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WHEN GLOBAL ENERGY COSTS TRAVEL: DOMESTIC TRADE NETWORK CHANNEL TO FIRM-LEVEL INFLATION EXPECTATIONS

ABSTRACT

Global energy price shocks can destabilise inflation expectations, with profound implications for monetary policy and price stability. In this paper we investigate how energy exposure in domestic supply chains shape the transmission of global energy price shocks to firm-level inflation expectations. Using administrative microdata for Türkiye, we show that firms more reliant on energy inputs within their trade networks exhibit stronger responses in medium term consumer and producer price expectations. These effects are most pronounced among larger, more leveraged and higher-employment firms. Firms with a higher level of dependency are also more likely to revise pricing and unit cost expectations following energy price increases. Our results highlight the role of domestic supply chain energy exposures in shaping inflation dynamics in emerging markets amid global commodity fluctuations.

Keywords: Global Energy Prices; Energy Exposure; Trade Network; Price Stability; Inflation Expectations
JEL Classification: D22; E31; L14; Q41

RIASSUNTO

Quando i costi globali dell'energia si trasmettono: il canale delle reti commerciali domestiche nelle aspettative di inflazione a livello di impresa

Gli shock dei prezzi globali dell'energia possono destabilizzare le aspettative di inflazione, con

profonde implicazioni per la politica monetaria e la stabilità dei prezzi. In questo articolo analizziamo in che modo l'esposizione a variazioni del prezzo dell'energia nelle catene del valore domestiche influenzi la trasmissione di shock energetici alle aspettative di inflazione a livello di impresa. Utilizzando microdati amministrativi relativi alla Turchia, mostriamo che le imprese maggiormente dipendenti dagli input energetici all'interno delle proprie reti commerciali presentano più marcate razioni nelle aspettative di medio termine sui prezzi al consumo e alla produzione. Questi effetti sono particolarmente pronunciati tra le imprese più grandi, più indebitate e con livelli occupazionali più elevati. Le imprese con un grado più alto di dipendenza energetica hanno inoltre una maggiore probabilità di rivedere le proprie aspettative sui prezzi e sui costi unitari a seguito di aumenti dei prezzi dell'energia. I nostri risultati evidenziano il ruolo dell'esposizione energetica nelle catene del valore domestiche nel determinare le dinamiche inflazionistiche dei mercati emergenti in presenza di fluttuazioni globali dei prezzi delle materie prime.

1. Introduction

Episodes of large and persistent movements in global energy prices have been a defining feature of the post-2000 macroeconomic environment. Examples include the surge in oil and natural gas prices around the global financial crisis, during the 2010s commodity super-cycle, and again in the wake of the Russia-Ukraine conflict. These shocks have reignited long standing discussions regarding how energy prices transmit into inflation and real economic activity, particularly in energy-importing emerging markets. Against this background, in this study, we investigate how energy exposure in domestic supply chains shapes the transmission of global energy price shocks to firm-level inflation expectations.

A sizeable macroeconomics literature documents that oil and energy price shocks can have significant and long-lasting impacts on output and inflation. The absolute magnitude and persistence depend upon the nature of the shock, the structure of the economy and the monetary policy regime (Hamilton, 1983, 2003; Rotemberg and Woodford, 1996; Bernanke, Gertler and Watson, 1997; Barsky and Kilian, 2002; Hooker, 2002; Blanchard and Galí, 2007; Kilian, 2009). Prior research using structural VARs and news-based identification further highlight the role of oil supply and demand shocks in driving output, economic activity, inflation and currency movements (Baumeister and Peersman, 2013; Baumeister and

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Hamilton, 2019; Känzig, 2021). Understanding this transmission is critical, given that energy price shocks can rapidly destabilise inflation expectations, amplifying macroeconomic volatility and complicating policy formulation and execution in energy-importing economies.

For inflation-targeting central banks and monetary authorities, the impact of energy price shocks is crucial not only because of the first-round impacts on energy and transport prices, but also because of their potential to de-anchor inflation expectations and trigger second-round wage-price dynamics. The modern expectations-augmented Phillips curve emphasises the central role of expectations in inflation dynamics (Mankiw and Reis, 2002; Coibion and Gorodnichenko, 2015a, 2015b; Coibion, Gorodnichenko and Kamdar, 2018). Survey-based studies show that firm and household expectations are often biased, sticky and heterogeneous. Yet provide crucial information regarding forward-looking behaviour in relation to product pricing, wage determination, labour supply, inventory management, credit utilisation, investment tendencies and other strategic decisions (Coibion, Gorodnichenko and Ropele, 2020; Weber *et al.*, 2022). Related evidence directly links energy prices to expectations. Binder (2018), Kilian and Zhou (2022), Wong (2015) and Aastveit, Bjørnland and Cross (2023) collectively show that movements in oil and gasoline prices affect household and firm inflation expectations. Wehrhöfer (2023), Adams and Barrett (2024) and Patzelt and Reis (2024) show that recent energy-related shocks have contributed to an increase in measured expectations in advanced economies.

Türkiye (the setting for the present study) provides a useful laboratory for studying the expectations channel of energy price shocks. The Turkish economy is structurally dependent on imported energy. Moreover, exchange rate and energy price (cost) shocks have historically played prominent roles in bouts of inflation. A growing body of evidence quantifies the pass-through of international oil prices to domestic prices at different stages of the supply chain. Akçelik and Öğünç (2016) show that crude oil price changes transmit quickly into domestic fuel prices, and estimate that a 10 percent permanent increase in oil prices raises consumer inflation by around 0.5 percentage points, with a more pronounced effect on producer prices. Özmen and Özşahin (2023) document that global energy and non-energy commodity prices exert time-varying and substantive impacts on Türkiye's inflation over 2003-2022. Thus, highlighting the macroeconomic salience of energy price shocks for an energy-importing emerging market. Overall, Türkiye's structural energy dependence and history of inflationary

episodes provide an ideal setting to uncover how global shocks propagate through domestic cost structures and expectations.

