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Revenue and Cost Uncertainties and Market Power

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Abstract: *Using administrative plant-level data from India, we estimate the effect of revenue and cost uncertainties on markup (product market power), markdown (labour market power), and combined market power. We show that historical two- and three-digit industry averages of exports, imported inputs, and oil share are valid instruments for exports, imported inputs, and oil share at the plant level. The results suggest that revenue and cost uncertainties affect markup differently: revenue uncertainty decreases markup, whereas cost uncertainty increases markup. Despite the opposite effect of these uncertainty measures on product market power, revenue and cost uncertainties tend to increase combined market power. This is because the revenue uncertainty significantly increases labour market power. Heightened cost uncertainties reduce labour market power but by less compared to increases in product market power. Given the results obtained in this paper, it is important to make a distinction between revenue and cost uncertainty to understand their cyclical nature.*

Keywords: Markup, Markdown, Labour Share, Uncertainty, Exchange Rate Volatility, Oil Price Volatility
JEL classifications: D21, D22

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1. Introduction

Understanding the effect of uncertainty shocks on households and firms has been an important area of research. The sharp drops in output and employment during COVID-19 have also been partly driven by uncertainty shocks. In the workhorse new-Keynesian model, an uncertainty shock is contractionary and markup is counter-cyclical (Basu and Bundick, 2017). A negative demand shock in the model with a sticky price leads to a decrease in wages and an increase in markup. An increase in markup is a wealth shock (higher profits) for households and decreases labour hours and output (Nekarda and Ramey, 2020; Broer et al., 2020). Hence, output decreases and markup increases, which gives us counter-cyclical markup. Uncertainty shocks driven by supply may increase markup too. This may be self-insurance by firms due to uncertainty as firms do not want to remain stuck with lower prices due to price rigidity and may increase prices immediately.

The empirical evidence regarding the effect of uncertainty shocks on markup is mixed and mostly based on theoretical models and aggregate data. Born and Pfeifer (2021) find little evidence of an increase in price markups due to an uncertainty shock, although they estimate an increase in wage markups. Kumar et al. (2021) find that uncertainty shocks are deflationary in advanced economies but inflationary in emerging economies. De Santis et al. (2022) suggest that uncertainty shocks are inflationary and increase markup. Di Maggio (2022) suggests that firm-level uncertainty reduces compensation, especially variable pay. Empirical literature on the effect of uncertainty on other market power enjoyed by firms, i.e. labour market power, does not exist. Labour market power, or markdown, which we define as the ratio of competitive and actual wages, has recently attracted a lot of attention (Yeh et al., 2022). Most importantly there is no distinction between revenue and cost uncertainty in the existing literature except for one recent study by Agrawal et al. (2021), which shows theoretically that markup acts as a hedge for input price uncertainty and provides empirical evidence for the same using data from Sweden.

We show that theoretically, product market power (markup) is related to labour market power (markdown) and labour share. Markup can be estimated using an output-based production function, for which firm-level output data are required. In the available data sets, we observe sales revenue and not the output that needs to be deflated to obtain output. Estimating the markup using microdata is problematic as the product/firm-level price information is not observed (Bond et al., 2021). However, we observe that labour share and the markdown can be estimated using revenue data (Brooks et al., 2021; Yeh et al., 2022).

In this paper, we estimate the effect of revenue and cost uncertainty on product market power (markup), labour market power (markdown), and combined market power using detailed plant-level data from India. Revenue uncertainty arises due to the volatility of the Indian rupee–US dollar exchange rate for exporting firms. Cost uncertainty arises due to the volatility of the exchange rate for firms using imported inputs and due to the volatility of oil prices for firms using oil as an input. We show that the coefficient of log uncertainty in a regression of the log material and log labour share on log uncertainty gives us the effect of uncertainty on the product and combined market power, respectively. Also, the coefficient of the log uncertainty in a regression of the log markdown on log uncertainty gives us the effect of uncertainty on labour market power. These uncertainties – exchange rate and oil price volatility – remain the same for all the firms in a cross-section, but different plants are exposed differently to these uncertainties due to differences in exports, imported inputs, and oil share at the plant level.

Hence, we interact these plants' shares with exchange rate and oil price volatility and obtain the revenue and cost uncertainty faced by these plants. The interaction of the export share and exchange rate volatility gives the revenue (domestic currency) uncertainty faced by plants. The interaction of the imported input share and exchange rate volatility gives the cost (domestic currency) uncertainty faced by the plants. The interaction of oil share and oil price volatility gives another cost (domestic currency) uncertainty faced by plants. A simple regression of the log material and labour share on these revenue and cost uncertainties measures does not identify the unbiased estimate of the revenue and cost uncertainties on different measures of market power. This is because of two reasons. First, the uncertainty measures are likely to be correlated with unobserved, pure time-varying omitted variables, which are also likely to affect the log material and labour share. We address this issue in two ways: using the time-fixed effects and by using the volatility of the Advanced Economies Dollar Index as an instrumental variable for the volatility of the India rupee–US dollar exchange rate. For oil price volatility, we use the volatility of the Brent crude oil price, which is a global measure. Second, the plant-level exports, imported inputs, and oil share are also likely to be correlated with unobserved time-varying variables, which may affect market power.

We show that the historical cross-sectional averages of exports, imported inputs, and oil share at two- and three-digit industries are valid instruments for plant-level exports, imported inputs, and oil share. Our instrumental variable strategy is a mixture of two popular methods of instrument construction in the literature. Since we use the past industry shares as

an instrument, this is similar to the Bartik instruments (see Bartik (1991); Blanchard and Katz (1992); and Goldsmith-Pinkham et al. (2020)). But unlike these papers, our instrument is not based on an explicit accounting identity. The main reason for using these industries' shares as instrumental variables is that these are highly persistent and highly relevant for predicting plant-level shares in the future. In this way, the instrumental variable approach in this paper is similar to the approach in the study by Acemoglu et al. (2001), which argues for the persistence of institutions and the use of early settlers' mortality as an instrument for present-day institutions. We argue that the industry average of exports, imported inputs, and oil shares are persistent and we use these as instruments for plant-level shares in the future. It is difficult to establish the exogeneity of these instruments, but several illustrative examples suggest that these are exogenous. As a measure of further precaution, we use these industries' averages from the past year, which are not included in the regression.

The results suggest that there is a fundamental difference between the revenue and cost uncertainties. Revenue uncertainty decreases markup, whereas cost uncertainty increases markup. Hence the results in this paper validate the theoretical prediction of Agrawal et al. (2021) and also corroborate the findings of Ma (2023), which argue that oil price uncertainty reduces markup in the US economy. Despite the opposite effect of these uncertainty measures on product market power, revenue and cost uncertainties increase combined market power. This is because revenue uncertainty leads to a significant increase in labour market power. An increase in cost uncertainties leads to a decline in labour market power, but the decline is lower than the increase in product market power and is less precisely estimated.

This paper is structured as follows. Section 2 gives the theoretical framework and explains the relationship between markup, markdown, and labour share. Section 3 explains the Annual Survey of Industries data from India and the uncertainty measures being used in this study. Section 4 presents the empirical framework. It also explains the construction of the instrumental variables and their exogeneity and relevance. This is followed by results and analysis in section 5. Section 6 gives concluding remarks.

2. Theoretical Framework

2.1. Product Market Power: Markup

The markup estimation follows the approach of De Loecker and Warzynski (2012) and De Loecker et al. (2020). We start with cost minimisation. The cost of production is given by:

$$w_{it}L_{it} + r_{it}K_{it} + P_t^M M_{it}$$

where we have used the actual wages w_{it} for plant i at time t. L_{it}, K_{it} and M_{it} are the labour, capital, and material inputs used by plant i at time t having w_{it}, r_{it} and P^M as the respective prices. The output is given by:

$$Y_{it} = F_{it}(L_{it}K_{it}M_{it})\exp(\omega_{it})$$

The Lagrangian for the cost minimisation is given by:

$$w_{it}L_{it} + r_{it}K_{it} + P_i^M M_{it} + \lambda_{it}\,(Y_{it} - F_{it}(L_{it}, K_{it}, M_{it})exp(\omega_{it}))$$

First-order condition with M_{it}

$$\frac{P_{it}^m}{\lambda_{it}} = \frac{\partial F_{it}(L_{it}K_{it}M_{it})\exp(\omega_{it})}{\partial M_{it}}$$

Multiplying both sides by $\frac{M_{it}}{F_{it}(L_{it}K_{it}M_{it})\exp(\omega_{it})}$, thereafter multiplying and dividing the left sides by P_{it} and defining markup (μ_{it}) as $\mu_{it} = \frac{P_{it}}{\lambda_t}$ gives:

Where the numerator is the elasticity of output with the material, and the denominator is the material share and, hence, can be written as:

$$\mu_{it} = \frac{\theta_i^M}{\text{Material Share}_{it}}$$

Where θ^M is the elasticity of output with the material. Essential markup is the elasticity of output with the material divided by the material share in the revenue. Taking the log of both sides we can write:

$$\log(\mu_{it}) = \log\theta_i^M - \log(\text{Material Share}_{it})$$

The % change in markup due to a 1% increase in the uncertainty measure is given by the negative of the percentage change in the material share. We assume that the uncertainty does not affect the elasticity of output with the material.

$$\Delta\log(\mu_{it}) = -\Delta\log(\text{Material Share}_{it})$$

Hence, we estimate the plant level (Market Share$_{it}$) on uncertainty to estimate the effect of uncertainty on markup (product market power).

2.2. Labour Market Power: Markdown

Markdown is another dependent variable of interest in this paper and is used to estimate the effect of uncertainty on markup. The markdown estimation does not require any price level information, and the labour share is directly available in the data. We start with a general production function given by:

$$Y_{it} = F_{it}(L_{it}, K_{it}, M_{it})exp(\omega_{it})$$

where Y_{it} is output, L_{it} is labour, K_{it} is capital, M_{it} is the materials, and ω_{it} is the total factor productivity of firm i at time t. The profit maximisation problem for the plant/firm is given by:

$$\pi_{it} = P_{it}(Y_{it})Y_{it} - W_{it}L_{it} - r_{it}K_{it} - P_i^M M_{it}$$

The above formulation for profit function is general, as it allows prices to be a function of output demanded, but we do not assume any specific demand.

$$\pi_{it} = R_{it}(Y_{it}) - W_{it}L_{it} - r_{it}K_{it} - P_i^M M_{it}$$

The first order condition with respect to M_{it} is given by:

$$\frac{\partial R_{it}}{\partial Y_{it}} \frac{\partial Y_{it}}{\partial M_{it}} = P_{it}^M$$

The first order condition with L_{it} is given by:

$$\frac{\partial R_{it}}{\partial Y_{it}} \frac{\partial Y_{it}}{\partial L_{it}} = W_{it}$$

This gives a competitive wage that is equal to the marginal revenue product of labour. We substitute the marginal effect of sales on revenue from the first order condition with materials in the first order condition with labour and obtain:

$$\frac{\partial R_{it}}{\partial Y_{it}} \frac{\partial Y_{it}}{\partial L_{it}} = \frac{\partial Y_{it}}{\partial M_{it}} (P_{it}^M)^{-1} \frac{\partial Y_{it}}{\partial L_{it}}$$

Wage markdown is the competitive wage W_{it} divided by the actual wage w_{it}:

$$\eta_{it} = \frac{\frac{\partial Y_{it}}{\partial M_{it}} (P_{it}^M)^{-1} \frac{\partial Y_{it}}{\partial L_{it}}}{w_{it}}$$

We can write the above as:

$$\eta_{it} = \frac{\text{Material Share of revenue}_{it} \times \theta_i^L}{\text{Labour Share of revenue}_{it} \times \theta_i^M}$$

where i stands for a firm and t for time. θ_i^L and θ_i^M are the elasticity of output with labour and materials. The elasticities of revenue with labour and materials are given by $\widetilde{\theta_i^L}$ and $\widetilde{\theta_i^M}$. Since we have $\frac{\theta_i^L}{\theta_i^M} = \frac{\tilde{\theta}_i^L}{\tilde{\theta}_i^M}$, we can write the markdown as:

$$\text{Markdown} = \eta_{it} = \frac{\text{Material Share of Revenue}_{it} \times \tilde{\theta}_i^L}{\text{Labour Share of Revenue}_{it} \times \tilde{\theta}_i^M}$$

The good thing is that for θ_i^M and θ_i^L, we need an output-based production function, but $\tilde{\theta}_i^M$ and $\tilde{\theta}_i^L$ are revenue-based elasticities that we can easily calculate using revenue data (Yeh, Macaulso, and Hershbein, 2022; Brooks et al., 2021). Output elasticities are subject to measurement error in prices (usually, we deflate revenue with price index to create a measure of output). But even in the case of revenue elasticities, the explanatory variables may be correlated with the error term in the revenue equation. Hence, we estimate revenue-based elasticities using Wooldridge (2009). Wooldridge (2009) addresses the problems of Olley and Pakes (1996) and Levinsohn and Petrin (2003) by replacing the two-step estimation procedure with a generalised method of moments (GMM) setup as in Wooldridge (1996). We estimate these elasticities at the two-digit level, and these are fixed over time.[4] It is important to mention that markdown is time-varying in the absence of time-varying elasticities as well because the firm/plant level inputs shares are time-varying.

