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Made in Mexico: Energy Reform and Manufacturing Growth

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Abstract

This paper assesses the real effects of the energy reform in Mexico by looking at its impact on manufacturing output through changes in energy prices. Using sub-sector and state-level manufacturing output data, along with past variation in energy prices, we find electricity prices—relative to oil and gas—to be more important in the manufacturing process, with a one standard deviation reduction in electricity prices leading to a 2.8 percent increase in manufacturing output. Our estimated elasticities together with plausible reductions in electricity tariffs derived from the energy reform, could increase manufacturing output by up to 3.6 percent, and overall real GDP by 0.6 percent. Larger reductions are possible over the long run if increased efficiency in the sector leads electricity prices to converge to U.S. levels. Moreover, including the impact of lower electricity tariffs on the services sector, could lead to significantly larger effects on GDP. Accounting for endogeneity of unit labor costs in a panel VAR setting leads to an additional indirect channel which amplifies the impact of electricity prices on output.

JEL Classification Numbers: C14, C31, C33, E30, E65

Keywords: growth; energy reform; manufacturing output; electricity; gas; Mexico; panel VAR.

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I. INTRODUCTION

In December of 2013, Mexico reformed its constitution and approved a controversial energy reform that will deeply transform oil, gas, and electricity markets. The reform aims at increasing oil and gas production by eliminating PEMEX's monopoly—which is state-owned—on exploration, production, and transportation of hydrocarbons, as well as increasing private participation in the electricity sector.

We assess the real effects of the energy reform through its impact on energy prices. We look in particular at manufacturing activity as this is the sector where—because of its energy dependence—real effects are most likely to occur. Moreover, despite exhibiting strong performance post-NAFTA, the sector has been stricken by high energy costs caused by infrastructure bottlenecks in recent years. We first study the composition and inter-linkages between the manufacturing and energy sectors in Mexico, and identify the potential impacts of the reform on energy prices. We then exploit past price variation to study the potential effects of energy cost reductions on manufacturing output. We also contrast the response of manufacturing output to changes in energy costs to those from the services industry.

We use sub-sector and state-level GDP data along with past variation in energy prices to estimate, in panel regressions and a panel Vector Auto Regression (VAR) model, the effects of energy cost reductions on manufacturing output. Our VAR approach is similar to models used in macroeconomic studies on the effect of oil prices on economic growth (Lee and Ni, 2002; Blanchard and Gali, 2007; Kilian, 2009; among others).

Using these empirical frameworks, we find electricity prices, among other energy prices, to have the largest quantitative impact on manufacturing output with a one-standard-deviation reduction in electricity prices being associated with a 2.8 percent increase in manufacturing output. Moreover, we estimate that, by changing the structure of electricity generation in favor of natural gas and away from fuel oil, the reform could lead electricity prices to decline by 13 percent, boost manufacturing output by up to 3.9 percent, and increase overall GDP by up to 0.6 percent. Larger effects are possible if increased efficiency in the sector leads electricity prices to converge to U.S. levels. When contrasted with the response of services, manufacturing is more sensitive to energy prices, but because services account for a larger fraction of GDP (about 60 percent), the combined impact of the reform on GDP through higher manufacturing and services output could reach about four times the contribution of manufacturing alone. Among specific manufacturing subsectors, we find larger effects in the metals, machinery and equipment, which includes the export-oriented auto industry. Lastly, we extend our analysis to consider the endogenous response of unit labor costs in a panel VAR framework to find a statistically significant response to changes in electricity prices, analogous to what has been found in the literature on the macroeconomic effects of oil prices. This additional result suggests a potential amplification mechanism of the direct impact found in the panel regressions.

Our work contributes to a strand of literature that is partially inconclusive about the effects of energy reforms in both energy production and prices. Williams and Ghanadan, (2006) argue that the experience of overall energy reform has yielded mixed results in many non-OECD countries. Steiner (2000) uses data from 19 OECD countries and concludes that privatized competitive generation lowers prices and increases efficiency. In the context of lower income countries, Zhang et al. (2008) use panel data from 36 developing and transitional economies that conducted reforms from 1985 to 2003 and conclude that introducing competition in the generation and transmission sectors can increase productivity in the energy sector and improve efficiency. A theoretical consequence of this, which they do not test, is a fall in energy prices. Similarly, Cubbin and Stern (2006) study 28 developing countries over from 1980 to 2001 and find that the regulatory framework is critical to achieve superior electricity efficiency and increased generation. Bortolotti (1998) reaches comparable conclusions by surveying the privatization of electricity generation in 38 countries between 1977 and 1997.

This paper is also related to literature exploring the effect of electricity production on economic growth. One related study is Ellison and Glaeser (1999) which explores subsector and state variation in U.S. electricity prices. In general, however, this literature has mixed findings as well. Payne (2010) surveys the literature and concludes that 22.95 percent of studies support the notion of electricity production causing growth, while the others support reverse causality or do not find a causal relationship at all. In a similar survey, Ozturk (2010) argues that there is no consensus in the literature and attributes this to the use of different data sets, alternative econometric techniques, and heterogeneity in country characteristics. Regional comparisons may be more apt for the case in Mexico, and Apergis and Payne (2010) indeed find Granger causality that runs from energy production to growth in Latin America. Nonetheless, country studies on Mexico using aggregate output in a time series (Cheng, 1997; Murray and Nan, 1996) lead to opposite results. All of these studies, however, have not explored effects through prices, nor do they focus on disaggregated GDP data in the way we do. Finally, the paper also adds to related to studies on the determinants of manufacturing productivity growth in Mexico (Chavez and Fonseca, 2013; Salgado and Bernal, 2007; Chiquiar and Ramos Francia, 2009; among others).

The rest of the paper is organized as follows. Section II presents stylized facts about the Mexican manufacturing sector and its evolution since NAFTA, the structure of the energy sector, and the potential impact of the energy reform on prices. Section III conducts difference in difference panel regressions to estimate elasticities of manufacturing output with respect to different energy prices. Section IV estimates price effects on manufacturing output in a panel Vector Autoregression framework. Section V concludes.