The literature on energy economics often relies upon aggregated data and treats the setting as a small open economy impacted by exogenous global energy price shocks. Production-network models instead emphasise that macroeconomic responses to sectoral shocks depend on the structure of inter-firm and inter-sectoral linkages (Acemoglu *et al.,* 2012; Carvalho, 2014; Carvalho and Tahbaz-Salehi, 2019; Barrot and Sauvagnat, 2016). Shocks impacting energy-intensive industries can cascade through input-output networks and generate outsized aggregate effects relative to their share in value added. Firm-level studies on the propagation of energy input cost shocks document heterogeneous pass-throughs across firms when energy or carbon prices change (Ganapati, Shapiro and Walker, 2020; Colmer *et al.,* 2025). This suggests that the impact of global energy prices on firms' costs and expectations depend not only on their own direct energy usage, but also on their position in domestic supplier networks, and the energy intensity of their upstream partners.

While direct energy consumption is a clear driver of cost, the domestic trade network acts as an indirect conduit for global shocks by embedding energy costs into intermediate inputs. In this context, firms with low direct energy needs may still be vulnerable if their upstream suppliers (such as those in the chemicals, or basic metals sectors) use energy-intensive production process, and pass increasing costs on via price increases (in order to maintain margins). Consequently, managers observe global energy signals as lead indicators for the cost pressures arriving through their supply chains. This network-driven anticipation causes firms to revise inflation expectations prior to any cost -shock fully permeating the aggregate economy.

An expanding literature utilises micro data on expectations to investigate how firms and households perceive and respond to macroeconomic shocks. For advanced economies, firm managers and household inflation expectations are often poorly anchored, but nevertheless are strongly predictive of price changes, employment and investment. These expectations also tend to be moved frequently by information and communications (Coibion and Gorodnichenko, 2015a, 2015b; Coibion *et al.,* 2020; Weber *et al.,* 2022). Kose *et al.* (2019) review the measurement of expectations and their role in monetary policy across advanced and

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emerging economies. The authors show that expectations in emerging markets tend to be more backward-looking and sensitive to relative-price shocks.

For Türkiye, there is a substantive, albeit aggregate-based literature on inflation expectations[1]. These studies confirm the central role of expectations in the Turkish inflation process, but focus on professional or aggregate expectations. As such they do not explicitly incorporate firms' heterogeneous energy exposures or their positions in domestic production networks. Our study brings together three strands of literature on energy price shocks, production networks and firm-level inflation expectations, by using a novel micro dataset for Türkiye. We combine an unbalanced monthly panel of manufacturing firms from the Central Bank of the Republic of Türkiye (CBRT) Business Tendency Survey over 2009–2023 with an administrative firm-to-firm transactions database and firm-level financial statements. The transaction data allow us to construct a time-varying measure of each firm's energy exposure in domestic supply chains, defined as the share of purchases sourced (directly or indirectly) from energy-intensive suppliers and sectors. We complement this with detailed firm-level information on size, leverage, employment and trade orientation to study heterogeneity in the transmission of global energy shocks.

We estimate a saturated panel model in which several expectation outcomes at the firm level are regressed on global energy prices interacted with firm-specific energy exposure. The outcome variables capture: 12-month-ahead expectations for consumer and producer price inflation (measured as continuous percentages); and binary indicators for whether firms expect their own unit prices and unit costs to increase over the next three months. The main explanatory variables are: the log level of global oil and alternative energy price indices; the firm-level energy exposure measure; and their respective interaction. Our baseline specification includes firm fixed effects to absorb time-invariant firm characteristics and sector-by-month fixed effects (at the 4-digit NACE level) to capture sector-specific and seasonal shocks. This design exploits within-firm variation over time in global energy prices

[1] Using panel data on financial and real sector expectations, Oral *et al.* (2011) test the rationality of Turkish inflation expectations. The authors present evidence of systematic biases and persistence. Soybilgen and Yazgan (2017) evaluate the forecast performance of expectations via survey-based data. Koç, Öğünç and Özmen (2021) estimate a joint system of inflation and expectations equations and show that expectations have become more important in Turkish inflation dynamics and are affected by inflation targets, realised inflation, exchange rate movements and oil prices. Gülşen and Kara (2021) study the changing behaviour of professional forecasters' expectations with evolving macroeconomic and policy performance. Akarsu, Aktug and Yalçin (2025) show that central bank communication and policy actions can shape expectations of households, firms and market participants in Türkiye.

and in firms' position in energy-intensive domestic trade networks to trace how cost shocks feed into expectations.

By way of preview, our results suggest that the impact of global energy price shocks on expectations is more pronounced for firms that are more reliant on energy-intensive inputs in domestic trade networks. An increase in global oil prices leads highly exposed firms to revise up their 12-month-ahead CPI and PPI expectations by more than otherwise similar, but less exposed counterparts. Moreover, these firms are more likely to report expectations of increasing unit prices and unit costs over the next three months. This pattern is robust across: alternative measures of expectations; different energy price indicators; and after controlling for non-energy commodity prices. We further show that the transmission of energy shocks to expectations is stronger for larger, more leveraged and higher-employment firms. This suggests that network-based energy exposure interacts with firm balance-sheet conditions in shaping expectation formation. Overall, these findings reveal that energy-dependent production structures are not passive recipients of global shocks, but instead are conduits that magnify their impact on inflation expectations, with resultant consequences and implications for macroeconomic stability and public policy.

Our contribution is to show that the transmission of global energy prices to inflation expectations depends on domestic input structures that are typically unobserved in expectation datasets. By combining monthly firm expectations with administrative buyer-seller transactions, we construct an objective firm-level measure of supply-chain energy exposure and show that it amplifies expectation responses to global energy price movements, even within the same 4-digit sector and month. This provides micro evidence consistent with production-network amplification and clarifies a channel through which commodity shocks can de-anchor inflation expectations in energy-importing emerging markets.