Taking the log of both sides, we can write:

$$log(\eta_{it}) = log\left(\tilde{\theta}_i^L\right) + \log(MaterialShare_{it}) - log\left(\tilde{\theta}_i^M\right) - \log(LabourShare_{it})$$

Using the definition of markup, we can write:

$$log(\eta_{it}) = log\left(\tilde{\theta}_i^L\right) - log(\mu_{it}) - \log(LabourShare_{it})$$

Hence, we regress the plant-level log (Labour Share$_{it}$) on uncertainty to estimate the effect of uncertainty on combined (product and labour) market power. As we can see from the above equation, if an increase in product market power is compensated by the decline in labour market power, then there will not be any effect on labour share.

[4] For robustness, we use alternative estimates for these elasticities being used in the markdown. We use the average share of these inputs (labour and material) in revenue at the two-digit level instead of the estimated elasticities. This gives similar results and is not reported in this paper but is available on request.

3. Data

3.1. Annual Survey of Industries: India

The plant-level data used in this paper for India is from the Annual Survey of Industries. This plant-level data set is widely used in empirical studies, such as Hsieh and Klenow (2009) and Bertrand, Hsieh, and Tsivanidis (2021). This is a nationally representative plant-level data set and contains both census and survey plants. Census plants are large plants that are surveyed every year together with a sample of small plants. We use data between 2008-09 and 2021-22. We do not use data before 2008-09, because data for exports is only available from 2008-09. We use the export share defined as export revenue/total revenue, the imported input share defined as imported inputs/total material inputs, and the oil share defined as oil expense/total material inputs to measure a plant's exposure to the exchange rate and oil price uncertainty. The export share allows us to understand the effect of revenue uncertainty through the exchange rate, whereas the imported input share and oil share allow us to understand the effect of input price uncertainty through exchange rate volatility and oil price volatility. We use next the fixed assets, sales, material expenses, imported inputs, oil inputs, exports, number of workers, and wages from this dataset. Using fixed assets, sales, material expenses, and wage bills, we obtain the markdown as explained above. The labour share is defined as the wage bill/sales revenue. The material share is defined as total material inputs/sales revenue.

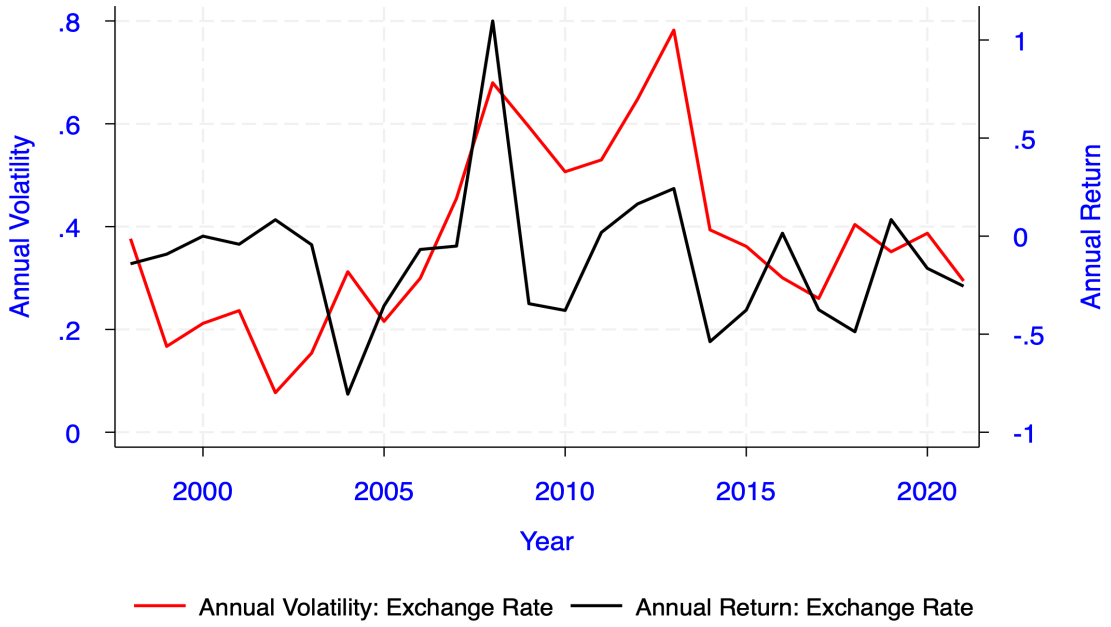
3.2. Measures of Uncertainty

We consider two measures of uncertainty in this paper, exchange rate and oil price. These two give us the revenue and cost uncertainty faced by the firms through their exports, use of imported inputs, and use of oil. Figure 1a shows the volatility of the Indian rupee–US dollar exchange rate return and the log return on the Rupee US Dollar exchange rate. The first measure of exchange rate volatility is the annual standard deviation of the daily return on the Indian rupee–US dollar exchange rate. The log return on the Indian rupee–US dollar exchange rate is the annual average of the daily log return. We create one more measure of exchange rate volatility using ARMA (1,1) GARCH (1,1) for robustness. We use ARMA (1,1) GARCH (1,1) models to make daily predictions of conditional volatilities and take an annual average of them to obtain the annual volatility. The ARMA (1,1) GARCH (1,1) model (Figure 3a) produces a similar volatility pattern as the annual standard deviation of daily return on the Indian rupee–US dollar exchange rate (Figure 1a). Figure 1b gives the volatilities of the

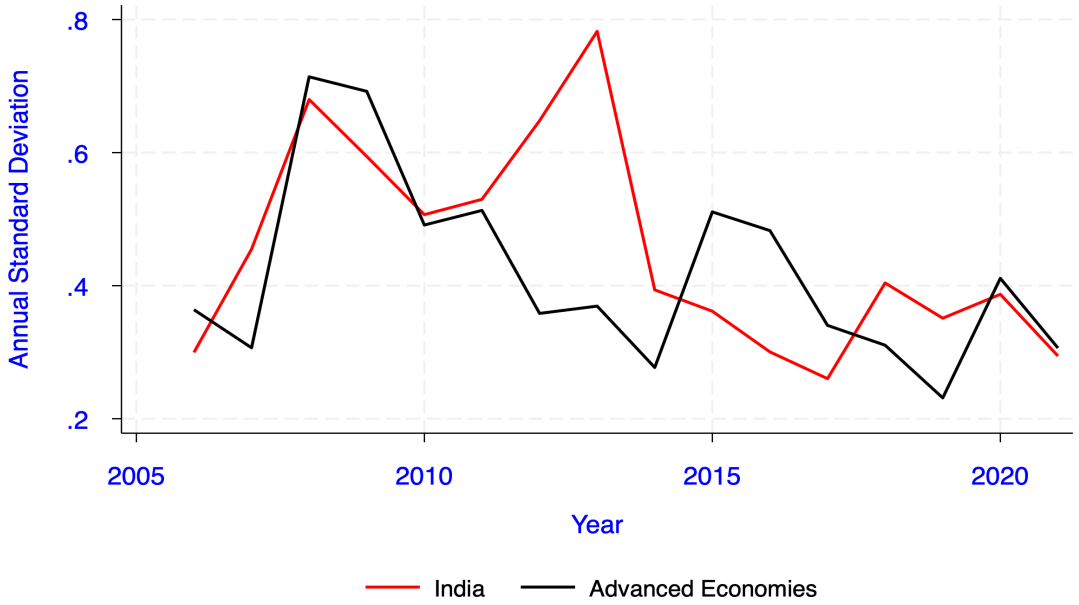
Indian rupee–US dollar exchange rate and the Nominal Advanced Foreign Economies US Dollar Index. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate.

Figure 1: Exchange Rate Return and Volatilities

(a) Volatility and Average Return: Indian Rupee–US Dollar Exchange Rate



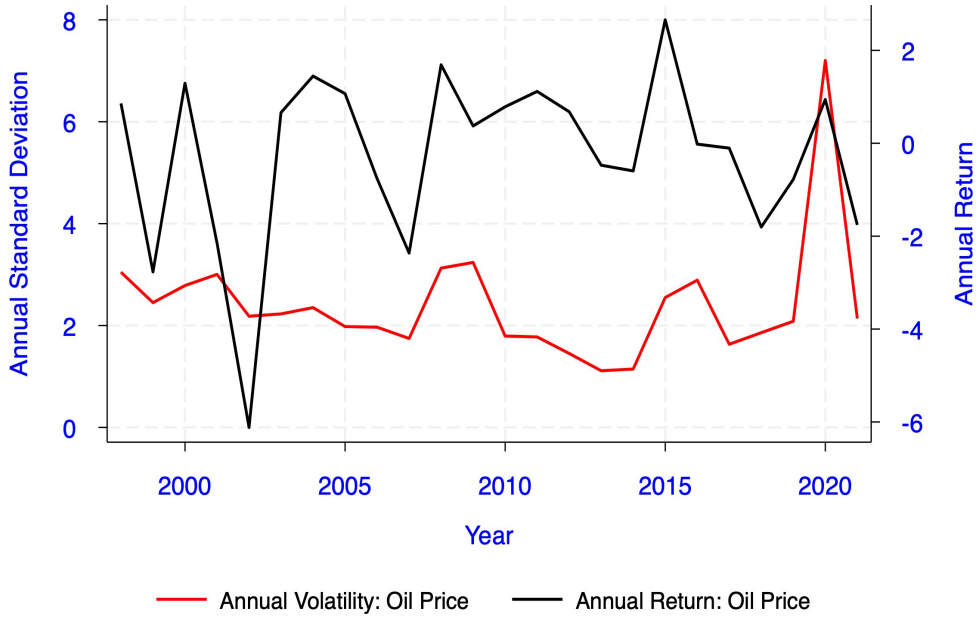
(b) Volatility: Indian Rupee–US Dollar Exchange Rate and Nominal Advanced Foreign Economies US Dollar Index



Source: Authors' construction and Federal Reserve Bank of Saint Louis.

