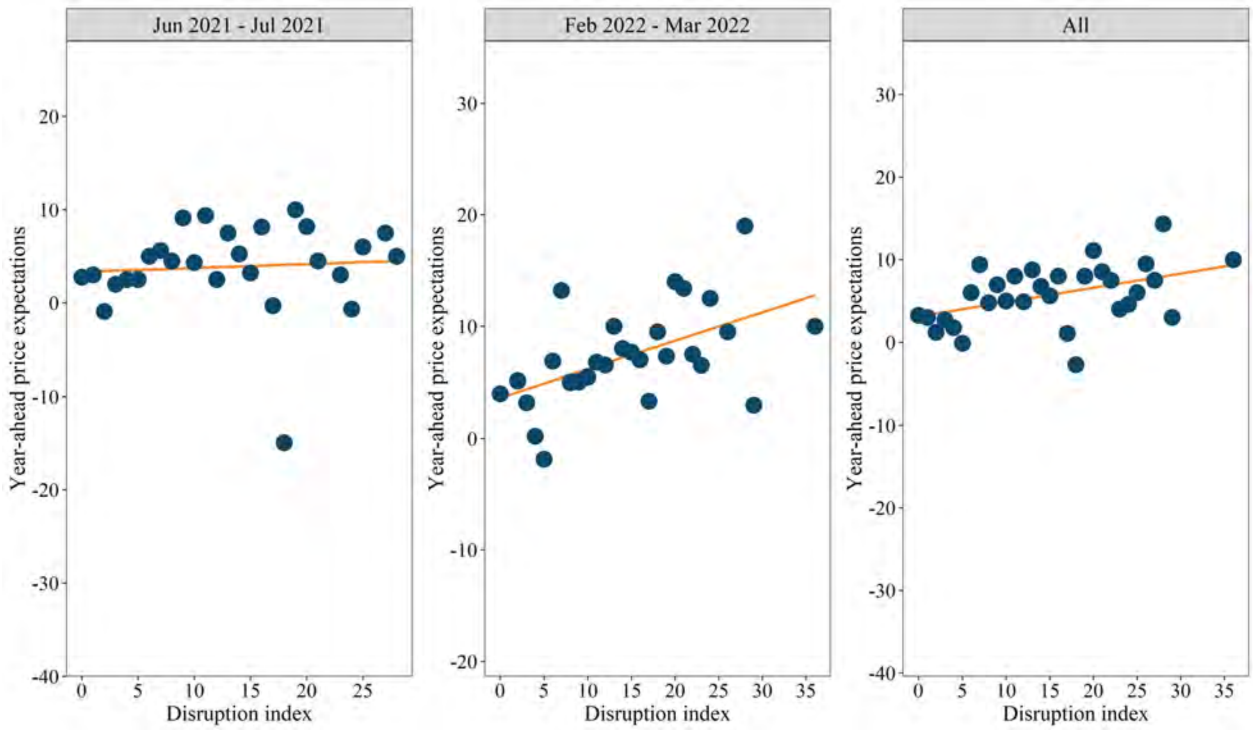
Figure C.4: Time-series of firms' level of supply chain disruption by firm type



Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.

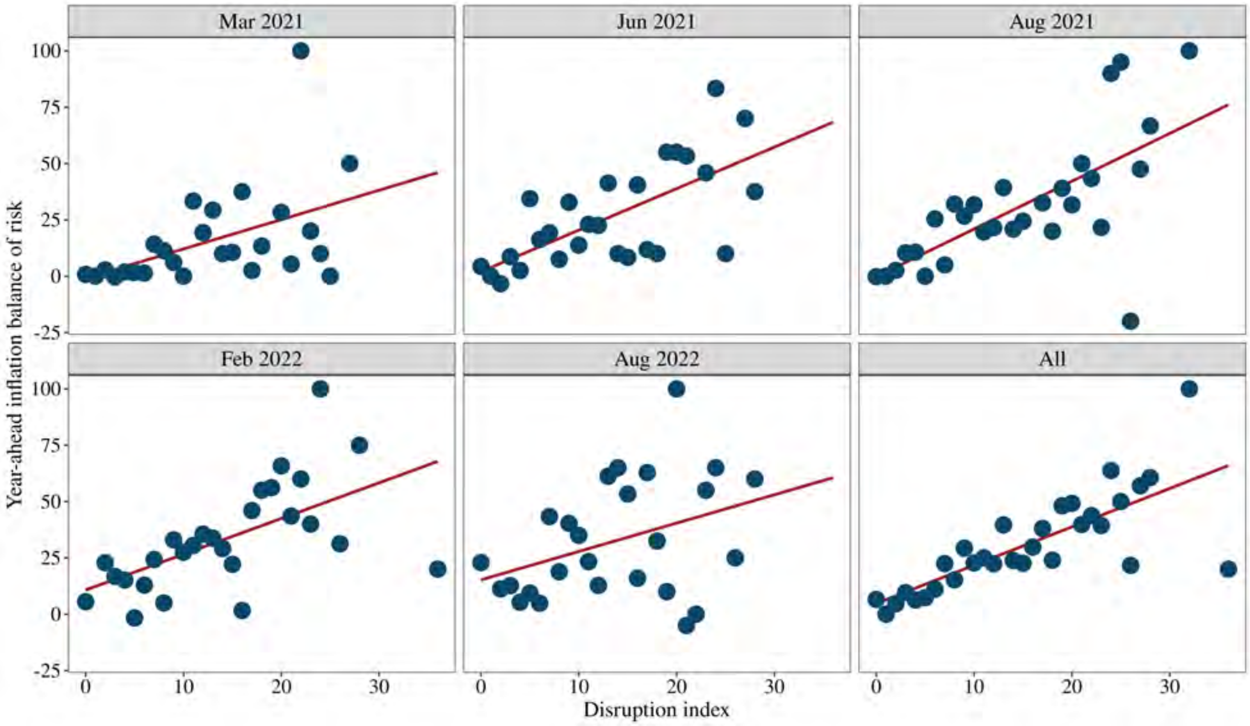
Notes: The y-axis represents the mean level of disruption reported by firms in the sector during that particular survey wave. A firm is considered "Goods" if they operate in the manufacturing, mining, utilities, or construction sectors. Otherwise, they are defined as "Services."