More specifically, our paper makes three contributions to the literature. First, we provide (to our knowledge), the first firm-level evidence on how global energy price shocks transmit into inflation expectations through domestic production networks for an emerging market. Thus, complementing aggregate studies of energy pass-through to inflation in Türkiye (Akçelik and Öğünç, 2016; Özmen and Özşahin, 2023). However, in contrast to existing studies that rely on self-reported shock assessments or broad sector-level proxies (which often suffer from

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perception bias or aggregation noise), our measure of energy exposure is derived from objective administrative trade-network data. This allows us to identify how network-based structural dependencies shape the formation of inflation expectations. Second, we contribute to the broader literature on firm expectations by documenting a novel form of heterogeneity. Specifically, firm expectations respond more to energy shocks when they are more exposed to energy-intensive suppliers upstream in the domestic network, even after conditioning on sector and size. This connects the micro-expectations literature (Coibion, Gorodnichenko and Ropele, 2020; Weber *et al.,* 2022) with production-network models of shock propagation (Acemoglu *et al.,* 2012; Carvalho and Tahbaz-Salehi, 2019). Third, by focusing on Türkiye's inflation-targeting period and episodes of elevated inflation and energy price volatility, we augment evidence on how expectations in emerging markets react to relative-price and cost-push shocks, with implications for the calibration and communication of monetary policy.

The remainder of the paper is organised as follows. Section 2 describes the institutional background, data sources and the construction of our firm-level energy exposure measure. Section 3 outlines the empirical strategy linking global energy prices, domestic trade-network exposure and firm-level expectations. Section 4 presents the main results, robustness checks and heterogeneity analyses. Section 5 concludes with policy implications for inflation-targeting central banks in energy-importing emerging markets.

2. DATA

Our sample comprises an unbalanced monthly panel of 3,724 manufacturing firms over the period January 2009 to December 2023. The empirical analysis (presented in Section 4) combines several administrative and publicly available datasets. First, we use the Business Tendency Survey (BTS) to obtain firms' inflation expectations. Conducted by the CBRT, the BTS monitors managers' assessments of recent performance and current conditions, as well as expectations regarding sales, production, pricing, and export activity. The survey enables the construction of backward- and forward-looking indicators for manufacturing sector conditions. In this framework, we collect firms' quantitative 12-month-ahead forecasts for consumer and producer inflation, along with their categorical three-month-ahead evaluations of expected changes in unit prices and costs. These qualitative responses are grouped as "increase," "decrease," or "remain the same".

Second, we employ the micro-level firm-to-firm transactions database compiled by the Revenue Administration (accessed via the CBRT) to characterise supply chain relationships. This dataset records all domestic trade among Turkish firms with invoice values above TL5,000 and allows us to identify linkages between firms. We aggregate these transactions to measure each firm's exposure to energy inputs, calculated as the annual share of purchases from firms operating in electricity, natural gas, and petroleum sectors in total inputs. The input supplier sectors according to 4-digit NACE REV.2 classification are: 3514 - Trade of electricity; 3523 - Trade of gas through mains; and 4671 - Wholesale of solid, liquid and gaseous fuels and related products.

Third, we incorporate firm characteristics from annual financial statements submitted to the Revenue Administration (and accessed via the CBRT). These regulatory filings (which are prepared under the Tax Procedure Law) require all corporate taxpayers to report balance sheets, income statements, and supplementary information. From these records, we obtain data on firm size classifications, number of employees, total assets, and financial liabilities. Fourth, we collect time-series data on global commodity price movements. Brent oil prices from Bloomberg serve as our main proxy for global energy shocks. In addition to Brent oil prices, we also incorporate alternative commodity benchmarks including European TTF Natural Gas prices as well as Goldman Sachs Agriculture and Industrial Metal Indices obtained from Bloomberg, which we later use in extended analyses[2].

Overall, the micro-level datasets (on firm expectations from the CBRT Business Tendency Survey, detailed supply-chain linkages from administrative transaction records, firm characteristics from financial statements, and global commodity price indicators) underpinning the empirical analysis (presented in section 4) allow us to construct a time-varying measure of energy exposure and link it to expectation formation[33]. Building on this foundation, the next section introduces our empirical strategy, which leverages these data to identify how global energy shocks interact with domestic trade-network structures to shape the inflation expectations of firms.

[2] We use the TTF because it is the primary European reference price. TTF provides a more accurate reflection of energy cost conditions faced by importers in the European region compared to North American benchmarks such as NYMEX/Henry Hub.

[3] The datasets monitoring firm expectations, supply chain composition and financial statement characteristics are not publicly available. The regulatory filings of these datasets are access via permission obtained from CBRT.

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3. EMPIRICAL DESIGN

Our baseline specification for empirical analysis is defined as follows:

$$Expectations_{i,t} = \beta_1\left(Brent\ Oil\ Price_t\ x\ Energy\ Exposure_{i,t-12}\right) + \beta_2(Brent\ Oil\ Price_t) + \beta_3\left(Energy\ Exposure_{i,t-12}\right) + \delta_i + \delta_{st} + \varepsilon_{i,t} \quad (1)$$

where $Expectations$ denotes the various outcome variables describing expectation formation of firm i observed at time t concerning 12 months ahead inflation rate ($CPI\ Expectations$ and $PPI\ Expectations$) as well as binary variables representing the likelihood of increase in unit price and cost ($Unit\ Price\ Expectations$ and $Unit\ Cost\ Expectations$). The variable $Brent\ Oil\ Price$ denotes the log-transformed level of global oil prices, while the variable $Energy\ Exposure$ denotes (one year-lagged) annual energy dependency of firms based on supply chain activities[4]. The main coefficient of interest, β_1, captures the extent to which energy dependency in domestic trade network facilitates the transmission of global energy shocks to firms' inflation expectations. The specification in Equation (1) is saturated with firm fixed effects (δ_i) to account for unobserved firm-level time-invariant heterogeneities that are likely to affect expectation formation. The model is also augmented with sector-by-month fixed effects (δ_{st}) to absorb time-varying macro-level and sectoral forces, where sector definitions are determined as 4-digit NACE classifications. Standard errors are clustered at firm level. The variable definitions and summary statistics are provided in Table 1.