Figure 2 shows the volatility of the oil return and log oil return. The first measure of oil volatility is the annual standard deviation of the daily return on oil (see the Appendix for data definitions and sources). The log return on oil is the annual average of the daily log return. We create one more measure of oil volatility using the ARMA (1,1) GARCH (1,1) model. The ARMA (1,1) GARCH (1,1) model (Figure 3b) produces very high volatility in 2020–2021 compared to the annual standard deviation of the daily return on oil prices (Figure 2). We obtain these exchange rate data from the Federal Reserve Bank of Saint Louis. We also obtain data on annual consumer inflation from the Federal Reserve Bank of Saint Louis.

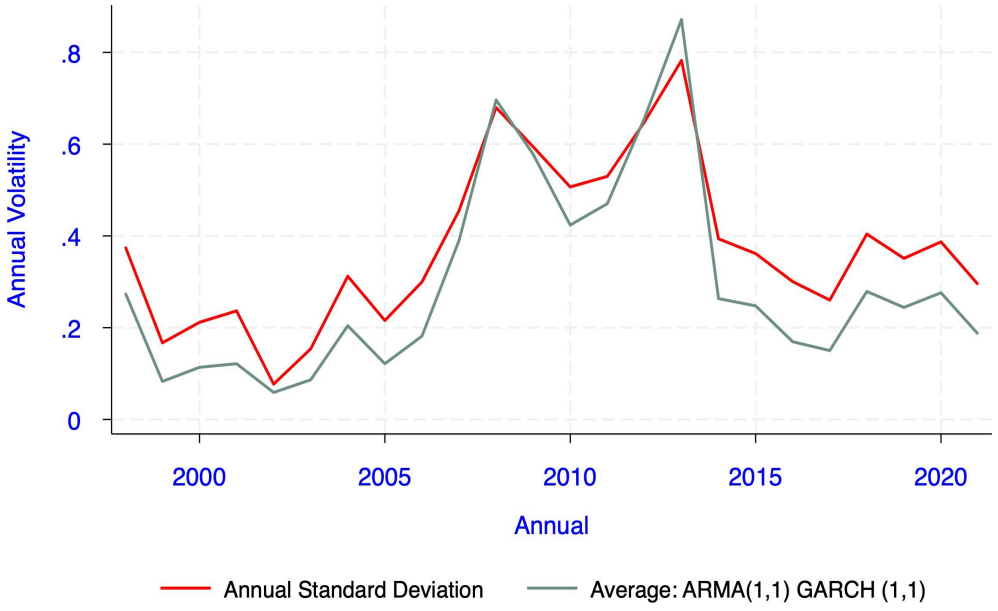
Figure 2: Oil Return and Volatility



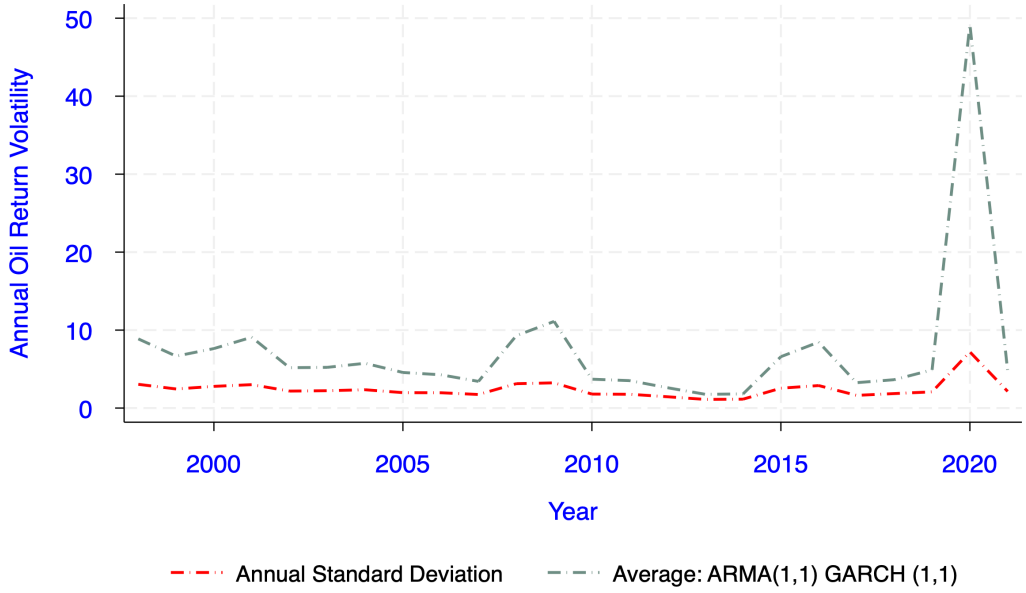
Source: Authors' construction and Federal Reserve Bank of Saint Louis.

Figure 3: Exchange Rate Return and Volatilities

(a) Volatility: Indian Rupee–US Dollar Exchange Rate



(b) Volatility: Oil Price



Source: Authors' construction and Federal Reserve Bank of Saint Louis.

4. Empirical Framework

We regress LogMaterial Share$_{it}$ on revenue uncertainty (interaction of export share and exchange rate volatility) as given below:

$$\text{LogMaterial Share}_{it} = \beta_1 \times \text{ExportShare}_{it} \times \text{Log Exchange Rate Volatility}_t$$
$$+\beta_2 \text{Log Exchange Rate Volatility}_t + \beta_3 \%\text{Change in Exchange Rate}$$
$$+\delta' z_{it} + \gamma' \bar{x}_{t-1} + \alpha \text{Inflation}_t + \theta_i + \epsilon_{it}$$

The elasticity of markup with uncertainty (exchange rate volatility) is the negative of the elasticity of the material share with uncertainty. The coefficient of interest is β_1, which is the elasticity of the material share with exchange rate volatility at different levels of export share. The materials and export shares are given by the proportion of materials and exports in sales revenue. Exchange rate volatility is calculated as the standard deviation of the daily log return of the Indian rupee–US dollar exchange rate for year *t*. The percentage change in exchange rate is the average of the daily log return of the Indian rupee–US dollar exchange rate for year *t*. Inflation is the annual consumer inflation rate. z_{it} includes the log size (sales), log size (workers), oil share, export share, and imported input share in plant *i* at time *t*. To eliminate cross-sectional dependence and control for time-varying unobserved factors, we include the lag cross-sectional averages of the material share, labour share, export share, imported inputs share, and oil share. $\bar{x}_{t-1}$ includes these variables. We estimate another model with time-fixed effects in which we do not include these cross-sectional averages and all other variables that remain the same for all the plants in a given year.

$$\text{Log Material Share}_{it} = \beta_1 \times \text{ExportShare}_{it} \times \text{Log Exchange Rate Volatility}_t$$
$$+\delta' z_{it} + \theta_i + \theta_t + \epsilon_{it}$$

Out of these two models, the model with time-fixed effects is more appropriate as it controls for unobserved time-varying confounding factors. However, this model only allows us to estimate the interaction effect or the differential effect of export shares on markup due to uncertainty, and, hence, we focus on the interaction coefficient only. As an additional measure to avoid time-varying confounding factors, we use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. We extend the model and bring the measure of cost uncertainty (interaction of the imported input share and exchange rate volatility) as given below.

$$\begin{aligned}\text{Log Material Share}_{it} = {} & \beta_1 \times \text{ExportShare}_{it} \times \text{Log Exchange Rate Volatility}_t \\ & + \beta_2 \times \text{Imported InputShare}_{it} \times \text{Log Exchange Rate Volatility}_t \\ & + \beta_3 \text{Log Exchange Rate Volatility}_t + \beta_3 \%\text{Change in Exchange Rate} \\ & + \delta' z_{it} + \gamma' \bar{x}_{t-1} + \alpha \text{Inflation}_t + \theta_i + \epsilon_{it}\end{aligned}$$

The imported input share is given by the share of imported inputs in total inputs. We normalise imported inputs by total inputs and not sales as this helps us in obtaining an estimate of the input price uncertainty faced by plants due to exchange rate volatility. A plant having a higher share of imported inputs faces higher input price uncertainty. This also allows us to compare the effect of uncertainty on plants having no imported inputs and plants using only imported inputs. We estimate another model with both revenue and cost uncertainty with time-fixed effects in which we do not include these cross-sectional averages and all other variables that remain the same for all the plants in a given year.

$$\begin{aligned}\text{Log Material Share}_{it} = {} & \beta_1 \times \text{ExportShare}_{it} \times \text{Log Exchange Rate Volatility}_t \\ & + \beta_2 \times \text{Imported InputShare}_{it} \times \text{Log Exchange Rate Volatility}_t \\ & + \delta' z_{it} + \theta_i + \theta_t + \epsilon_{it}\end{aligned}$$

We extend the model and bring the second measure of cost uncertainty (interaction of oil share and oil price volatility) as given below.

$$\begin{aligned}\text{Log Material Share}_{it} = {} & \beta_1 \times \text{ExportShare}_{it} \times \text{Log Exchange Rate Volatility}_t \\ & + \beta_2 \times \text{Imported InputShare}_{it} \times \text{Log Exchange Rate Volatility}_t \\ & + \beta_3 \times \text{OilShare}_{it} \times \text{Log Oil Price Volatility}_t \\ & + \beta_4 \text{Log Exchange Rate Volatility}_t + \beta_5 \%\text{Change in Exchange Rate} \\ & + \beta_6 \text{Log Oil Price Volatility}_t + \beta_7 \%\text{Change in Oil Price} \\ & + + \delta' z_{it} + \gamma' \bar{x}_{t-1} + \alpha \text{Inflation}_t + \theta_i + \epsilon_{it}\end{aligned}$$

Oil share is given by the share of oil in total inputs. We normalise oil use by total inputs and not sales as this helps us in obtaining an estimate of another input price uncertainty faced by plants due to oil price volatility. A plant having a higher share of oil faces a higher input price uncertainty. This also allows us to compare the effect of uncertainty on plants using no oil and plants using only oil as an input. We estimate another model with revenue and these two measures of cost uncertainty with time-fixed effects in which we do not include these cross-sectional averages and all other variables that remain the same for all the plants in a given year.

$$\text{Log Material Share}_{it} = \beta_1 \times \text{ExportShare}_{it} \times \text{Log Exchange Rate Volatility}_t +$$
$$\beta_2 \times \text{Imported InputShare}_{it} \times \text{Log Exchange Rate Volatility}_t +$$
$$\beta_3 \times \text{OilShare}_{it} \times \text{Log Oil Price Volatility}_t + \delta' z_{it} + \theta_i + \theta_t + \epsilon_{it}$$

We estimate similar models for log markdown and log labour share. These models give us the effect of uncertainty on labour market power and combined market power. Unbiased estimation of the coefficients β_1, β_2, and β_3 is difficult due to another important reason. Plant-level exports, imported inputs, and oil share are likely to be correlated with unobserved confounding factors that affect plant-level markup, markdown, and labour share (i.e. combined market power). We use the two-digit industry averages in 2008 as instruments for these plant-level variables. Our instrumental variable strategy is similar to the strategy adopted by Bartik (1991), Blanchard and Katz (1992), and Goldsmith-Pinkham et al. (2020). However, in our case, the instrumental variable is not an explicit outcome of accounting identity as illustrated in Ferri (2022). But like these papers, we use industry share as an instrument. Our instrumental variable strategy is more closely related to that of Acemoglu et al. (2001), who argue for the persistence of institutions and the use of early settlers' mortality as an instrument for present-day institutions. We show that the exports, imported inputs, and oil share in an industry are persistent and use these as instruments for the plant-level exports, imported inputs, and oil share.