Figure C.5: Price expectations and business disruptions



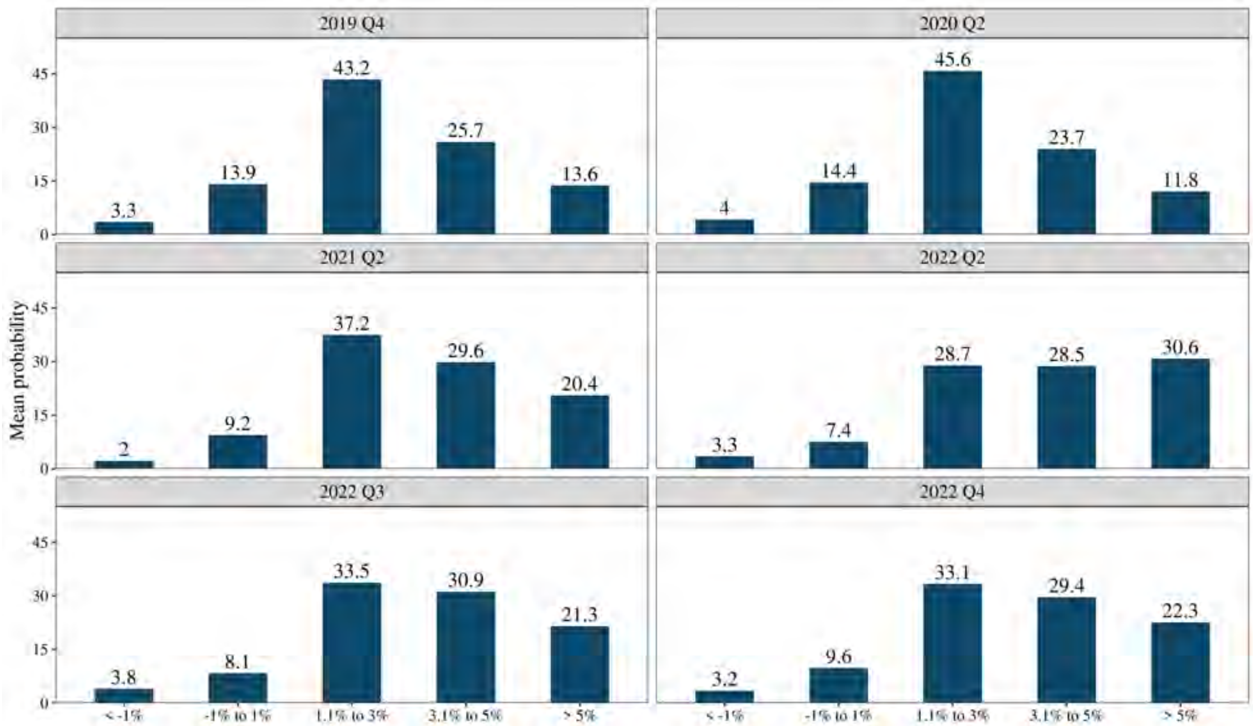
Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.
Notes: The binscatters are constructed using 30 bins. Price expectations are winsorized at the 2.5 and 97.5 percent levels.

Figure C.6: Business disruptions and short-run balance of unit cost risk



Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey; authors' calculations.
Notes: We define balance of unit cost risk as the difference in probabilities assigned to the largest and smallest year-ahead unit cost scenario. The binscatters are constructed using 30 bins.

Figure C.7: Distribution of firms' mean long-run unit cost expectation probabilities



Sources: Federal Reserve Bank of Atlanta's *Business Inflation Expectations* survey.
Notes: The distributions represent the mean probability that firms assigned to each potential long-run unit cost bin for 2019:Q4, 2020:Q2, 2021:Q2, 2022:Q2, 2022:Q3, and 2022:Q4.