Overall, our empirical framework combines global energy price movements with firm-specific energy exposure to identify how supply-chain structures condition expectation responses. The next section applies this model to the Turkish firm-level data, presenting baseline estimates, robustness checks, and heterogeneity patterns that reveal the strength and channels of this transmission.

[4] The lag on energy exposure indicator identifies the firm's established supply-chain structure. However, this structural lag is distinct from the dependent variable's 12-month-ahead horizon, which refers to the survey respondent's forward-looking inflation forecast for the upcoming year.

TABLE 1 – *Variable Definitions and Summary Statistics*

(1) Variables	(2) Definitions	(3) Mean	(4) St Dev.	(5) p5	(6) p95
CPI Expectations	A continuous variable representing 12 months ahead expectations of firms for annual consumer price inflation rate	17.945	19.302	6.250	65.000
PPI Expectations	A continuous variable representing 12 months ahead expectations of firms for annual producer price inflation rate	19.444	24.367	5.000	75.000
Unit Price Expectations	A binary variable taking the value of one if surveyed firms expect an increase in unit prices for the next three months, otherwise zero	0.277	0.447	0.000	1.000
Unit Cost Expectations	A binary variable taking the value of one if surveyed firms expect an increase in unit costs for the next three months, otherwise zero	0.449	0.497	0.000	1.000
Brent Oil Price	The log-transformed global Brent oil price index	4.281	0.344	3.743	4.725
Energy Exposure	The ratio of sum of electrical, natural gas-based and petrol-related purchases (made by a specific firm in a given timepoint) to total input purchases	2.168	5.314	0.000	9.198
Natural Gas Price	The log-transformed global natural gas price index, European TTF	3.106	0.631	2.371	4.604
Firm Size	A binary variable taking the value of one for large firms based on regulatory classification, otherwise zero	0.762	0.426	0.000	1.000
Employment	The number of employees	403	711	38	1348
Financial Debt	The ratio of financial liabilities to total assets	14.834	15.948	0.000	46.152

Notes: This table presents the variable definitions and summary statistics of the main outcome, independent and channel variables used in the estimations. Column (2) presents variable definitions, whereas columns (3) to (6) provide mean, standard deviation, 5th percentile and 95th percentile of variable distributions, respectively.

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4. RESULTS

The baseline estimates in Table 2 show that global energy price shocks translate into increases in firm-level inflation expectations in a way that is systematically shaped by firms' energy exposure in domestic supply chains[5]. Across all specifications, the interaction between Brent oil prices and firm-specific energy exposure is positive and significant, implying that firms with a higher share of energy inputs revise expectations more strongly in response to global price movements than firms with lower exposure. The regressions for unit price and cost expectations yield comparable dynamics, indicating that the same mechanism operates in near-term pricing plans and cost predictions for firms' own operations. These findings are consistent with the view that energy-dependent production structures amplify the pass-through of global price shocks into expectation formation and pricing behaviour. This interpretation aligns with recent evidence showing that firms adjust inflation expectations and pricing intentions rapidly following input-cost shocks (De Fiore, Lombardi and Mangiante 2025; Gödl-Hanisch and Menkhoff, 2023). Our estimation results also remain similar when WTI oil prices are used instead of Brent prices.

Recent firm-level studies corroborate the asymmetric and state-dependent nature of cost-pass-through. Using Italian firm survey data, De Fiore, Lombardi and Mangiante (2025) show that positive cost shocks raise inflation expectations substantially more than equivalent negative shocks, while Gödl-Hanisch and Menkhoff (2023) document significant heterogeneity across firms and sectors in the responsiveness to cost-push shocks. The estimates for Turkish case extend this evidence by demonstrating that heterogeneity in expectation pass-through is not only present, but structurally linked to an objective measure of energy exposure derived from administrative trade-network data rather than self-reported shock assessments. This structural linkage highlights that expectation formation is not merely behavioural, but rather is related to production-network characteristics. Consequently, highlighting the need to examine the mechanisms via which these channels amplify global shocks.

[5] The effects are also economically relevant. To gauge the economic magnitude of our findings, we consider a one-standard-deviation increase in both global oil prices and a firm's domestic energy exposure. Our estimates based on column (1) of Table 2 imply that such a combination leads to a 0.38 percentage point increase in CPI expectations. While this may seem small relative to the mean of CPI expectations, it represents a pure network-driven marginal effect above and beyond the general sectoral price trend. Importantly, since our model includes sector-by-month fixed effects, this finding represents the additional inflationary pressure experienced by highly exposed firms relative to their direct competitors.

TABLE 2 – *Baseline Estimations*

	(1) CPI Expectations	(2) PPI Expectations	(3) Unit Price Expectations	(4) Unit Cost Expectations
Brent Oil Price x Energy Exposure	0.205***	0.265***	0.0025**	0.0039***
	(0.066)	(0.091)	(0.0010)	(0.0011)
Brent Oil Price	10.644***	14.578***	0.0573***	0.0432***
	(0.311)	(0.417)	(0.0055)	(0.0065)
Energy Exposure	-0.394	-0.555	-0.0086**	-0.0161***
	(0.262)	(0.363)	(0.0043)	(0.0047)
Obs.	226,152	229,222	262,442	262,442
Firm FE	✓	✓	✓	✓
Sector x Month FE	✓	✓	✓	✓
Adj. R^2	0.299	0.284	0.254	0.275

Notes: This table presents the main results based on Equation (1). The estimations are based on an unbalanced monthly panel of 3,724 Turkish manufacturing firms for the period January 2009-December 2023. In column (1), the dependent variable (*CPI Expectations*) is 12 months ahead expectations for annual consumer price inflation rate (in percentages) of surveyed firms, whereas, in column (2), the dependent variable (*PPI Expectations*) is 12 months ahead expectations for annual producer price inflation rate (in percentages) of surveyed firms. In column (3), the outcome series (*Unit Price Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit prices for the next three months, otherwise zero. In column (4), the outcome series (*Unit Cost Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit costs for the next three months, otherwise zero. The data on all outcome variables are obtained from microdata on responses from CBRT Business Tendency Survey. In terms of independent variables, *Brent Oil Price* is the log-transformed global Brent oil price index. The variable *Energy Exposure* is the ratio of sum of electrical, natural gas-based and petrol-related purchases (made by a specific firm in a given timepoint) to total input purchases, which is calculated from microdata on firm-to-firm trade taken from CBRT sources. All columns include firm and sector-by-month fixed effects. Standard errors clustered at firm level are reported. ***, **, * represent statistical significance at 1%, 5%, 10%, respectively.