II. THE MEXICAN MANUFACTURING AND ENERGY SECTORS, AND THE ENERGY REFORM

A. The components of manufacturing growth

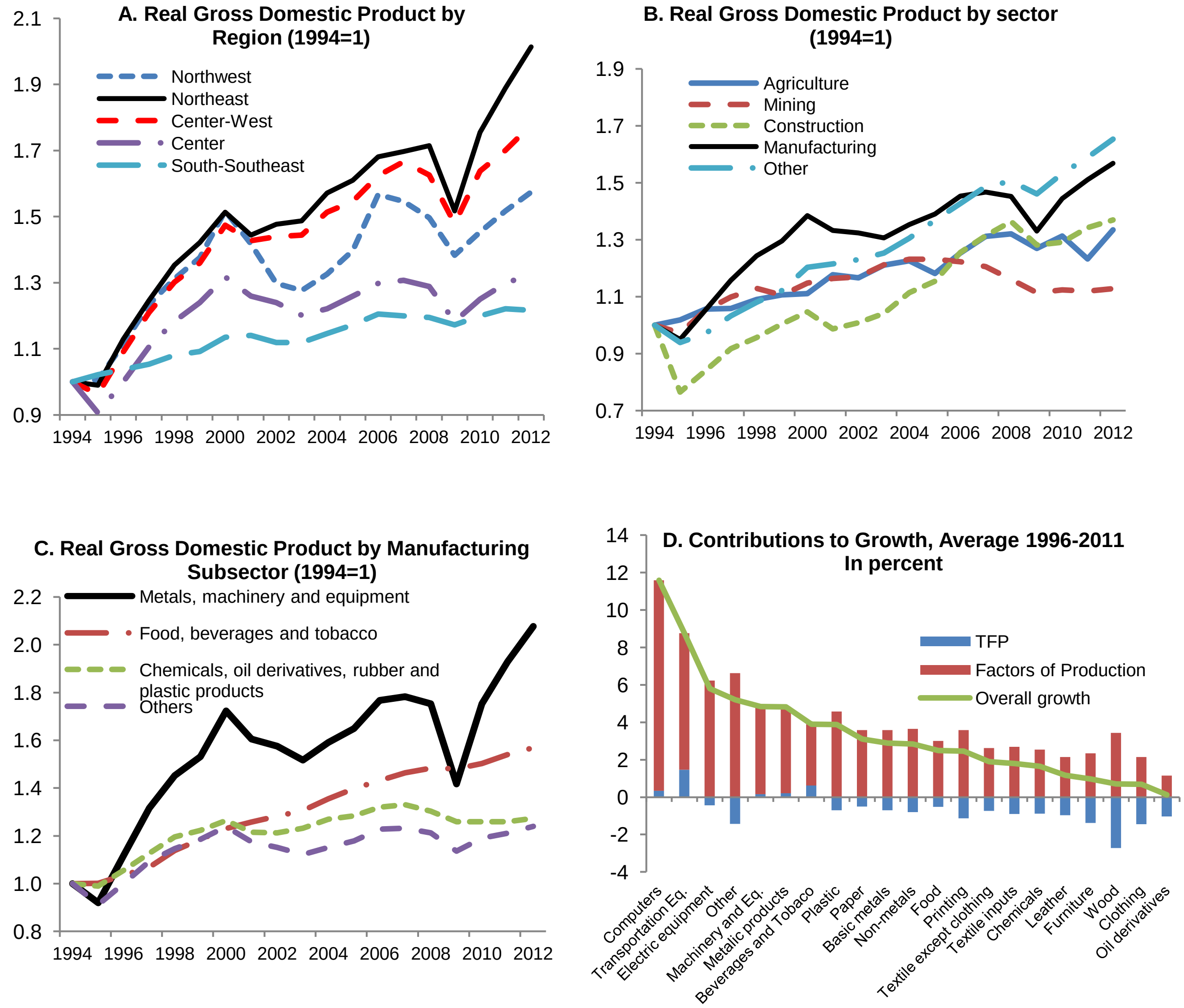
Manufacturing activity in Mexico surged after the signing of the North America Free Trade Agreement (NAFTA) in 1994, particularly in the production of transportation equipment. The period 1994–2000 saw an explosive average annual growth of 5.6 percent in manufacturing output, and exports rose from 15 percent of GDP before NAFTA to over 30 percent in 2012. However, the manufacturing surge did not translate into spectacular growth rates in overall GDP, which grew at an annualized rate of 2.6 percent from 1994–2012, partially because growth was unevenly distributed across sectors and regions (Figure 1A and 1B).

In the last two decades, the north outperformed the south, a trend that was particularly present in the 90s and in the recent recovery. This is consistent with the general view that the north was the region that benefited most from its greatest proximity to the U.S. market, and attracted the largest export-oriented investment projects. As a direct consequence, the north gained greater susceptibility to the booms and busts of the U.S., explaining the pattern observed since 2008 in Figure 1A. The differential trend of the north relative to the south appears to be connected to the differential growth observed in export-oriented manufacturing relative to other sectors. Furthermore, differential gains are even clearer when decomposing manufacturing into its subsectors (Figure 1C).

It is evident from the graph that the metals, machinery, and equipment sector is an outlier relative to the other industries. In fact, there is a remarkable similarity between the pattern of this subsector's output and the story of Northeast growth in Figure 1A, for both grew in the 90's, slowed in the early 2000s, and have recovered with renewed strength after the 2008 crisis. Altogether, heterogeneity in performance across sectors probably translated into geographical disparities in performance, as regional manufacturing clusters implied much stronger performance in the north than in the south.

Manufacturing of automobiles is a key part of the story, which is included in the metals, machinery, and equipment category in Figure 1C. Mexico's car production tripled since NAFTA and it was the only subsector with meaningful contributions from total factor productivity to growth (Figure 1D). After slowing in the early 2000s, this subsector regained strength after the 2008 crisis, with recent announcements of investments in new plants such as those by Daimler Benz and BMW further supporting this trend. In fact, Mexico has now surpassed Japan to become the second biggest car exporter to the United States, and currently supplies one third of all U.S. imports of auto parts.