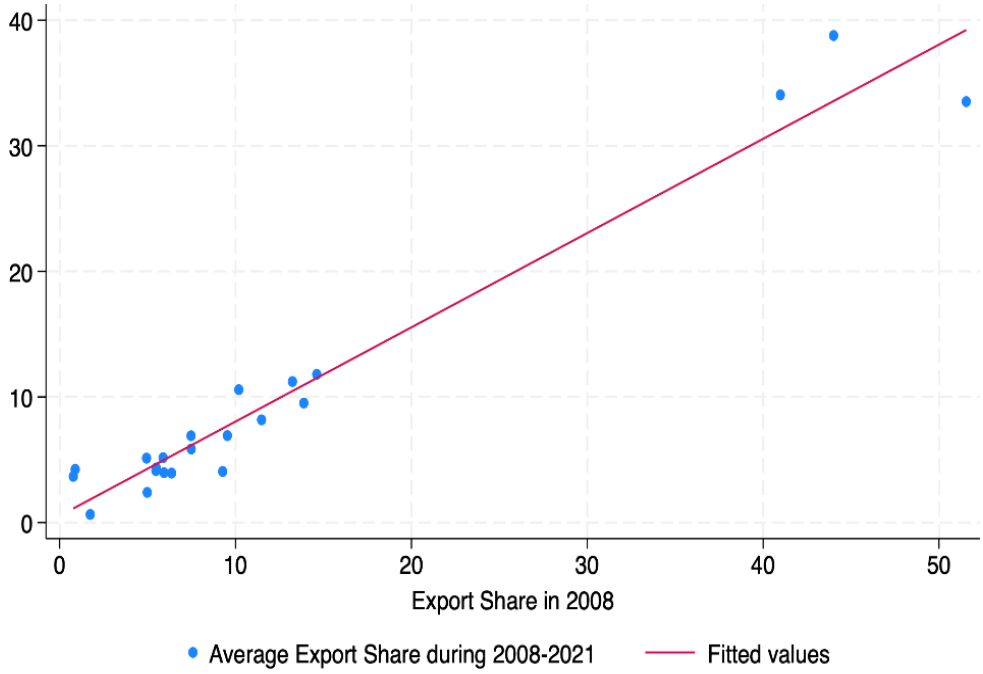
Figure 4a shows the average export share for two-digit industries in 2008-09 and an average of the year-wise average of the export share in two-digit industries during 2008-09 and 2021-22. As we can see, there is a very high correlation, and the points are very close to a straight line having a slope very close to 1. Figure 4b gives the average export share for two-digit industries in 2008-09 and 2020-21. Again, we see that there is a very high correlation, and the points are very close to a straight line having a slope very close to 1. These two figures suggest that the export share in two-digit industries is very persistent and very unlikely to be influenced by time-varying variables.

Figure 5a gives the average imported input share for two-digit industries in 2008- 09 and the average of the year-wise average of imported inputs in two-digit industries during 2008-09 and 2021-22. As we can see, there is a very high correlation, and the points are very close to a straight line having a slope very close to 1. Figure 5b gives the average imported input share for two-digit industries in 2008-09 and 2020-21. Again, we see that there is a very high correlation and the points are very close to a straight line having a slope very close to 1. These two figures suggest that the imported input shares of two-digit industries are very

persistent and very unlikely to be influenced by time-varying variables. We find similar patterns for oil share, suggesting that the oil shares of two-digit industries are very persistent and very unlikely to be influenced by time-varying variables.

Figure 4: Export Share: Two-digit Industries

(a) Share in 2008-09 and Average Share During 2008-09 and 2021-22

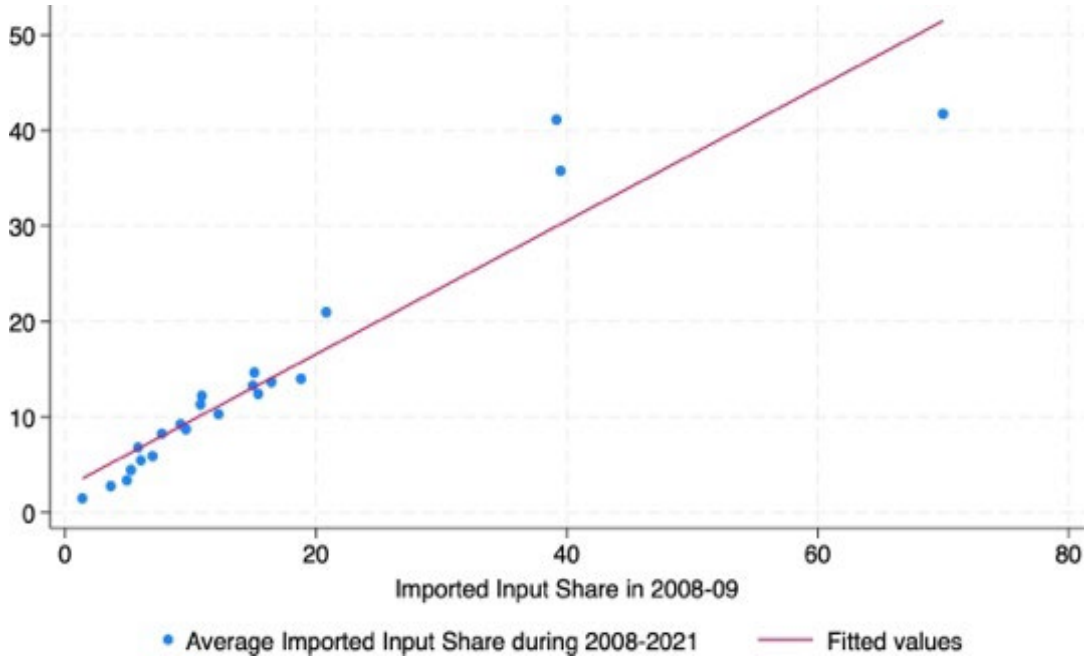


(b) Share in 2008-09 and in 2020-21

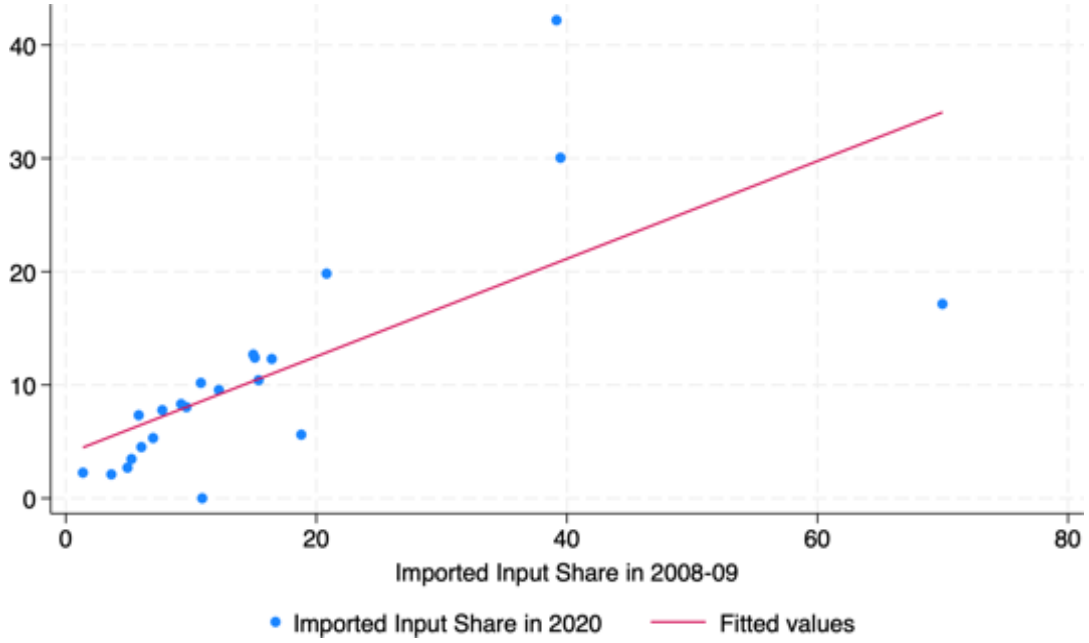
Notes: Figure 4a gives the average export share for two-digit industries in 2008-09 and an average of the year-wise average of the export share in two-digit industries during 2008-09 and 2021-22. Figure 4b gives the average export share for two-digit industries in 2008-09 and 2020-21.
Source: Authors' construction and Annual Survey of Industries, India.

Figure 5: Imported Inputs Share: Two-digit Industries

(a) Share in 2008-09 and Average Share During 2008-09 and 2021-22



(b) Share in 2008-09 and in 2020-21

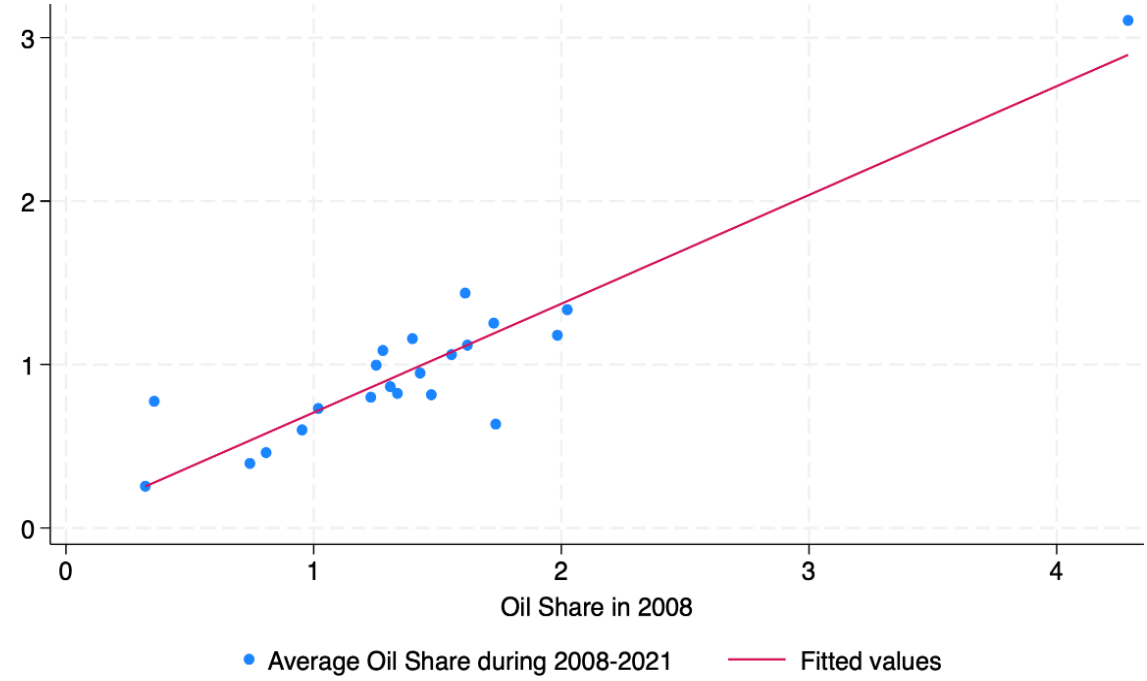


Notes: Figure 5a gives the average imported input share for two-digit industries in 2008-09 and the average of the year-wise average of the imported input share in two-digit industries during 2008-09 and 2021-22. Figure 5b gives the average imported input share for two-digit industries in 2008-09 and 2020-21.