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We subject our baseline findings to various checks. Using alternative energy price measures, additional controls of global commodity prices and the incorporation of firm characteristics, we confirm that our baseline findings are not an artefact of a particular specification. When natural gas replaces oil as the benchmark energy price (Table 3), the interaction estimates remain positive and economically relevant, indicating that amplification is not specific to the oil market. Incorporating global agricultural and non-industrial metal price indices (Table 4) leaves the energy-exposure coefficients largely unchanged, and produces slightly larger coefficients in the CPI and PPI specifications. This is suggestive of a distinct role for energy rather than a general commodity-price effect[6]. In the next step, we revise the baseline specification by including a set of firm characteristics (Table 5), comprising: the ratio of equity capital to total assets ($Capital$); the ratio of total sales to total assets ($Sales$), the ratio of net income to total assets ($Income$), the ratio of inventory to total assets ($Inventory$), and the ratio of foreign sales to total sales ($Foreign\ Sales$). We continue to obtain similar results to those obtained in our baseline estimations[7].

[6] For the robustness pertaining to other commodity prices, we undertake an auxiliary analysis. First, we regress global agricultural product prices on Brent oil prices, global non-industry metal prices and time trend. Then, we take the residual of this first-stage regression as a control variable representing the genuine agricultural product price shocks. Second, we repeat the same process by regressing global non-industry metal prices on Brent oil prices, global agricultural product prices and time trend in order to construct another control variable in a similar manner. Finally, we re-run our baseline estimations by augmenting the specification with the aforementioned synthesized controls.

[7] We also check to see whether the potential multicollinearity problems are evident. The correlation values between the main independent variables and firm controls are relatively low.

TABLE 3 – *Alternative Proxy for Energy Prices*

	(1) CPI Expectations	(2) PPI Expectations	(3) Unit Price Expectations	(4) Unit Cost Expectations
Natural Gas Price x Energy Exposure	0.083*	0.096	0.0011*	0.0018**
	(0.048)	(0.066)	(0.0006)	(0.0007)
Natural Gas Price	16.159***	22.276***	0.0992***	0.0901***
	(0.225)	(0.349)	(0.0038)	(0.0037)
Energy Exposure	0.117	0.132	-0.0019	-0.0053**
	(0.145)	(0.202)	(0.0022)	(0.0023)
Obs.	226,152	229,222	262,442	262,442
Firm FE	✓	✓	✓	✓
Sector x Month FE	✓	✓	✓	✓
Adj. R^2	0.512	0.524	0.271	0.286

Notes: This table presents the robustness checks of the main results by using an alternative proxy for global energy prices. The estimations are based on an unbalanced monthly panel of 3,724 Turkish manufacturing firms for the period January 2009-December 2023. In column (1), the dependent variable (*CPI Expectations*) is 12 months ahead expectations for annual consumer price inflation rate (in percentages) of surveyed firms, whereas, in column (2), the dependent variable (*PPI Expectations*) is 12 months ahead expectations for annual producer price inflation rate (in percentages) of surveyed firms. In column (3), the outcome series (*Unit Price Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit prices for the next three months, otherwise zero. In column (4), the outcome series (*Unit Cost Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit costs for the next three months, otherwise zero. The data on all outcome variables are obtained from microdata on responses from CBRT Business Tendency Survey. In terms of independent variables, *Natural Gas Price* is the log-transformed global natural gas price index. The variable *Energy Exposure* is the ratio of sum of electrical, natural gas-based and petrol-related purchases (made by a specific firm in a given timepoint) to total input purchases, which is calculated from microdata on firm-to-firm trade taken from CBRT sources. All columns include firm and sector-by-month fixed effects. Standard errors clustered at firm level are reported. ***, **, * represent statistical significance at 1%, 5%, 10%, respectively.

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TABLE 4 – *Controlling for Other Commodity Price Movements*

	(1) CPI Expectations	(2) PPI Expectations	(3) Unit Price Expectations	(4) Unit Cost Expectations
Brent Oil Price x Energy Exposure	0.269***	0.353***	0.0029***	0.0043***
	(0.069)	(0.094)	(0.0010)	(0.0011)
Brent Oil Price	10.241***	14.207***	0.0618***	0.0477***
	(0.305)	(0.411)	(0.0056)	(0.0065)
Energy Exposure	-0.663**	-0.914**	-0.0097**	-0.0171***
	(0.275)	(0.378)	(0.0043)	(0.0047)
Obs.	226,152	229,222	262,442	262,442
Other Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Sector x Month FE	✓	✓	✓	✓
Adj. R^2	0.327	0.310	0.257	0.277

Notes: This table presents the robustness checks of the main results by using additional controls for global agriculture and non-industry metal prices. The estimations are based on an unbalanced monthly panel of 3,724 Turkish manufacturing firms for the period January 2009-December 2023. In column (1), the dependent variable (*CPI Expectations*) is 12 months ahead expectations for annual consumer price inflation rate (in percentages) of surveyed firms, whereas, in column (2), the dependent variable (*PPI Expectations*) is 12 months ahead expectations for annual producer price inflation rate (in percentages) of surveyed firms. In column (3), the outcome series (*Unit Price Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit prices for the next three months, otherwise zero. In column (4), the outcome series (*Unit Cost Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit costs for the next three months, otherwise zero. The data on all outcome variables are obtained from microdata on responses from CBRT Business Tendency Survey. In terms of independent variables, *Brent Oil Price* is the log-transformed global Brent oil price index. The variable *Energy Exposure* is the ratio of sum of electrical, natural gas-based and petrol-related purchases (made by a specific firm in a given timepoint) to total input purchases, which is calculated from microdata on firm-to-firm trade taken from CBRT sources. All columns include additional control variables monitoring other global commodity prices. Specifically, we incorporate an indicator for global agricultural commodity prices, which is taken as the residuals of an auxiliary time series model regressing agricultural commodity price index on Brent oil prices, global non-industry metal price index and time trend. Similarly, we also incorporate and indicator for global non-industry commodity prices, which is taken as the residuals of an auxiliary time series model regressing non-industry metal commodity price index on Brent oil prices, agricultural commodity price index and time trend. All columns include firm and sector-by-month fixed effects. Standard errors clustered at firm level are reported. ***, **, * represent statistical significance at 1%, 5%, 10%, respectively.