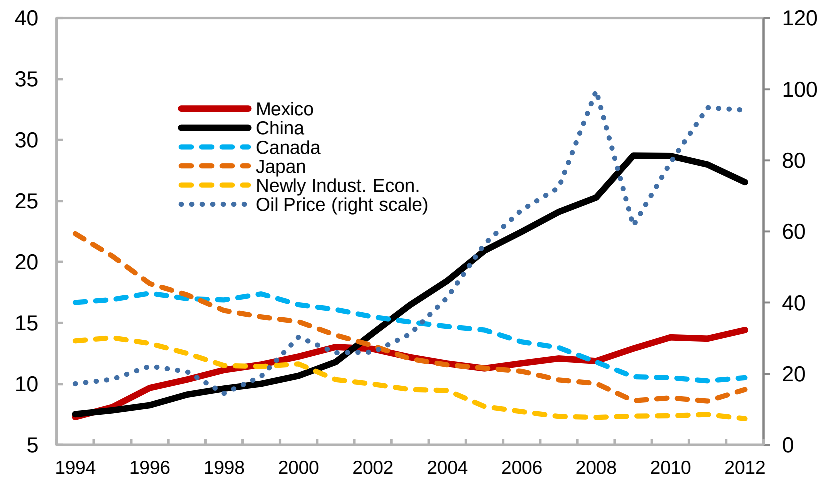
Figure 1. Mexican Manufacturing Output Since NAFTA



Source: Instituto Nacional de Estadisticas y Geografia (INEGI), and staff calculations.

It is important to highlight that—because of the influence of U.S. demand—the effect of energy prices on overall manufacturing output in Mexico appears to have a somewhat unique dual nature. On one hand, energy inputs enter the production function of manufacturing companies, and thus changes in relative prices lead to different input compositions. On the other hand, they change the comparative advantage of Mexico's economy relative to other countries. This is a central issue when analyzing the role of international oil prices in export-oriented manufacturing industries in Mexico, both because of the importance of U.S. demand and because of the geographical proximity advantage that Mexico has in U.S. markets. For instance, the post-NAFTA rise of Mexico's manufacturing sector was hard hit by China's rise to the global stage when it joined the WTO in 2001 (Figure 2). Kamil and Zook (2012) argue that China was able to crowd out Mexican exports in the U.S. market because Mexico had lost its advantage in several labor-intensive manufacturing sectors in which it specialized. But almost as quickly as it stumbled, Mexico regained its footing and began to claw its way back. By increasing transportation costs, rising oil prices may have contributed to an inflexion point in Mexico's U.S. market share around 2005 since they raised the importance of proximity to the U.S. market as a competitiveness factor. We highlight this issue as a potential source of a bias in the coefficients on oil price changes.

Figure 2. Share of U.S. Manufacturing Imports by Origin and Oil Prices. In percent and US$ per barrel (right)



Source: Kamil and Zook (2012) based on U.S. import data.

B. The role of energy as an input in production and the structure of the energy sector

Energy is vital for manufacturing production. In 2012, for instance, the industrial sector (which includes manufacturing) consumed 58.6 percent of the electricity, 17.7 percent of the gas, and 6.3 percent of the oil derivatives in Mexico.[2] Industrial activities are indeed a large source of energy demand in Mexico. Moreover, industrial demand for these resources is rapidly increasing at a pace that appears too fast for the more sluggish growth in energy infrastructure investments. In fact, some estimates suggest that under current usage patterns, energy demand in 2024 could be 79 percent higher than in 2010.[3]

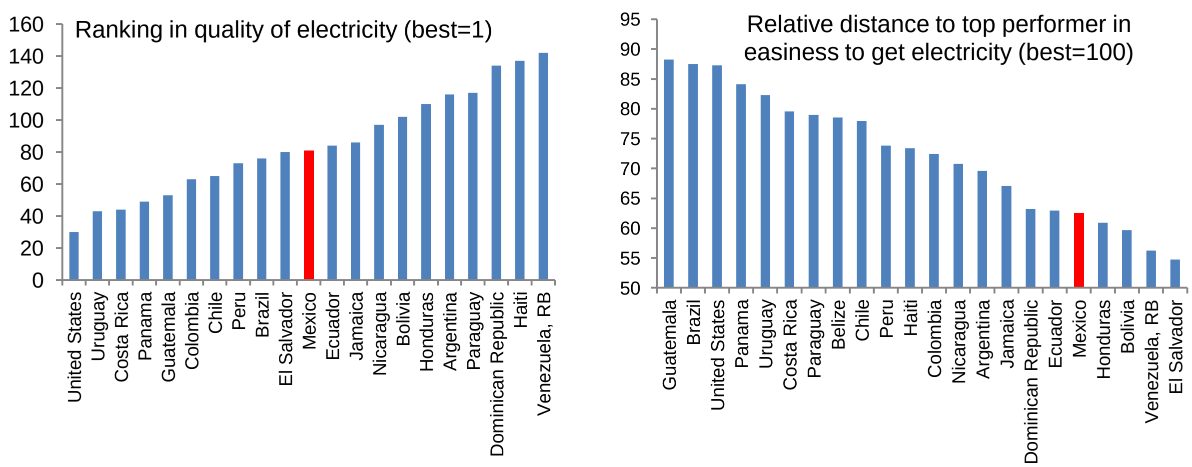
Among the different energy sources, electricity and natural gas are the most important for industrial production. Table 1 shows the composition of energy consumption for the aggregate industrial sector and auto manufacturing. As shown in the table, electricity

[2] Prospectiva del Gas Natural 2013–2027, SENER (2013). Prospectiva del Sector Eléctrico 2013–2027, SENER (2013). Prospectiva de Petroleo Crudo y Petroliferos 2013–2027, SENER (2013).

[3] McKinsey Global Institute (2014). Estimates assume a 3.5percent growth rate in overall GDP, and energy production to rely on the same proportion of energy sources that is observed in 2012.

comprises 34.5 percent of the total consumption of the industrial sector in terms of energy units. Natural gas is used as an input in electricity generation, indirectly affecting manufacturing production through this channel; however, natural gas also accounts for 35.8 percent of consumption when it enters industrial production as a direct input. Finally, oil derivatives, which include liquefied petroleum gas, diesel, gasoline, and fuel oil, only account for a total of 15.6 percent of energy inputs. Similarly to natural gas, some of these oil derivatives—especially fuel oil—are used for electricity generation but are also a direct input in manufacturing production. Overall, when accounting for each energy source by their direct contribution to the manufacturing processes, electricity and natural gas are more important than other sources. This pattern is even clearer in the vital auto industry, where 60.4 percent of energy inputs are in the form of electricity and 28.7 percent are in the form of natural gas.