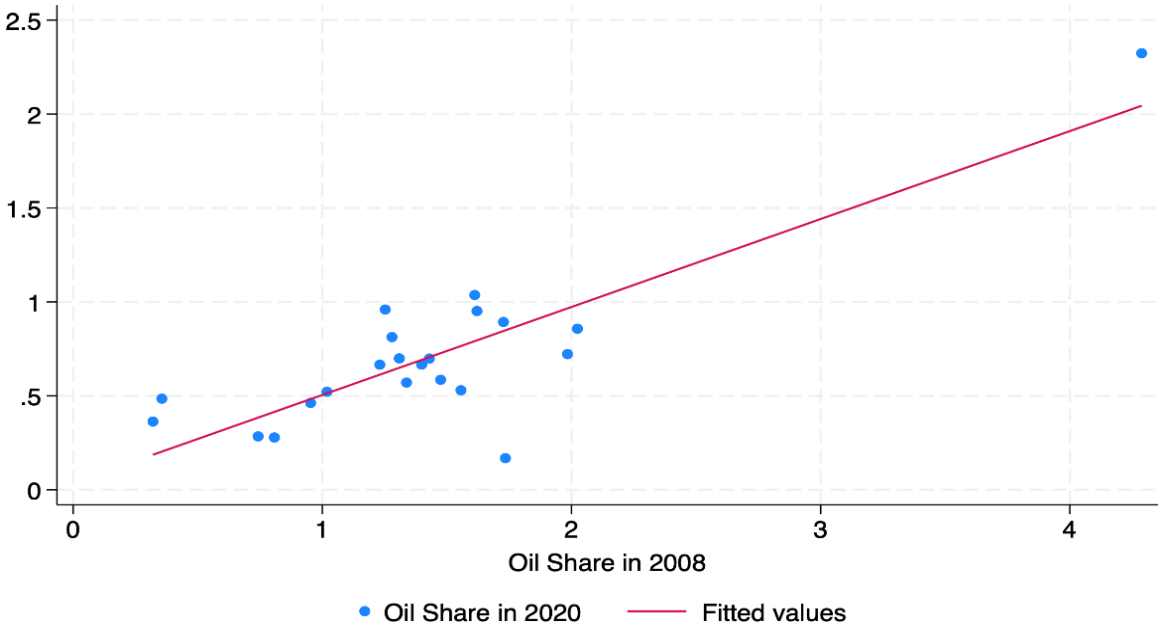
Source: Authors' construction and Annual Survey of Industries, India.

Figure 6: Oil Share: Two-digit Industries

(a) Share in 2008-09 and Average Share During 2008-09 and 2021-22



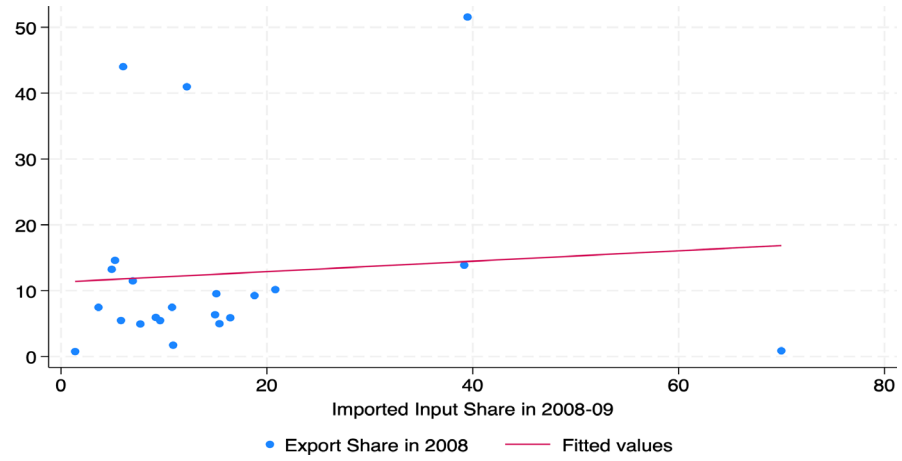
(b) Share in 2008-09 and in 2020-21



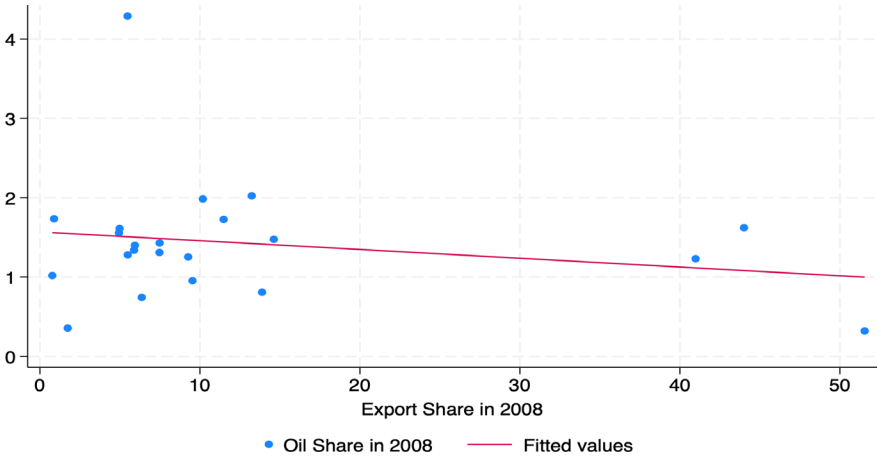
Notes: Figure 6a gives the average oil share for two-digit industries in 2008-09 and an average of the year-wise average of the oil share in two-digit industries during 2008-09 and 2021-22. Figure 6b gives the average oil share for two-digit industries in 2008-09 and 2020-21.
Source: Authors' construction and Annual Survey of Industries, India.

Figure 7: Exports, Imported Inputs, and Oil Shares: Two-digit Industries

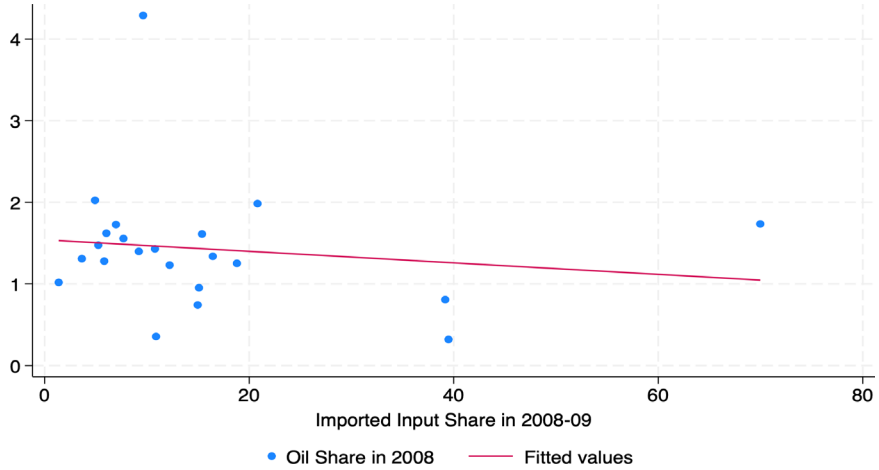
(a) Exports and Imported Inputs Share



(b) Oil and Imported Inputs Share



(c) Oil and Export Share



Notes: Figure 7a gives the average exports and imported input share for two-digit industries in 2008-09. Figure 7b gives the average oil and imported input share for two-digit industries in 2008-09. Figure 7c gives the average oil and export share for two-digit industries in 2008-09.
Source: Authors' construction and Annual Survey of Industries, India.

Goldsmith-Pinkham et al. (2020) and Ferri (2022) argue that the exogeneity of these industrial shares is important for these to be valid instruments. Although theoretically it is hard to argue for exogeneity, we show that these shares seem to be exogenous and related to intrinsic industrial characteristics, which have very little time variation. One obvious test in our case would be to see the correlation between these shares. Figure 7a gives the average exports and imported input share for two-digit industries in 2008-09, and we find an absence of a statistically significant correlation. Figure 7b gives the average oil and imported input share for two-digit industries, and figure 7c gives the average oil and export share for two-digit industries in 2008-09. In both cases, we do not find a statistically significant correlation. The persistence of these industry shares and the absence of correlation between these shares convincingly suggest that these industry shares are exogenous.[5]

Table 1 gives the regression of the plant-level export share on the two-digit industry average of the export share in 2008-09. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21. We find that the average export share for two-digit industries in 2008-09 is statistically significant in predicting the plant-level export share during 2009-10 to 2021-22 and for individual years as well. We also see that the coefficient of the two-digit industries' average of the export share in 2008-09 is highly persistent in these regressions, and the F-value is very high. Similar results are obtained in the case of the imported input share and oil share. These results suggest that these past industries' shares are not only likely to be exogenous but are also very relevant for predicting the plant-level shares.[6] Hence, these shares are valid instruments for plant-level shares. The Appendix shows that a similar conclusion can be drawn for average exports, imported inputs, and oil share for three-digit industries in 2008-09. These are also valid instruments and we use these for robustness exercises.

[5] Figures C.1, C.2, C.3 and C.4 in the Appendix draw similar conclusions for the three-digit industry averages of exports, imported inputs, and oil share in 2008-09.

[6] Tables C.1, C.2, and C.3 in the Appendix draw similar conclusions for the three-digit industry averages of exports, imported inputs, and oil share in 2008-09.

Table 1: Regression: Plant-level Export Share and Two-digit Industry Average Export Share in 2008-09

	(1) Export Share: 2009-2021	(2) Export Share: 2010	(3) Export Share: 2015	(4) Export Share: 2020
Industry Export Share in 2008-09	0.699***	0.872***	0.714***	0.607***
	(213.66)	(62.41)	(59.39)	(56.19)
Observations	330,964	19,839	26,645	28,629
R-Squared	0.121	0.164	0.117	0.0993
F-Statistic	45,650.2	3,894.9	3,527.5	3,157.7

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21.
Source: Authors.

Table 2: Regression: Plant-level Imported Input Share and Two-digit Industry Average Imported Input Share in 2008-09

	(1) Imported Input Share: 2009-2021	(2) Imported Input Share: 2010	(3) Imported Input Share: 2015	(4) Imported Input Share: 2020
Industry Imported Input Share in 2008-09	0.305***	0.348***	0.288***	0.301***
	(115.97)	(29.35)	(31.12)	(35.95)
Observations	330,964	19,839	26,645	28,629
R-Squared	0.0391	0.0416	0.0351	0.0432
F-Statistic	13,449.4	861.6	968.5	1,292.6

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21.
Source: Authors.

Table 3: Regression: Plant-level Oil Share and Two-digit Industry Average Oil Share in 2008-09

	(1) Petrol Share: 2009-2021	(2) Petrol Share: 2010	(3) Petrol Share: 2015	(4) Petrol Share: 2020
Industry Petrol Share 2008-09	0.847***	0.734***	0.816***	0.911***
	(128.70)	(26.32)	(36.89)	(43.52)
Observations	330,964	19,839	26,645	28,629
R-Squared	0.0477	0.0337	0.0486	0.0621
F Statistic	16,563.5	692.7	1,360.7	1,894.4

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21.
Source: Authors.

5. Results and Analysis

5.1. Baseline Results: Plant-level Export and Import Shares

Table 4 gives the baseline results using plant-level shares. As explained above, the negative value of the coefficient associated with uncertainty in the regression of the log material share on log uncertainty gives the elasticity of markup with uncertainty, whereas the negative value of the coefficient associated with uncertainty in the regression of the log labour share on log uncertainty gives the elasticity of combined market power with uncertainty. The value of the coefficient associated with uncertainty in the regression of the log markdown on log uncertainty gives the elasticity of labour market power with uncertainty. These results are for a 10% increase in exchange rate uncertainty. The interaction term implies the incremental effect of uncertainty on product, labour, and combined market power for firms having a 100% export share compared to a 0% export share due to a 10% increase in exchange rate uncertainty. A similar interpretation of the coefficients is applicable in the case of the imported input share and oil share.

For each of these measures of market power, we estimate two regressions. The first is with year-fixed effects in which we do not include any variables that do not have cross-sectional variation. These variables are the first moment of the exchange rate, inflation, log of exchange rate volatility, and cross-sectional average of material share, labour share, export share, imported input share, and oil share. In the second regression, we do not include the time fixed effects and include these variables. We use plant-level controls – log size (sales), log size (workers), oil share, export share, and imported input share – and plant-level fixed effects

in both these regressions. In all these regressions, we use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate.