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TABLE 5 – *Inclusion of Time-Varying Firm Controls*

	(1) CPI Expectations	(2) PPI Expectations	(3) Unit Price Expectations	(4) Unit Cost Expectations
Brent Oil Price x Energy Exposure	0.143**	0.185**	0.0021**	0.0036***
	(0.067)	(0.093)	(0.0010)	(0.0011)
Brent Oil Price	10.741***	14.738***	0.0601***	0.0433***
	(0.322)	(0.437)	(0.0056)	(0.0066)
Energy Exposure	-0.158	-0.251	-0.0072*	-0.0146***
	(0.266)	(0.373)	(0.0043)	(0.0046)
Obs.	226,075	229,145	262,358	262,358
Firm Controls	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Sector x Month FE	✓	✓	✓	✓
Adj. R^2	0.334	0.320	0.259	0.278

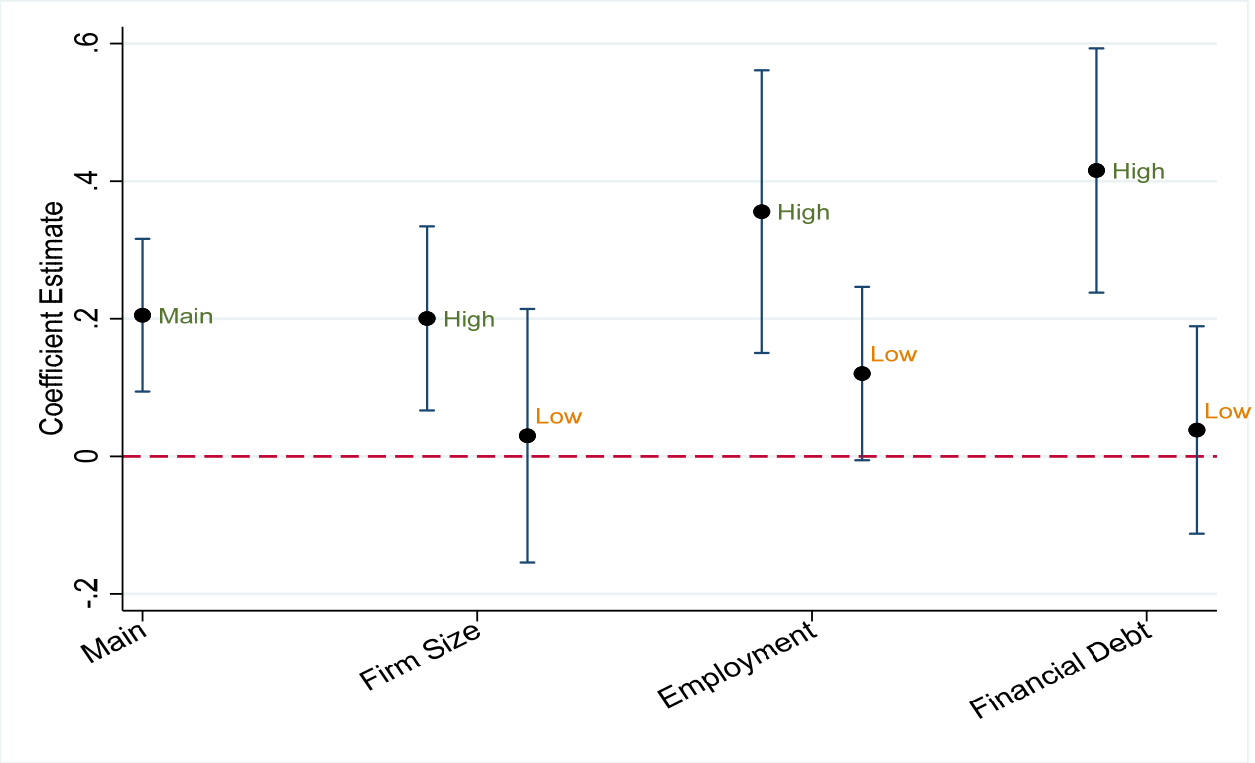
Notes: This table presents the robustness checks of the main results by using additional controls for time-varying firm characteristics. The estimations are based on an unbalanced monthly panel of 3,724 Turkish manufacturing firms for the period January 2009-December 2023. In column (1), the dependent variable (*CPI Expectations*) is 12 months ahead expectations for annual consumer price inflation rate (in percentages) of surveyed firms, whereas, in column (2), the dependent variable (*PPI Expectations*) is 12 months ahead expectations for annual producer price inflation rate (in percentages) of surveyed firms. In column (3), the outcome series (*Unit Price Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit prices for the next three months, otherwise zero. In column (4), the outcome series (*Unit Cost Expectations*) is a binary variable taking the value of one if surveyed firms expect an increase in unit costs for the next three months, otherwise zero. The data on all outcome variables are obtained from microdata on responses from CBRT Business Tendency Survey. In terms of independent variables, *Brent Oil Price* is the log-transformed global Brent oil price index. The variable *Energy Exposure* is the ratio of sum of electrical, natural gas-based and petrol-related purchases (made by a specific firm in a given timepoint) to total input purchases, which is calculated from microdata on firm-to-firm trade taken from CBRT sources. All columns include additional firm controls such as the ratio of equity capital to total assets (*Capital*), the ratio of total sales to total assets (*Sales*), the ratio of net income to total assets (*Income*), the ratio of inventory to total assets (*Inventory*) and the ratio of foreign sales to total sales (*Foreign Sales*). All columns include firm and sector-by-month fixed effects. Standard errors clustered at firm level are reported. ***, **, * represent statistical significance at 1%, 5%, 10%, respectively.