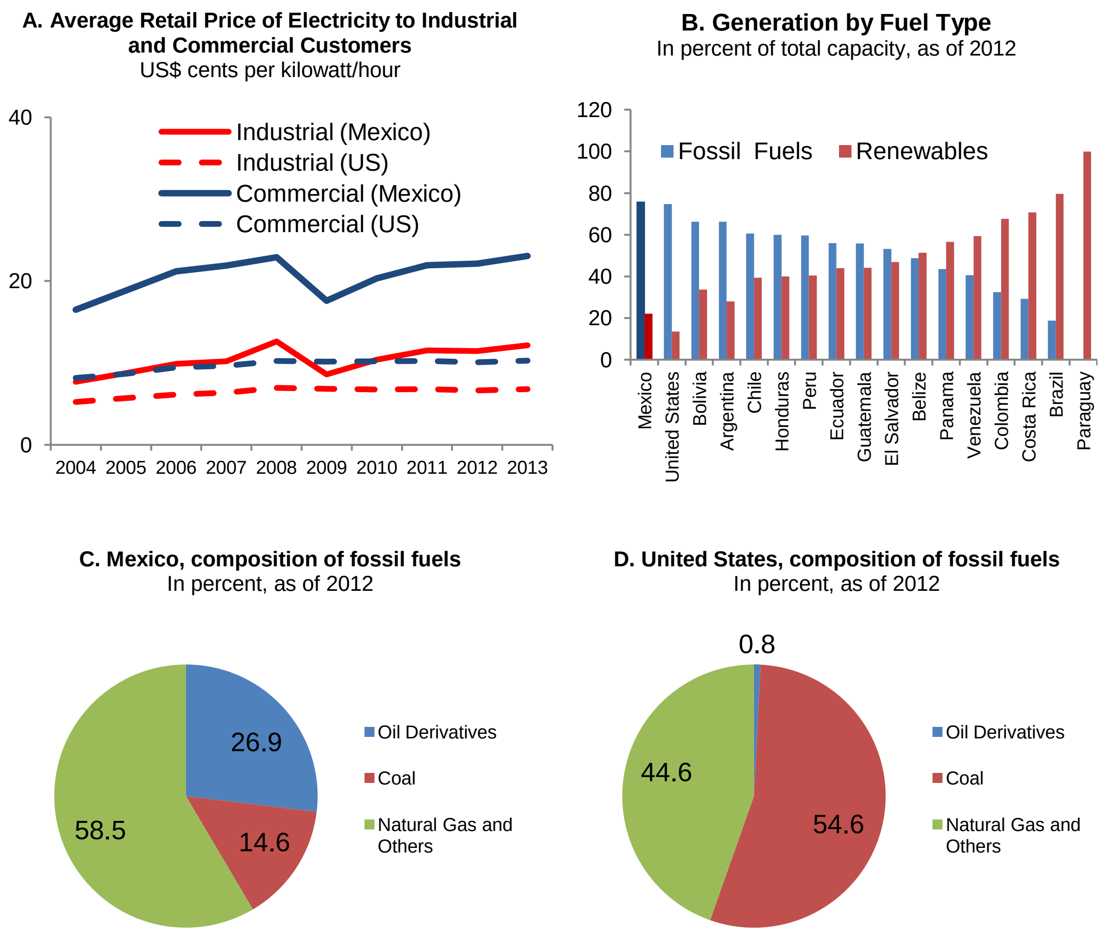
Figure 3. Quality and Easiness to Get Electricity in Selected Countries



Source: World Economic Forum Competitiveness Report (2014) for quality of electricity and Doing Business Report (2014) for easiness to get electricity, which looks at procedures, time, and cost required for a business to obtain a permanent electricity connection for a newly constructed warehouse

Almost paradoxically, electricity and natural gas have been widely identified as two factors limiting output growth in Mexico. According to a recent study on Mexican production by the McKinsey Global Institute "despite its energy endowments, Mexico lacks a cost-efficient and reliable power supply, which limits the productivity of even the best-run enterprises" (McKinsey Global Institute, 2014). In terms of reliability and access, both gas and electricity have exhibited problems. For example, limited investment in infrastructure has led natural gas pipelines to operate close to maximum capacity in recent years. In early 2013, poor gas transport capacity combined with demand increases generated temporary but severe gas shortages. The Central Bank of Mexico estimates that these shortages accounted for a loss of 0.3 percent of GDP growth during the second quarter of that year (Bank of Mexico, 2013). This type of phenomenon is particularly striking in a country like Mexico, since its geographical location allows access to cheap natural gas from the U.S. at a price which is about a third of the average price in Western Europe. Infrastructure shortcomings have forced Mexico to increase imports of expensive natural liquid gas mainly from Qatar, Peru, Nigeria, and Indonesia in order to prevent such shortages from happening, and these are expected to increase in the short term (SENER, 2013). Moreover, the situation in the electricity sector is not much better, with Mexico ranking consistently low in indicators of global competitiveness regarding the costs and quality of electricity. For instance, the Doing Business Report ranks Mexico 133rd on easiness to get electricity and the World Economic Forum's Competitiveness report ranks it 81st on quality of electricity.[4] Mexico even ranks lower than several regional peers with lower GDP per capita as shown in Figure 3.

Figure 4. Electricity prices and generation in Mexico and the United States



Source: U.S. Energy Information Administration, Secretaria de Energia de Mexico, and staff calculations.