Table 4: Effect of Revenue and Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-1.368***	-1.102***	1.430***	1.297***	2.799***	2.399***
	(5.29)	(4.26)	(-3.78)	(-3.41)	(5.97)	(5.14)
ER Volatility* Imported Inputs Share	1.980***	1.973***	1.076	1.178*	-0.904	-0.796
	(-4.79)	(-4.78)	(-1.57)	(-1.70)	(-1.14)	(-1.00)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant Level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate volatility, respectively. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at the plant level. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of the daily returns on the respective rates. In models without time fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

The results suggest that a 10% increase in exchange rate uncertainty reduces the product market power by more than 1% for only exporting plants. However, it increases the combined market power due to an increase in labour market power. The results suggest that a 10%

increase in exchange rate uncertainty increases the product market power of plants using only imported inputs by almost 2% and the combined market power by more than 1%. The increase in combined market power is less than the increase in product market power because exchange rate uncertainty reduces the labour market power plants using only imported inputs. We find heterogeneity in the effect of revenue uncertainty being captured by exports, and cost uncertainty being captured by imported inputs. Exchange rate uncertainty drives these two uncertainties for the plants. Revenue uncertainty reduces markup and increases markdown, whereas cost uncertainty increases markup and decreases markdown. But both these revenue and cost uncertainties lead to similar increases in combined market power. Tables A.1, A.2, and A.3 in the Appendix show more results using plant-level shares, and these results also suggest that revenue uncertainty reduces markup, increases markdown, and increases combined power, whereas cost uncertainty increases markup, reduces markdown, and increases combined market power.

5.2. Instrumental Variable Regressions

As mentioned before, plant-level exports, imported inputs, and oil share are likely to be correlated with unobserved confounding factors that affect plant-level product, labour, and combined market power. We explained in the previous section that two-digit industry averages in 2008-09 are valid instruments for these plant-level variables. Next, we present these instrumental variable regressions.

Table 5 gives the instrumental variable regression where we use the two-digit industry average of exports and imported inputs shares in 2008-09 as instruments for plant-level exports and imported inputs shares.[7] The results suggest that a 10% increase in exchange rate uncertainty reduces the product market power by more than 12% for only exporting plants, but it increases the combined market power due to an increase in labour market power. The results suggest that a 10% increase in exchange rate uncertainty increases the product market power of plants using only imported inputs by more than 9% and the combined market power by more than 2%. The increase in combined market power is less than the increase in product market power because exchange rate uncertainty reduces the labour market power for plants using only imported inputs. We find that the effect of uncertainty on combined and labour market power is not significant for plants using imported inputs. However, these instrumental variable regressions give significantly higher change in market powers than given in Table 4.

[7] Tables B.1 and B.2 in the Appendix give results for only exports and imported input shares, and the results are similar to the results reported here.

However, these results are qualitatively similar to the results reported in Table 4. Revenue uncertainty reduces markup and increases markdown, whereas cost uncertainty increases markup and decreases markdown.

Table 5: Effect of Revenue and Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-12.81***	-13.21***	7.991***	6.885***	20.80***	20.09***
	(7.81)	(7.92)	(-4.14)	(-3.58)	(7.55)	(7.38)
ER Volatility* Imported Input Share	9.074***	9.138***	2.871	2.841	-6.202	-6.297
	(-3.36)	(-3.37)	(-0.85)	(-0.83)	(-1.42)	(-1.43)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate volatility, respectively. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on respective rates. We use two-digit industries' average of exports and imported input shares in 2008-09 as instruments for the plant-level export and imported input shares. In models without time fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

5.3. Extended Models

Table 6: Effect of Revenue and Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-12.54***	-12.63***	8.250***	7.979***	20.79***	20.61***
	(7.83)	(7.85)	(-4.32)	(-4.18)	(7.68)	(7.62)
ER Volatility* Imported Input Share	9.511***	9.528***	3.304	3.342	-6.207	-6.186
	(-3.59)	(-3.60)	(-0.99)	(-1.00)	(-1.44)	(-1.44)
Oil Volatility* Petrol Share	2.560**	2.587**	2.533*	2.378*	-0.0276	-0.209
	(-2.39)	(-2.41)	(-1.84)	(-1.73)	(-0.02)	(-0.12)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate and log oil price volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate and oil price volatility, respectively. The value of the coefficient associated with exchange rate and log oil price volatility in the regression of log markdown on log exchange rate and log oil price volatility gives the elasticity of labour market power with exchange rate and oil price. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. Oil volatility is the annual standard deviation of daily returns on oil prices. We use the two-digit industries' average of exports and imported input shares in 2008-09 as instruments for plant-level export and imported input shares. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as the controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

Table 6 gives the instrumental variable regression where we include another measure of cost uncertainty being captured by oil share and oil price volatility. The results suggest that a 10% increase in exchange rate uncertainty reduces the product market power by more than 12% for only exporting plants, which is similar to the results reported in Table 5. However,

it increases the combined market power due to an increase in labour market power. The results suggest that a 10% increase in exchange rate uncertainty increases the product market power of plants using only imported inputs by more than 9%, which is again similar to the results reported in Table 5, and the combined market power by more than 2%.

Similar to the effects of cost uncertainty driven by exchange rate volatility, we find that the cost uncertainty driven by oil price volatility also leads to an increase in markup and combined market power but has negligible effects on labour market power. These results substantiate the points made above that revenue uncertainty reduces markup, whereas cost uncertainty increases markup.[8]

5.4. Robustness Exercises

Table 7 gives the instrumental variable regression where we use another measure of exchange rate volatility. We estimate the ARAM (1,1) GARCH (1,1) model on daily exchange rate returns and take an average of the daily conditional volatilities. The results suggest that a 10% increase in exchange rate uncertainty reduces the product market power by more than 4% for only exporting plants. However, it increases the combined market power by a similar magnitude due to an increase in labour market power. The results suggest that a 10% increase in exchange rate uncertainty increases the product market power of plants using only imported inputs by almost 4% and the combined market power by more than 1%. The increase in combined market power is less than the increase in product market power because exchange rate uncertainty reduces the labour market power for plants using only imported inputs.

Table 7: Effect of Revenue and Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-4.170***	-4.185***	4.040***	3.865***	8.211***	8.050***
	(7.31)	(7.32)	(-5.27)	(-5.04)	(8.13)	(7.99)
ER Volatility* Imported Input Share	3.962***	3.988***	1.276	1.276	-2.686	-2.712
	(-3.20)	(-3.21)	(-0.79)	(-0.78)	(-1.31)	(-1.32)
Oil Volatility* Petrol Share	1.647*	1.635*	3.207**	3.183**	1.560	1.548

[8] Tables C.4 in the Appendix draws a similar conclusion for the three-digit industry averages of exports, imported inputs, and oil share in 2008-09.

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
	(-1.68)	(-1.66)	(-2.43)	(-2.40)	(0.94)	(0.93)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate and log oil price volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate and oil price volatility, respectively. The value of the coefficient associated with exchange rate and log oil price volatility in the regression of log markdown on log exchange rate and log oil price volatility gives the elasticity of labour market power with exchange rate and oil price. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are obtained using the ARMA (1,1) GARCH (1,1) model on daily returns on the respective rates. Oil volatility is the annual standard deviation of daily returns on oil prices. We use two-digit industries' average of export and imported input shares in 2008-09 as instruments for the plant-level export and imported input shares. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as the controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

We find that the effect of uncertainty on combined and labour market power is not significant for plants using imported inputs. The results suggest that a 10% increase in oil price uncertainty increases the product market power of plants using only oil inputs by almost 2% and the combined market power by more than 3%.

Table 8: Effect of Revenue and Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-4.168***	-4.183***	4.046***	3.882***	8.214***	8.065***
	(7.30)	(7.32)	(-5.27)	(-5.06)	(8.13)	(8.00)
ER Volatility* Imported Input Share	3.968***	3.994***	1.288	1.296	-2.680	-2.698
	(-3.19)	(-3.21)	(-0.79)	(-0.79)	(-1.30)	(-1.31)
Oil Volatility* Petrol Share	0.959*	0.954*	1.871***	1.817**	0.911	0.862
	(-1.80)	(-1.79)	(-2.60)	(-2.52)	(1.01)	(0.95)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate and log oil price volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate and oil price volatility, respectively. The value of the coefficient associated with exchange rate and log oil price volatility in the regression of log markdown on log exchange rate and log oil price volatility gives the elasticity of labour market power with exchange rate and oil price. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rates and oil price volatilities are obtained using the ARMA (1,1) GARCH (1,1) model on daily returns on respective prices. We use two-digit industries' average of export and imported input shares in 2008-09 as instruments for plant-level export and imported input shares. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

The combined market power increases more than the product market power because the oil price volatility increases labour market power, although the effect of oil price volatility on labour market power is not statistically significant. These results are qualitatively similar to

the results reported before. Revenue uncertainty reduces markup, whereas cost uncertainty increases markup and both these uncertainties increase combined market power.

Table 8 gives the instrumental variable regression where we use another measure of oil price volatility. We estimate the ARMA (1,1) GARCH (1,1) model on the daily exchange rate and oil returns and take an average of the daily conditional volatilities. The effect of the exports and imported inputs shares are similar to the effect shown in Table 7. The effect of the oil share is lower in magnitude but qualitatively similar to the results shown in Table 7.

6. Concluding Remarks

In this paper, we estimate the effect of revenue and cost uncertainty on product market power (markup), labour market power (markdown), and combined market power using detailed plant-level administrative data from India. We interact the plant-level export share with exchange rate volatility to obtain a measure of revenue (domestic currency) uncertainty faced by plants. Similarly, interaction of imported inputs and oil shares with exchange rate and oil price volatility gives two measures of cost uncertainty faced by these plants. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. We measure oil price volatility by the volatility of Brent crude oil prices.

We show that the coefficient of log uncertainty in a regression of log material and log labour share on log uncertainty gives us the effect of uncertainty on product and combined market power, respectively. The coefficient of log uncertainty in a regression of log markdown on log uncertainty gives us the effect of uncertainty on labour market power. To address the endogeneity of these plant-level shares, we use historical cross-sectional averages of exports, imported inputs, and oil share at the two- and three-digit industries as instruments.

We find a fundamental difference disconnect between the revenue and cost uncertainties. Revenue uncertainty decreases the product market power, whereas the cost uncertainty increases the product market power. Although these two uncertainty measures have opposite effects on product market power, both these uncertainties increase combined market power. This is because revenue uncertainty leads to a significant increase in labour market power, and the cost uncertainty leads to a decline in labour market power, but this decline in less compared to increases in product market power due to cost uncertainty.