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The magnitude and consistency of responses in Türkiye contrast with estimates produced by prior studies for advanced economies. Using German survey data, Wehrhöfer (2023) observes robust expectation responses among households, but weaker effects for firms. In contrast, Turkish data reveals pronounced adjustments by firms when energy exposure is high. This discrepancy may reflect: the higher salience of energy shocks in emerging-market settings; the prevalence of cost-plus pricing under high inflation; or the use of administrative input-flow data used in the present study (rather than the self-reported shock exposure measures used elsewhere).

The heterogeneity analysis reported in Figures 1 and 2 provide additional insights into the channels through which firm characteristics condition the strength of the energy-exposure effect. These figures split the sample by size (large versus non-large firms based on: regulatory classification); employment (above- versus below-median number of employees); and financial leverage (above- versus below-median financial liabilities to asset ratio), and then re-estimated the baseline model used in columns (1) and (2) of Table 2. In each dimension, the estimated interaction between global energy prices and energy exposure is higher for large firms, high-employment firms, and highly leveraged firms. This pattern suggests that network-based energy exposure does not operate in isolation, but rather interacts with firm characteristics that amplify vulnerability to global shocks. The stronger responsiveness among large, highly leveraged, and high-employment firms suggests that these firms play a particularly important role in magnifying the macroeconomic impact of energy price volatility.

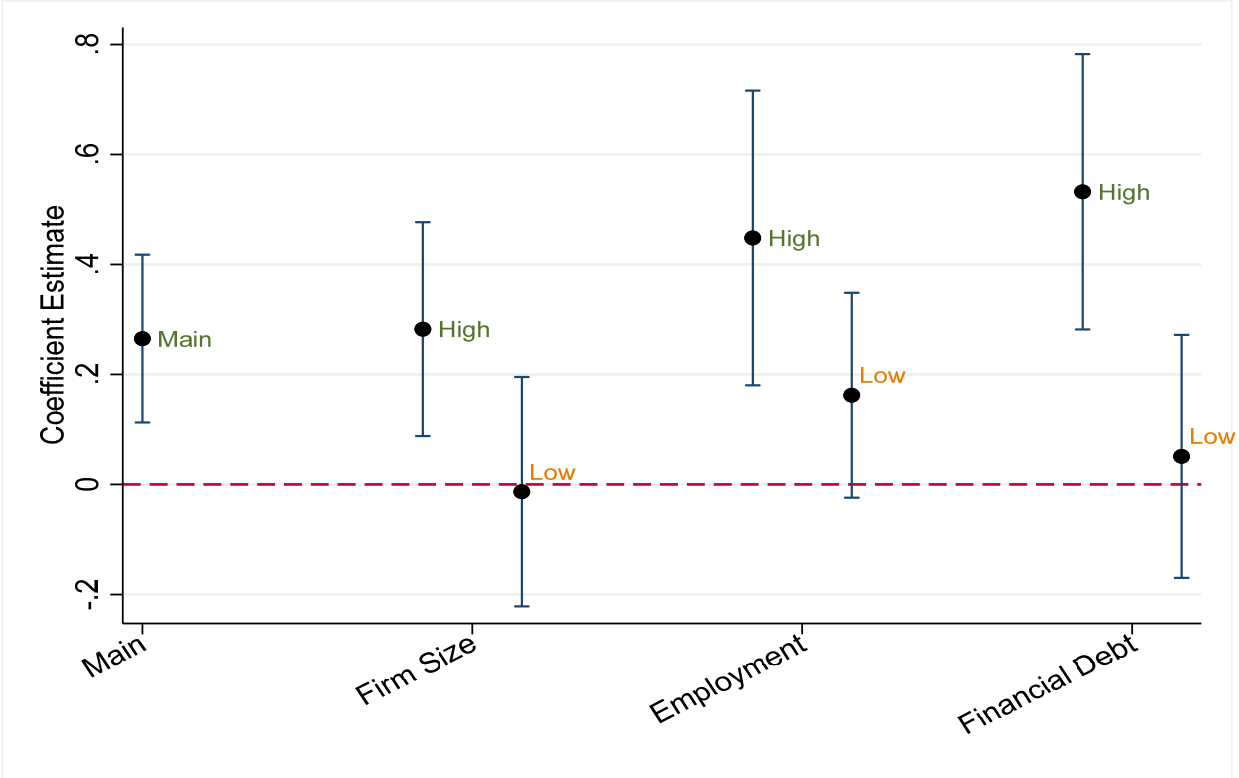
FIGURE 1 – *Sub-Sample Analysis Effect on CPI Expectations (Brent Oil Price x Energy Exposure)*



Notes: This figure demonstrates the results of heterogeneity analysis for the estimations given in column (1) of Table 2. The model specification given in Equation (1) is repeated for sub-sample groups with higher and lower than median values of firm characteristics. The heterogeneity analysis is conducted with respect to *Firm Size* (a binary variable taking the value of one for large firms based on regulatory classification, otherwise zero), *Employment* (the number of employees) and *Financial Debt* (the ratio of financial liabilities to total assets).