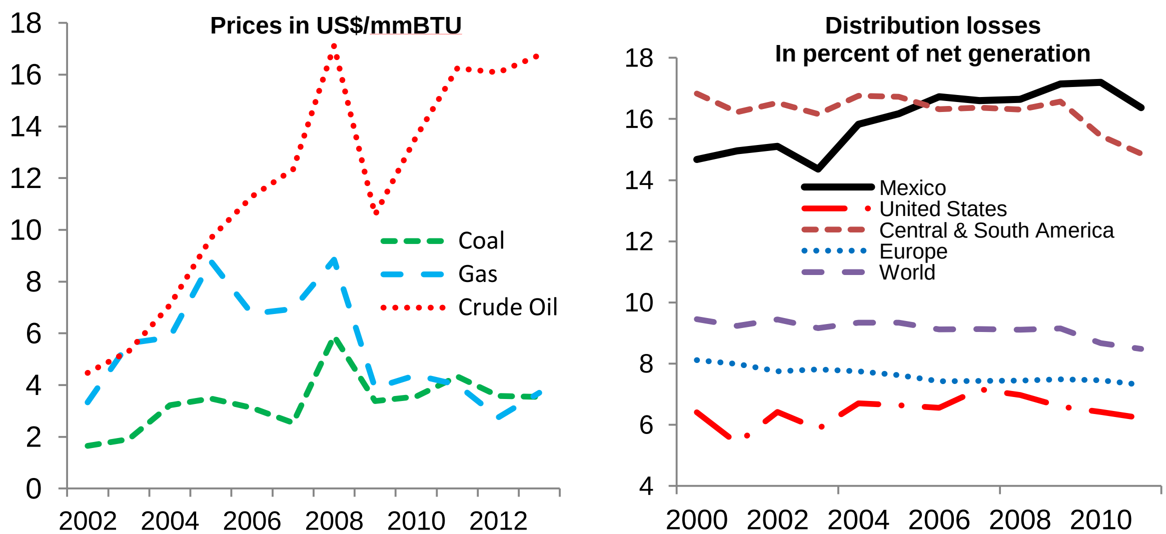
In terms of prices, Mexican electricity prices for residential consumers and agricultural producers are subsidized and regulated, but prices for industrial producers, including manufacturing ones, are not. Remarkably, the prices for industrial Mexican producers have been about twice the ones observed in the U.S. for the same client category for at least a decade (Figure 4A). One reason for this gap is the oil-dependent structure of Mexican electricity generation. More specifically, industrial prices are intended to reflect

[4] 2014 Doing Business Report data available at http://www.doingbusiness.org/data/exploreeconomies/mexico/.

production costs, and are therefore periodically adjusted to reflect changes in the cost of inputs in electricity generation.[5] Electricity generated using non-renewable resources—hydroelectric generation in particular—tend to have much lower marginal costs than fossil fuel-based generation. This is problematic for Mexico since close to 80 percent of the installed electricity generation capacity in the country is based on fossil fuels, far above most regional peers, and only close to the United States as shown in Figure 4B. The difference between the U.S. and Mexico stems from the composition of fossil fuel dependence. Though they have similar natural gas capacity shares with 58.5 percent and 44.6 percent respectively, the U.S. does not use expensive oil derivatives in electricity generation. In contrast, these account for 26.9 percent of fossil fuel generation capacity and about 18 percent of actual generation in Mexico.

Reliance on oil derivatives for electricity generation has been a problem for Mexico, since, as shown in Figure 4, oil has always been much more expensive than gas and coal, and this gap has widened in the last decade. In fact, if Mexico used natural gas instead of fuel oil under current conditions, the input cost structure for electricity generation would be closer to the one for the U.S., implying a drop of about 13 percent in electricity prices for industrial users.[6]

Figure 5. Energy prices and distribution losses



Source: Statistical Review of World Energy (BP, 2014), SENER, and the U.S. Energy Information Administration (EIA) data for the year 2011.

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[5] Prospectiva del Sector Eléctrico 2013-2027, SENER (2013).

[6] The current pricing mechanism in Mexico contemplates monthly adjustments for industrial users according to the evolution of fuel prices and inflation using weights for each fuel determined by its importance in electricity generation. Under the current scheme, and given that oil derivatives (mostly fuel oil) represent 18.1percent of total generation, an immediate substitution of fuel oil for natural gas (about 71 percent cheaper than fuel oil) would imply, ceteris paribus, a reduction of about 13 percent in electricity prices (0.181*-0.71). The recent decline in oil prices has not altered much this gap.

This, however, does not explain the full electricity price gap. A second important factor behind high electricity prices are distribution losses, which are defined as the difference between the amounts invoiced and the amounts generated. In Mexico, these losses account for more than 16 percent of total generation which more than doubles the losses observed in developed economies and surpasses the regional average of Central and South America (Figure 5). While an important component of these losses is electricity theft, the largest component is technical losses attributable to a large extent to an aging infrastructure.

C. The Mexican energy reform and energy prices

The constitutional reform approved in December of 2013 and the associated secondary legislation approved in August of 2014 comprises a substantial transformation of the state-controlled oil, gas, and electricity sectors in Mexico. In a nutshell, the reform attempts to open parts of these sectors to private investors while retaining control of transmission and distribution channels through more autonomous regulatory agents. The main objective of this radical reorganization is increasing much needed investment to finance the exploitation of current reserves, the exploration of new ones, the expansion of transmission networks, and the general improvement of oil, gas, and electricity infrastructure.

In the oil industry, the reform increases the autonomy of the state-owned oil company PEMEX,[7] and allows joint ventures with private agents in order to take advantage of unexploited Mexican oil and gas reserves.[8] The production of oil has remained on a declining trend since the mid 2000’s; therefore, by potentially increasing oil production, the reform is expected to turn this trend around (IMF, 2014, ch. 1). Together with increases in oil production, the reform opens up the possibility of exploiting Mexico’s vast gas reserves, estimated at 63,229 Mmcf. Over the short term, however, increased availability of natural gas will take place through increased transportation capacity of natural gas imports from the U.S. The lack of enough supply of natural gas leads businesses and consumers to rely on more expensive fuels as well. For example, the industrial sector in Mexico consumes about 10 percent of total liquefied petroleum gas (LPG) demanded in the country, and liquefied natural gas (LNG) is also imported to meet the domestic demand for gas. Partial substitution of these fuels for natural gas could provide an additional impetus to growth in manufacturing. The more concrete and immediate gains from the energy reform in terms of natural gas availability will come from facilitating private and public investment to improve natural gas transportation lines.

With regards to electricity markets, the new legislation opens the electricity generation sector to private competition. Private investors and operators will be able to buy, sell, or build new generation plants and sell electricity to a centralized regulatory body that will be in charge of transmission and distribution lines. Second, the new regime also allows

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[7] Changes to article 25 of the constitution created the figure of State Productive Enterprises, a more autonomous legal figure that both PEMEX and the electricity regulatory body (CFE) will adopt.