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Appendix

A. Plant-level shares: Baseline regressions

Table A.1: Effect of Revenue and Cost Uncertainty on Product Market Power

	(1) Product	(2) Product Share	(3) Product	(4) Product
ER Volatility* Export Share	-1.192***	-0.929***		
	(4.68)	(3.65)		
ER Volatility* Imported Input Share			1.722***	1.765***
			(-4.24)	(-4.34)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes
Inflation	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate volatility in the regressions of log material share give the product market power with exchange rate volatility. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

Table A.2. Effect of Revenue and Cost Uncertainty on Labour Market Power

	(1) Labour	(2) Labour	(3) Labour	(4) Labour
ER Volatility* Export Share	2.718***	2.329***		
	(5.87)	(5.05)		
ER Volatility* Imported Input Share			-0.376	-0.342
			(-0.48)	(-0.43)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes
Inflation	No	Yes	No	Yes
Lag Cross- sectional Averages	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee– US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

Table A.3. Effect of Revenue and Cost Uncertainty on Combined Market Power

	(1) Combined	(2) Combined	(3) Combined	(4) Combined
ER Volatility* Export Share	1.526*** (-4.08)	1.400*** (-3.72)		
ER Volatility* Imported Input Share			1.346** (-1.98)	1.423** (-2.08)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes
Inflation	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate volatility, respectively. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

B. Two-digit Industries' Averages of Exports, Imports, and Oil Shares in 2008-09 as Instrumental Variables

Table B.1: Effect of Revenue Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-10.98***	-11.35***	8.569***	7.462***	19.55***	18.81***
	(7.59)	(7.73)	(-4.75)	(-4.16)	(7.73)	(7.55)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate volatility, respectively. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. We use the two-digit industries' average export share in 2008-09 as an instrument for the plant-level export share. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

Table B.2: Effect of Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Imported Input Share	5.956**	5.911**	4.817	4.523	-1.140	-1.388
	(-2.43)	(-2.42)	(-1.50)	(-1.40)	(-0.28)	(-0.34)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No
Observations	330,964	330,964	330,964	330,964	330,964	330,964

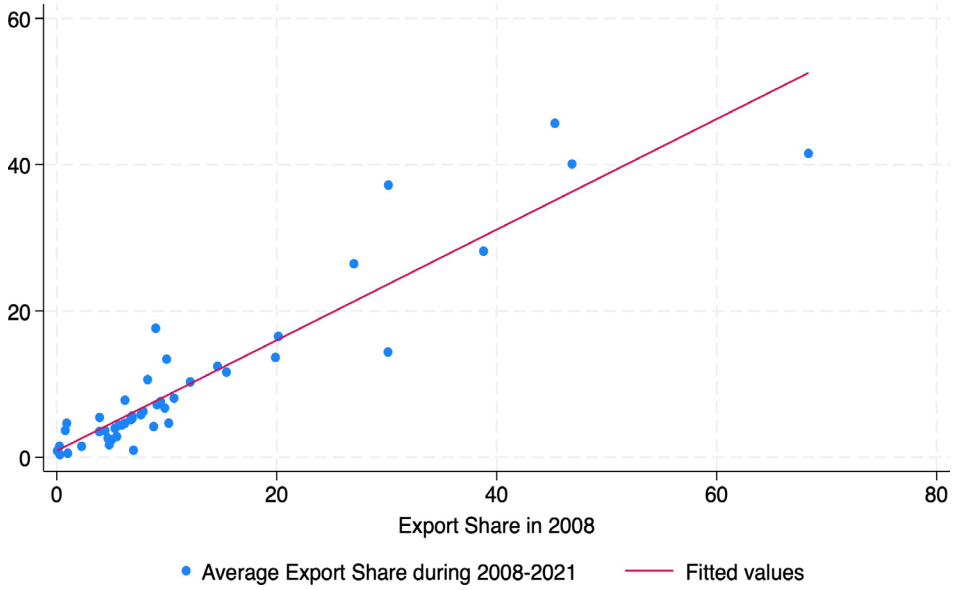
Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate volatility, respectively. The value of the coefficient associated with exchange rate volatility in the regression of log markdown on log exchange rate volatility gives the elasticity of labour market power with exchange rate volatility. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US Dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. We use the two-digit industries' average of imported input share in 2008-09 as an instrument for the plant-level imported input share. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

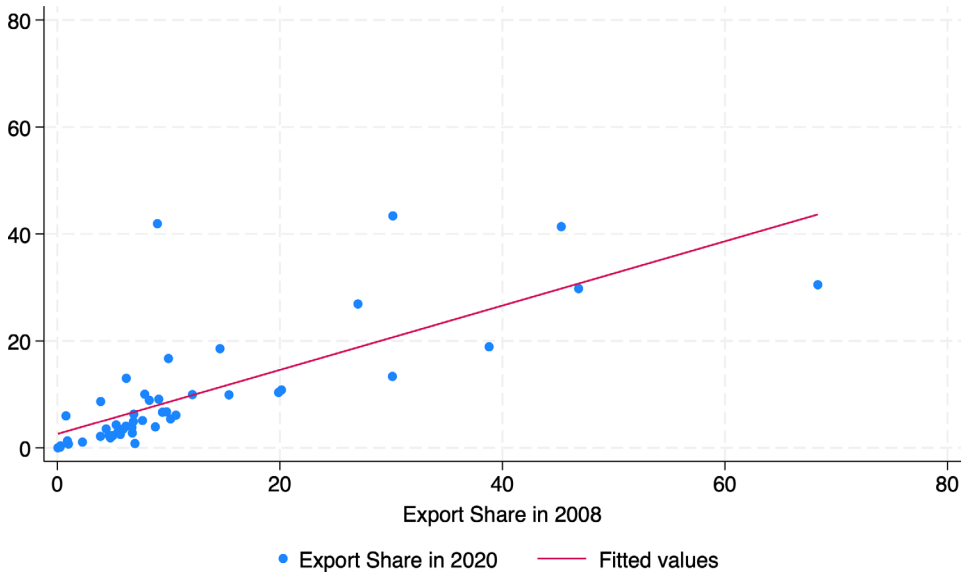
C. Instrumental Variables: Three-digit Industry Averages

Figure C.1: Export Share: Three-digit Industries

(a) Share in 2008-09 and Average Share During 2008-09 and 2021-22



(b) Share in 2008-09 and in 2020-21

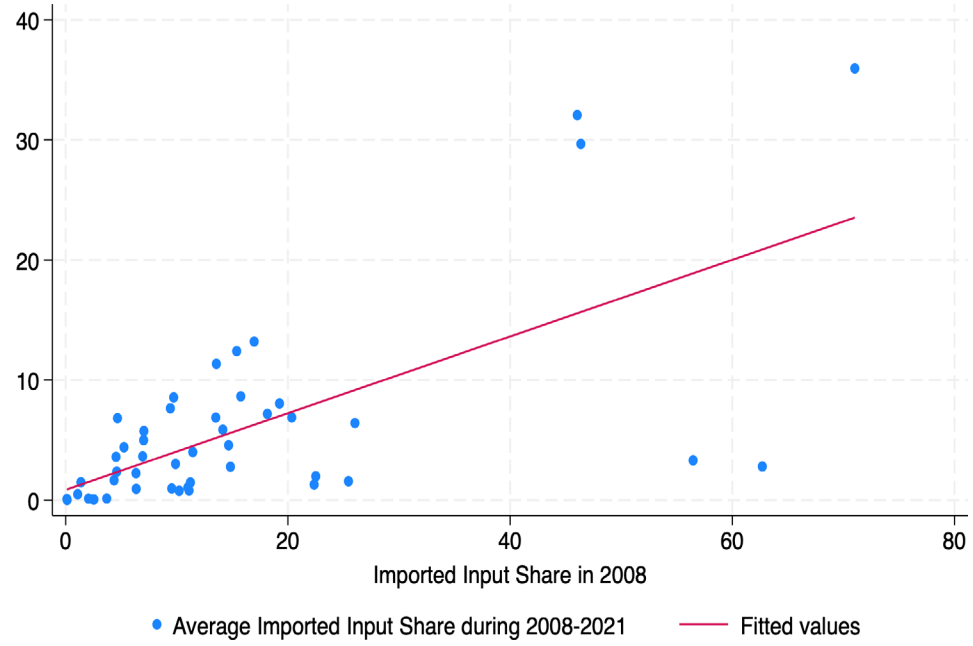


Notes: Figure C.1a gives the average export share for three-digit industries in 2008-09 and an average of the year-wise average of the export shares in three-digit industries during 2008-09 and 2021-22. Figure C.1b gives the average export share for three-digit industries in 2008-09 and 2020-21.

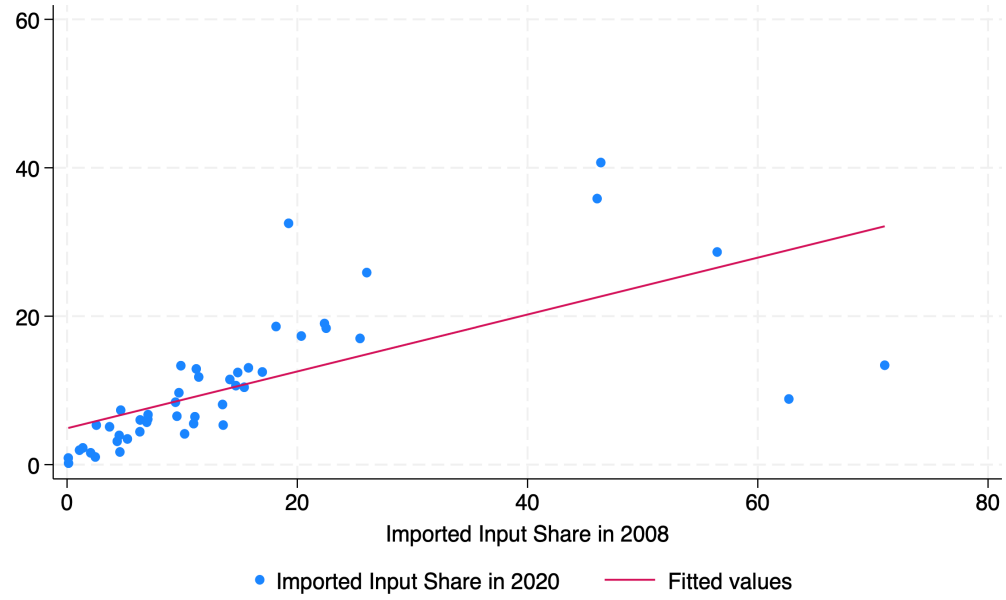
Source: Authors.