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FIGURE 2 – *Sub-Sample Analysis Effect on PPI Expectations (Brent Oil Price x Energy Exposure)*



Notes: This figure demonstrates the results of heterogeneity analysis for the estimations given in column (2) of Table 2. The model specification given in Equation (1) is repeated for sub-sample groups with higher and lower than median values of firm characteristics. The heterogeneity analysis is conducted with respect to *Firm Size* (a binary variable taking the value of one for large firms based on regulatory classification, otherwise zero), *Employment* (the number of employees) and *Financial Debt* (the ratio of financial liabilities to total assets)

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While network centrality provides one plausible channel behind the stronger sensitivity of large and high-employment firms to global energy shocks, several additional mechanisms may reinforce this pattern. Firms operating extensive capital-intensive production technologies may experience a disproportionately large rise in marginal costs when energy prices increase. This is consistent with evidence showing higher pass-through among energy- and capital-intensive manufacturers (Lafrogne-Joussier, Martin and Mejean, 2023). Limited short-run substitutability of energy inputs may further constrain adjustment margins for large production lines, echoing findings on low substitution elasticities in energy-intensive sectors (Bun, Koistinen and Stokman, 2023). Larger firms may also process global information and commodity signals more quickly, due to dedicated forecasting capacity and greater exposure to international markets. This is consistent with prior research findings that link expectation responsiveness to information acquisition (Coibion, Gorodnichenko and Ropele, 2020). Finally, firms with greater pricing power or market dominance may internalize external shocks into pricing plans more confidently increasing expectations markedly because they anticipate successful pass-through. This interpretation aligns with firm-level experimental evidence on cost-shock pass-through (De Fiore, Lombardi and Mangiante, 2025; Gödl-Hanisch and Menkhoff, 2023). Taken together, the stronger amplification observed in Figures 1 and 2 may reflect not only supply-network centrality, but also capital intensity, substitution rigidity, information advantage, and pricing-power channels, each of which predicts larger expectation responses among energy-dependent large firms.

Second, the leverage dimension points to a financial-constraints channel. More leveraged firms face tighter cash-flow and financing constraints, so energy cost increases reduce internal funds and borrowing capacity more sharply. Evidence from firm-level studies suggests that financially fragile firms exhibit stronger cost pass-through to prices and greater sensitivity of their expectations to shocks (Demir *et al.,* 2024; Berardi, 2024). The Turkish results align with this pattern. Among energy-dependent firms, those with higher leverage have CPI and PPI expectations that move closely with changes in global energy prices. This suggests that these firms have limited scope to absorb shocks in their respective margins.

We view network exposure and financial leverage as reinforcing rather than competing channels. Essentially, the supply chain delivers the cost shock, but a firm's debt level determines the capacity to absorb it. Given that the most sensitive firms in our sample also

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hold the largest employment shares and central supplier roles, their internal expectations carry an outsized macroeconomic weight. In turn, this implies that a small group of structurally vulnerable, but systemically important firms may drive aggregate inflation trends.

Finally, the Turkish results connect directly to an emerging body of research linking energy shocks to firm-level inflation expectations (Wehrhöfer, 2023; Baumann *et al.*, 2024; Mello and Ponce, 2025). In line with this literature, we find that exposure matters. However, in contrast to most Euro-Area evidence (where pass-through is often moderate or episodic), the amplification in Türkiye is strong, persistent, and associated with the heavy dependence of economic activity on imported energy sources. The evidence therefore suggests that energy shocks play a first-order role not only in realised cost inflation, but also in firms' belief formation, particularly among large, high-employment, and financially constrained manufacturers.

5. Conclusion

This study uses high-frequency survey data and administrative supply-chain linkages from Turkish manufacturing firms to investigate how global energy shocks shape inflation expectations at the firm level. Our analysis employs a saturated panel model with fixed effects to trace how global energy shocks interact with domestic network exposure in shaping inflation expectations. The results show that energy price increases are not passively absorbed across firms, but instead trigger expectation revisions that are systematically conditioned by firms' energy intensity, size, financial leverage, and supply-chain centrality. These findings highlight that energy-dependent production structures serve as transmission channels through which global shocks permeate domestic price-setting behaviour. Thus, firm heterogeneity becomes central to understanding inflation dynamics in emerging-market settings.

The observed amplification among large, high-employment and highly leveraged firms suggests that production-network position and financial capacity are among important determinants of shock transmission. These firms are not only more exposed to energy costs, but are also likely to hold more pricing power and exert broader macroeconomic influence. Such microeconomic structures can thus magnify the pass-through of global shocks to

domestic inflation expectations. Hence, aggregate inflation may be disproportionately shaped by a subset of exposed firms rather than representative averages.

These insights carry important implications for macroeconomic stability in emerging markets. In economies such as Türkiye that rely on imported energy, sudden and unexpected increases in global energy costs can quickly de-anchor inflation expectations among firms. This in turn has the potential to fuel broader price pressures and complicate price stabilisation efforts. For inflation-targeting central banks, this implies the need to proactively anchor expectations in the face of commodity shocks. For example, through communication that distinguishes temporary cost swings from sustained inflationary trends. Macroeconomic forecasting and policy practices should incorporate firms' varying energy exposures and financial constraints in order to anticipate more accurately aggregate inflation dynamics. By recognizing which sectors and firms are most vulnerable to global energy fluctuations, policymakers can calibrate more effective responses to maintain price stability. While our analysis focuses on Türkiye, the core findings are applicable to any energy-importing emerging market (from Southeast Asia to Eastern Europe) where manufacturing is linked tightly through domestic supply chains.

The findings also present implications for the international banking system and financial stability frameworks. Energy-driven revisions in inflation expectations among manufacturing firms can lead to deteriorating credit quality through multiple channels. As firms (particularly those that are large, highly leveraged and deeply embedded in energy-intensive supply chains) revise their cost and price expectations upwards, debt service capacity erodes and the probability of loan impairment increases. For internationally active banks with cross-border exposures to energy-importing emerging markets, correlated credit risk materialises rapidly when energy shocks are global in scope and affect multiple borrower markets concurrently. From a regulatory and supervisory standpoint, these interconnections suggest that stress-testing frameworks and macroprudential tools should explicitly incorporate energy price movements and supply-chain energy exposure as systemic risk factors. Central banks and supervisory authorities operating within international frameworks may therefore benefit from integrating commodity-price sensitivity and network-based energy exposure into their assessments of bank resilience, particularly for institutions with significant lending portfolios in energy-dependent emerging markets.

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