[8] Changes to article 27 of the constitution open the energy sector (including hydrocarbons and electricity) to private investment.

generation companies to sell directly to high-volume customers. There are important synergies between the reforms to the electricity sector and those in the area of natural gas. If more regions have access to natural gas from either new gas fields or increased imports from the north, a new competitive electricity generation market provides an incentive to build gas-based generation plants and sell it in the centralized market. Twenty-one generation projects amounting to US$7.7 billion are expected to be completed by 2018.[9] Among these, the reconversion of seven power plants from fuel oil to natural gas has already been announced. The reconverted plants account for 4560 MW, which is about 9 percent of the installed capacity of the system and about half what is needed to achieve the 13 percent price reduction computed earlier. For this reason, and given existing plans for pipeline investments (SENER, 2013), it seems feasible to reach this price reduction within five years.

Furthermore, under the new regulation, the reformed and more autonomous state body in charge of the transmission and distribution grids is able to contract private firms to develop and maintain this infrastructure. There is much uncertainty about the shape and consequences that this might take; nonetheless, this could in theory reduce the abnormally high distribution losses of the Mexican grid. As a limiting case—given the similarities between the U.S. and Mexican electricity generation structure—this type of gains could lead to the eventual convergence of U.S. and Mexico's electricity prices. This would imply a reduction of about 50 percent of the prices faced by the manufacturing industry today. The interaction of gas and electricity investments may therefore bring an improved availability of natural gas as an energy resource in the near term, resulting in a gradual yet significant decrease in electricity prices.

III. Energy Prices and Manufacturing Output

We now focus on the potential effects of the reform on manufacturing through changes in energy costs. Therefore, we limit the scope of our current investigation to an inference exercise that exploits past variation in energy prices and output. In particular, we measure the responsiveness of manufacturing output to different energy input prices, and we then proceed to explore dynamic effects in a panel Vector Autoregression (VAR) framework.

A. Data description

We use real output data at the state and subsector level from the Mexican National Institute of Statistics and Geography (INEGI) for the period covering 1996 to 2012. In contrasting the results with that of services, we also use services output at the subsector level. Moreover, unit labor costs for manufacturing—compiled by INEGI—are available at the subsector level in local currency, deflated by the Mexican CPI to obtain values in real terms. Changes in national accounts imply a more disaggregated breakdown starting in 2003. Therefore, to form a consistent time series, we re-group categories from 2003 on to match the breakdown under the old national accounts.

[9] El Economista, August 21, 2014.

To proxy for the opportunity cost of capital in an open economy context, we use Moody's yield on corporate bonds for all industries deflated by the U.S. core CPI. In addition, U.S. Industrial Production is also included to account for the significant demand effects of U.S. industrial output on Mexican manufacturing exports taken from Haver Analytics. Similarly, the IMF trade-weighted real exchange rate is also included in the regressions.

The source of energy prices is the Mexican Energy Ministry (SENER). For electricity prices we use the average of industrial prices for medium and large industrial users. Since gas prices are only available for the 1994–1997 period, price changes for other years are calculated as the change in the ratio of total reported revenues from sales divided by the volume of total sales in each year. All local energy price differences are in real terms, deflated using Mexico's CPI. Furthermore, the West Texas Intermediate (WTI) crude oil average spot price is used as a measure of international oil prices.

B. Estimation of energy price elasticities

We estimate the responsiveness of manufacturing output to changes in energy prices using a simple panel regression analysis. The left-hand side corresponds to the real gross domestic product for state *i*, manufacturing subsector *j*, and year *t*. The right hand-side includes a lag of the dependent variable and the variables of interest based on the discussion of energy inputs in section II: the lagged change in electricity prices, *EL*, in natural gas prices, *NG*, and oil derivatives prices, *OD*. Changes are computed after deflating energy prices with the consumer's price index to reflect changes in real terms. The regression includes a vector of controls (*X* in the equation below) that are crucial to both the local and export-oriented manufacturing sector in Mexico. This includes unit labor costs, the real effective exchange rate, the cost of capital, industrial production in the United States, and world price of crude oil, all in first difference form. The regressions also include fixed effects at the sector-state pair level, $\delta_{ij,}$with robust standard errors clustered at the sector-state paired.

$$\Delta \boldsymbol{y}_{\boldsymbol{ijt}} = \boldsymbol{\alpha}_{\mathbf{0}} + \boldsymbol{\beta}_{\mathbf{0}} \Delta \boldsymbol{y}_{\boldsymbol{ijt-1}} + \boldsymbol{\beta}_{\mathbf{1}} \Delta \boldsymbol{EL}_{\boldsymbol{t-1}} + \boldsymbol{\beta}_{\mathbf{2}} \Delta \boldsymbol{NG}_{\boldsymbol{t-1}} + \boldsymbol{\beta}_{\mathbf{3}} \Delta \boldsymbol{OD}_{\boldsymbol{t-1}} + \boldsymbol{\beta}_{\mathbf{4}} \Delta \boldsymbol{X}_{\boldsymbol{t-1}} + \boldsymbol{\delta}_{\boldsymbol{ij}} + \boldsymbol{\varepsilon}_{\boldsymbol{t}}$$

Reverse causality concerns are limited because the left-hand side variable is defined at the subsector-state pair, whereas energy prices are defined at the national level. Concerns about simultaneity problems derived from the relationship between demand for manufacturing products and energy prices are mitigated by lagging the regressors one period. And there would be residual concerns of this type if the coefficients turn out positive. However, as we will show shortly, the estimated coefficients are negative, implying that the supply effects dominate.

Tables 2–4 show the estimated elasticity coefficients—under various specifications—of the most important energy sources. We focus first on Table 2, which estimates the overall elasticity of each energy source independently. These results suggest that both electricity and gas are negatively associated with output with an elasticity of -0.174 and -0.024 respectively.

A somewhat puzzling result is that oil derivatives, conditional on international crude oil prices, come up with a positive sign in this specification; we will come back to this later.

Table 3 includes all energy sources simultaneously, which allows us to study the relative importance of the different energy sources. There, we confirm that manufacturing output is most sensitive to variations in electricity prices with an elasticity estimate ranging from -0.114 to -0.283 when all manufacturing subsectors are considered and -0.323 when the subsector that includes oil refining—which is positively affected by high oil prices—is excluded in column (8). This is consistent with the fact that electricity is the most important energy input in manufacturing production (see section II), and that part of the effect of other energy prices on output is channeled through their effects on electricity generation costs.