Figure C.2: Imported Input Share: Three-digit Industries

(a) Share in 2008-09 and Imported Share During 2008-09 and 2021-22



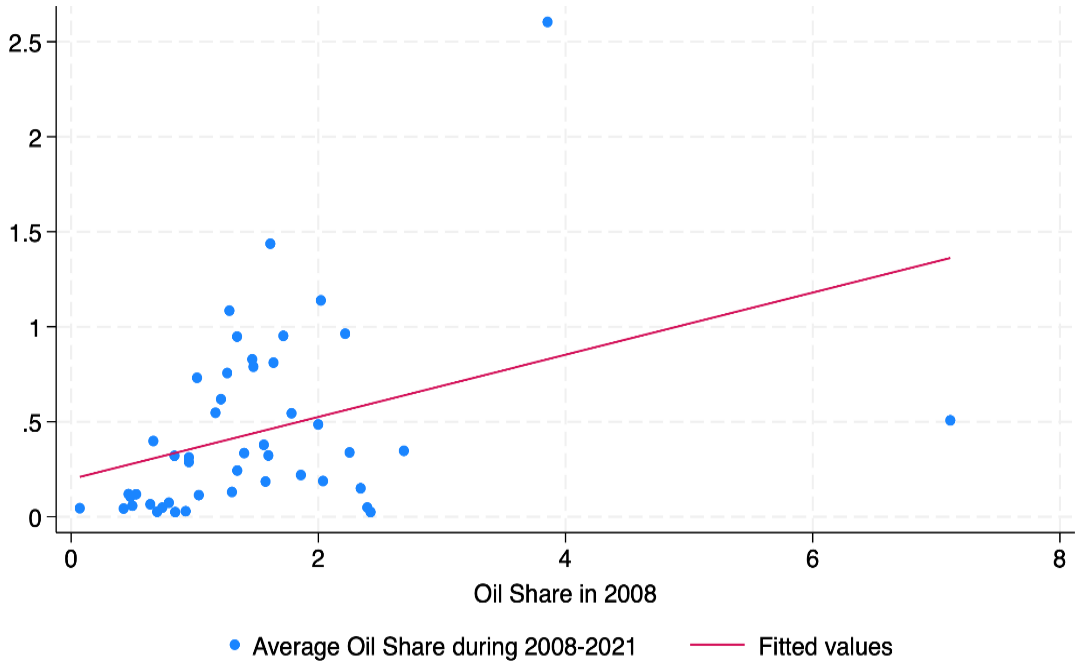
(b) Share in 2008-09 and in 2020-21



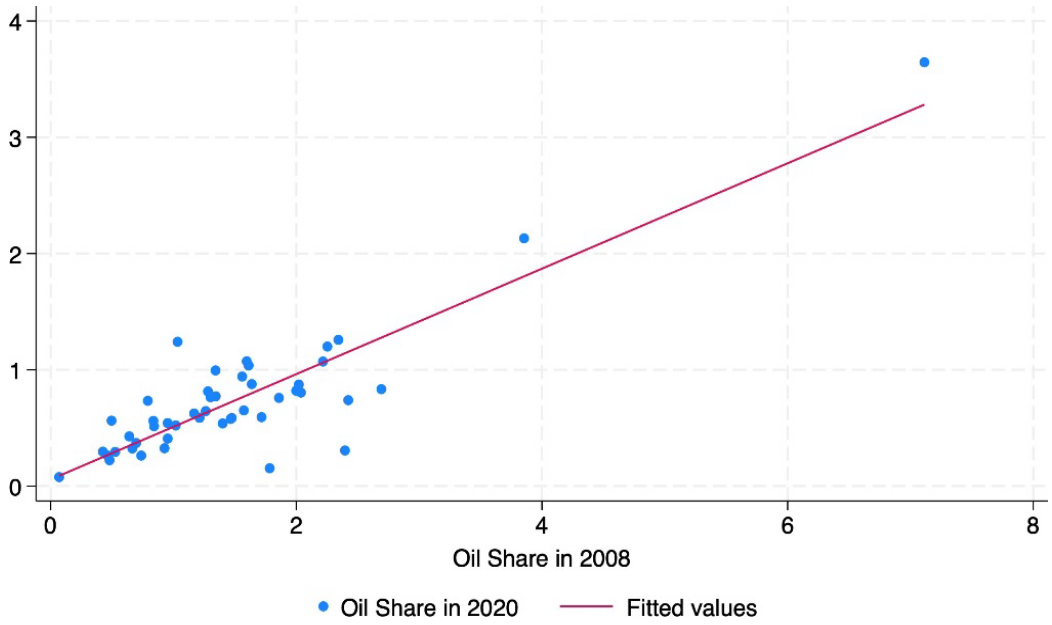
Notes: Figure C.2a gives the average imported input share for three-digit industries in 2008-09 and an average of the year-wise averages of the imported input share in three-digit industries during 2008-09 and 2021-22. Figure C.2b gives the average imported input share for three-digit industries in 2008-09 and 2020-21.
Source: Authors.

Figure C.3: Oil Share: Three-digit Industries

(a) Share in 2008-09 and Share During 2008-09 and 2021-22

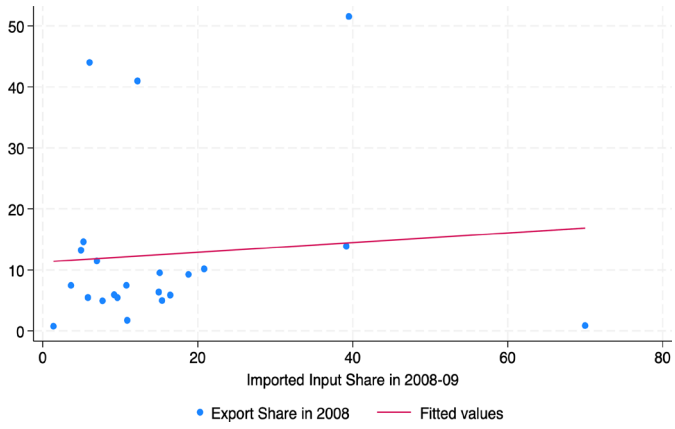


(b) Share in 2008-09 and in 2020-21

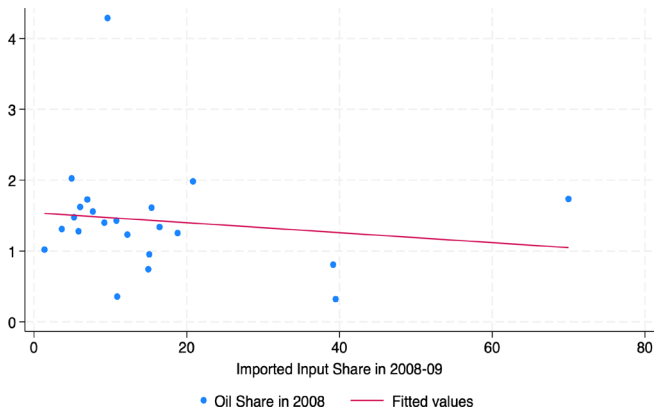


Notes: Figure C.3a gives the average oil share for three-digit industries in 2008-09 and an average of the year-wise averages of the oil share in three-digit industries during 2008-09 and 2021-22. Figure C.3b gives the average oil share for three-digit industries in 2008-09 and 2020-21.
Source: Authors.

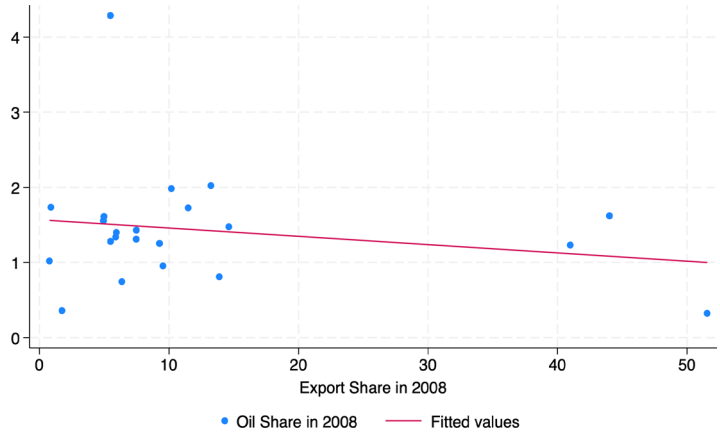
Figure C.4: Export, Imported Inputs, and Oil Shares: Three-Digit Industries



(a) Export and Imported Input Share



(b) Oil and Imported Input Share



(b) Oil and Export Share

Notes: Figure C.4a gives the average export and imported input shares for three-digit industries in 2008-09. Figure C.4b gives the average oil and imported input shares for three-digit industries in 2008-09. Figure C.4c gives the average oil and export shares for three-digit industries in 2008-09.
Source: Authors.

Table C.1: Regression: Plant-level Export Share and Three-digit Industry Averages of Export Share in 2008-09

	(1) Export Share: 2009-2021	(2) Export Share: 2010	(3) Export Share: 2015	(4) Export Share: 2020
Industry Export Share 2008-09	0.765***	0.937***	0.770***	0.635***
	(235.44)	(68.13)	(64.50)	(58.54)
Observations	307,902	18,520	24,762	26,623
R-Squared	0.153	0.200	0.144	0.114
F-Statistic	55,431.4	4,641.8	4,159.9	3,427.1

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21.

Source: Authors.

Table C.2: Regression: Plant-level Imported Input Share and Three-Digit Industry Average of Imported Input Share in 2008-09

	(1) Imported Inputs Share: 2009-2021	(2) Imported Inputs Share: 2010	(3) Imported Inputs Share: 2015	(4) Imported Inputs Share: 2020
Industry Imported Input Share 2008-09	0.273***	0.343***	0.254***	0.250***
	(109.44)	(28.96)	(28.70)	(32.40)
Observations	307,902	18,520	24,762	26,623
R-Squared	0.0374	0.0433	0.0322	0.0379
F-Statistic	11,977.6	838.6	823.5	1,050.0

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21.

Source: Authors.

Table C.3: Regression: Plant-level Oil Share and Three-Digit Industry Average of Oil Share in 2008-09

	(1) Petrol Share: 2009-2021 Petrol_Share1	(2) Petrol Share: 2010 Petrol_Share1	(3) Petrol Share: 2015 Petrol_Share1	(4) Petrol Share: 2020 Petrol_Share1
Industry Petrol Share 2008-09	0.796***	0.762***	0.754***	0.758***
	(120.49)	(26.65)	(33.74)	(37.05)
Observations	307902	18520	24762	26623
R-Squared	0.0450	0.0369	0.0439	0.0490
F-Statistic	14516.7	710.3	1138.1	1373.0

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Column 1 includes all the plants from 2009-10 to 2021-22. Column 2 includes all the plants in 2010-11. Column 3 includes all the plants in 2015-16. Column 4 includes all the plants in 2020-21.

Source: Authors.

C.1. Three-digit industry averages of export, import, and oil shares in 2008-09 as instrumental variables

Table C.4: Effect of Revenue and Cost Uncertainty on Market Power

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
ER Volatility* Export Share	-9.712***	-9.762***	8.826***	8.747***	18.54***	18.51***
	(6.73)	(6.75)	(-4.64)	(-4.59)	(7.14)	(7.13)
ER Volatility* Imported Input Share	7.162**	7.163**	-0.507	-0.867	-7.669	-8.030
	(-2.46)	(-2.46)	(0.13)	(0.23)	(-1.57)	(-1.64)
Oil Volatility* Petrol Share	4.051***	4.070***	1.251	1.198	-2.800	-2.871
	(-4.02)	(-4.04)	(-0.86)	(-0.82)	(-1.54)	(-1.57)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Plant-level Controls	Yes	Yes	Yes	Yes	Yes	Yes
First Moment	No	Yes	No	Yes	No	Yes
Inflation	No	Yes	No	Yes	No	Yes
Lag Cross-sectional Averages	No	Yes	No	Yes	No	Yes
Year Fixed Effects	Yes	No	Yes	No	Yes	No

	(1) Product Market	(2) Product Market	(3) Combined	(4) Combined	(5) Labour Market	(6) Labour Market
Observations	307,902	307,902	307,902	307,902	307,902	307,902

Notes: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The negative values of the coefficients associated with log exchange rate and log oil price volatility in the regressions of log material share and log labour shares give the elasticity of the product and combined market power with exchange rate and oil price volatility, respectively. The value of the coefficient associated with exchange rate and log oil price volatility in the regression of log markdown on log exchange rate and log oil price volatility gives the elasticity of labour market power with exchange rate and oil price. We include log size (sales) and log size (workers) at the plant levels. We further include exports, imported inputs, and oil share as plant-level controls. The export share is the ratio of exports to sales revenue; imported input share is the ratio of imported inputs to total raw materials; and oil share is the ratio of oil input to total raw materials. We use the volatility of the Nominal Advanced Foreign Economies US Dollar Index as an instrument for the volatility of the Indian rupee–US dollar exchange rate. Both these exchange rate volatilities are annual standard deviations of daily returns on the respective rates. Oil volatility is the annual standard deviation of daily returns on oil prices. We use three-digit industries' average of exports and imported input share in 2008-09 as instruments for plant-level exports and the imported input share. In models without time-fixed effects, we also include the log of exchange rate volatility, % change in the exchange rate for the year (first moment), inflation, and lag of the cross-sectional average of material, labour, exports, and imported inputs and oil share as controls. The markdown is based on the estimated material and labour elasticity at the two-digit industry level.

Source: Authors.

D. Data

United States

Federal Reserve Bank of Saint Louis

- Nominal Advanced Foreign Economies US Dollar Index, Index Jan 2006=100, Daily, Not Seasonally Adjusted (DTWEXAFEGS)
- Indian Rupees to US Dollar Spot Exchange Rate, Indian Rupees to US$1, Daily, Not Seasonally Adjusted (DEXINUS)
- Inflation, Consumer Prices for India, Percent, Annual, Not Seasonally Adjusted (FPCPITOTLZGIND)
- Crude Oil Prices: Brent-Europe, US Dollars per Barrel, Daily, Not Seasonally Adjusted (DCOILBRENTEU)

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