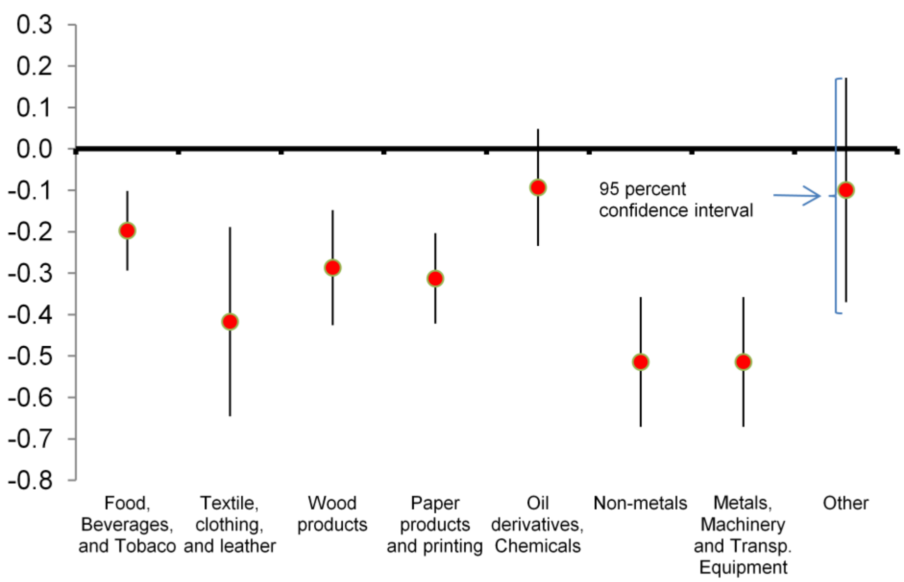
In the case of natural gas, its statistically significant coefficient, after controlling for electricity prices, confirms the importance of this energy source as direct input in manufacturing production, above and beyond its impact through electricity prices. This result comes from the fact that about 18 percent of the national demand for natural gas comes from the industrial sector. Both the relative importance of electricity prices on output and the direct impact of gas prices are robust to different econometric specifications as well. Table 4 estimates fixed effect and random effect models under different specifications and shows stable energy coefficients and standard errors. It also shows GMM estimations using Arellano and Bond (1991) panel estimator, given that we are including a lag of the dependent variable as regressor. The coefficient of electricity, which ranges from -0.278 to -0.284, is consistently larger than the one on natural gas, which ranges from -0.036 to -0.037. This is not the outcome of the different volatilities observed in the two price series. For instance, one standard deviation reduction in electricity prices has an impact of 2.8 percent on manufacturing output, compared to a 1.1 percent increase associated to a one standard deviation reduction in natural gas prices. Hence, the results suggest a higher quantitative importance of changes in electricity prices relative to those of natural gas.

The effect of international crude oil prices is also of particular interest given its significance in all specifications and the large variation observed over the last two decades. In Table 2, the coefficient on the WTI oil price is negative, as it is capturing the effects of other energy sources not included in the regression that commove with oil prices. However, once all energy sources are included in Tables 3–4, the coefficient turns positive and significant. The answer for this change may lie in the dichotomy of international versus local effects of oil prices. As discussed in section II, increases in oil prices are associated with higher transportation costs, which may have given Mexico a competitive edge over Asian competitors in U.S. markets. This mechanism would suggest a positive association between oil price increases and manufacturing production. As the coefficient is positive in the regressions, these mechanisms may dominate the cost effect of higher oil prices as oil derivatives enter as an input in the production function of manufacturing firms. Notice also that the puzzling result of a positive effect of domestic prices of oil derivatives weakens statistically as other controls are included (Table 3). Therefore, during the rest of our discussion, we focus on the price of electricity and natural gas, which not only are much more important than oil derivatives for manufacturing production, but also the estimated coefficients are more robust and of the expected sign.

To further confirm the robustness of the above results, we also expanded the sample to include output in the services subsectors. We re-estimate the regressions corresponding to Table 3 in the augmented sample and report the results in Table 5. The coefficients are highly significant as before in all specifications, but magnitudes are smaller, suggesting a smaller elasticity for services subsectors than for those in manufacturing.

In addition, we study whether the effects of energy prices differ significantly across manufacturing subsectors in Table 6. Here, we allow elasticity coefficients with respect to both gas and electricity prices to differ by manufacturing subsector. Dummies for each subsector are therefore interacted with price changes, with the coefficient on the uninteracted price change term measuring the elasticity observed in the metals, machinery and equipment subsector—which includes the auto industry. Column (1) and (2) estimate these elasticities for natural gas and oil prices independently, while column (3) estimates them jointly. In column (1), the interactions of subsector dummies with gas prices are statistically significant in a few cases, but when interaction terms with electricity prices are included, those with electricity prices clearly dominate. These results are more clearly summarized by Figure 9, which focuses on electricity prices and provides a clearer comparison by plotting the elasticity magnitudes and confidence intervals for each subsector. It is visually clear in the figure that the largest impact takes place in the subsector that includes the export-oriented auto industry with an elasticity of -0.51 relative to the manufacturing average of -0.28. Lastly, note that this exercise also serves the purpose of confirming that the results are not entirely driven by a single manufacturing subsector. In fact, Table 6 suggests that an increase in electricity prices impacts negatively on all subsectors, though the gains are far from being homogenous and not all of them are significant. This is an important point because within the manufacturing sector we find activities directly related to energy such as refining of crude oil.

Figure 6. Elasticities to energy prices by subsector



Source: INEGI and staff calculations.

C. Quantitative Importance

To assess the quantitative importance of the estimated elasticities in the context of the energy reform, we perform back of the envelope calculations that use the potential effects of the reform on electricity prices discussed in Section II. Two different scenarios are considered. In the first scenario, fuel oil is completely replaced by natural gas in the generation of electricity using today's energy prices. As discussed before, this would represent a 13 percent reduction in the electricity price. The second scenario considers a limiting case where the gap between U.S. and Mexican prices is completely closed as investment improves distribution networks, reducing energy losses and efficiency differences between the two countries. In this case, the closing of the gap implies a 50 percent drop in electricity prices. For both scenarios, we use the range of estimated manufacturing output elasticities of between -0.11 and -0.28 shown in Tables 3 and 4.

Economic Impact of a Reduction in Electricity Prices

(In percent)	Lowest	Highest
Elasticities	-0.11	-0.28
Scenario 1: Substitution of fuel for natural gas		
Increase in manufacturing output	1.4	3.6
Increase in overall GDP	0.2	0.6
Scenario 2: Convergence to U.S. Levels		
Increase in manufacturing output	5.5	14.0
Increase in overall GDP	0.9	2.2

Note: Scenario 1 assumes a reduction in electricity prices of 13 percent, consistent with fuel oil being substituted by natural gas. Scenario 2 assumes convergence of electricity prices for industrial and commercial users to U.S. levels.
Source: National authorities and staff calculations.

As shown above, the estimated elasticities imply that manufacturing output could increase between 1.4 and 3.6 percent if a reduction in electricity prices of 13 percent materializes. Furthermore, the increase in manufacturing output could reach 14 percent if prices were to converge to U.S. levels. For the economy as a whole, these responses for manufacturing activity imply an increase in real GDP of up to 0.6 percent and up to 2.2 percent for each scenario respectively, given today's importance of the manufacturing sector in the economy. However, the impact could potentially be much larger if one takes into account the impact through higher services output. We showed in Table 5 that the results are highly statistically significant when the sample includes the services sector, although the magnitudes of the elasticities are somewhat smaller. This means that, while manufacturing responds more strongly to a unit change in electricity prices, the larger importance of services in GDP implies a much larger effect than what is suggested by manufacturing alone. Repeating the same exercise above and using the elasticities shown in Table 5 of -0.25 instead of -0.28, implies an overall increase in GDP that is more than four times larger than what is shown above. This is the case because manufacturing and services combined represent close to 80 percent of the economy, whereas manufacturing alone is less than

20 percent. Some of this impact, however, can be the indirect consequence of manufacturing as there are services subsectors that are closely linked to manufacturing activity.

It is important to highlight, however, that these are one-off gains which could materialize over the horizon that takes electricity prices to exhibit these drops. As mentioned before, it is reasonable to expect the gains estimated under scenario 1 to materialize within 4 years. Convergence to U.S. levels is much more uncertain and subject to debate, since reducing energy losses in transmission and distribution is challenging. Nevertheless, the scenario offers a benchmark for how large the effects over the long-run can be.

IV. Energy Prices in a Panel VAR Framework

The elasticities estimated in the panel regressions above focus on the direct effect of changes in energy prices on manufacturing output taken all control variables as exogenous. Nonetheless, some of the variables included in the panel regressions might themselves respond to changes in prices and output, and there might be important dynamic effects generated by the feedback between output and input prices. To assess the importance of these mechanisms and the robustness of our results to allowing certain variables to endogenously respond to changes in electricity prices and other variables in the system, we now turn to a multivariate panel Vector Auto Regression model.

We focus on an open economy framework, where export-oriented firms take the costs of capital, labor and energy as given. Firm output, therefore, responds to foreign demand given by the U.S. industrial sector,[10] the international cost of capital, local labor prices and energy prices. More specifically, we include manufacturing output ($y_{i,j,t}$) measured at each state (*i*), subsector (*j*), and year (*t*), the U.S. interest rate (r_t), a U.S. industrial production index ($USIP_t$), unit labor costs measured at the subsector level ($ULC_{j,t}$) and industrial electricity prices ($Elec_t$) to estimate the model. Analogous to Blanchard and Gali (2007), Kilian (2009), and others, using VAR models to study the macroeconomic impact of oil shocks on output, our choice of variables attempts to account for the labor and cost of capital channels that are central to their models in an open economy setting. [11]

[10] US Industrial production is a stronger predictor of growth in Mexico than headline U.S. growth, in particular of manufacturing growth, given the degree of integration of manufacturing production in both countries.

[11] Blanchard and Gali (2007), Kilian (2009) and Melolinna (2012) use three to six variable VARS that include GDP, unemployment, wages, cost of capital, and oil market variables. Here, we are interested in the effect of relative prices on output, and therefore we do not include aggregate employment or capital accumulation measures.

The specification includes fixed effects at the state-subsector level to account for trend differences in each industry and region. The main estimating equation is thus given by

$$J\begin{pmatrix}\Delta r_t\\ \Delta USIP_t\\ \Delta ULC_{j,t}\\ \Delta y_{i,j,t}\\ \Delta Elec_t\end{pmatrix} = A * \begin{pmatrix}\Delta r_{t-1}\\ \Delta USIP_{t-1}\\ \Delta ULC_{j,t-1}\\ \Delta y_{i,j,t-1}\\ \Delta Elec_{t-1}\end{pmatrix} + c_{i,j} + u_{i,j,t}$$

$$t = 1, \dots, T \;\; i = 1, \dots, I \;\; j = 1, \dots, J \;\; u_{i,j,t} \sim N(0, \textstyle\sum)$$

where J is an lower triangular matrix, $c_{i,j}$ are state-subsector fixed effects, $u_{i,j,t}$ is the error term, $\sum$ is a constant covariance matrix and *A* is a 5x5 coefficient matrix. We restrict *r* and *USIP* to be exogenous.

By imposing a triangular structure on the *J* matrix, the identification specification also takes important assumptions on timing. In particular, the model's structure assumes that unit labor costs respond to output and energy price fluctuations with a lag and that output also responds to electricity prices with a lag. This is a conservative assumption since there might be contemporaneous supply effects which we assume to be zero.

Figure 7.A reports cumulative impulse response functions to a 1 percent shock in electricity prices in the baseline model. These are shown along with bootstrapped confidence intervals for a 5-year period. Similar to the panel regressions, there is a negative and significant effect of electricity prices on output, which lasts for at least 2 years before turning flat. The impact effect that comes up from the VARs is biased downwards compared to the estimates from the panel regressions (i.e. the effect on output of a change in electricity prices as of period 2 is comparable to the lower end of the range of estimates shown in Table 3), reflecting a more parsimonious specification in the VAR. Nevertheless, the impulse responses show a cumulative effect after 5 years that is about 50 percent larger in magnitude to the impact effect.

The increase in unit labor costs resonates with results found in the VAR literature on the macroeconomic effects of oil-price shocks. Higher energy prices seem to bring inflationary pressures on real wages, a feature that is also detected by Blanchard and Gali (2007) in several advanced economies.[12] This result, which is significant and robust to using parametric or non-parametric bootstrapped standard errors (Figure 7.B), may be due to a substitution effect that induces a labor demand increase, or to labor supply channels associated with greater transportation costs and higher costs of living.

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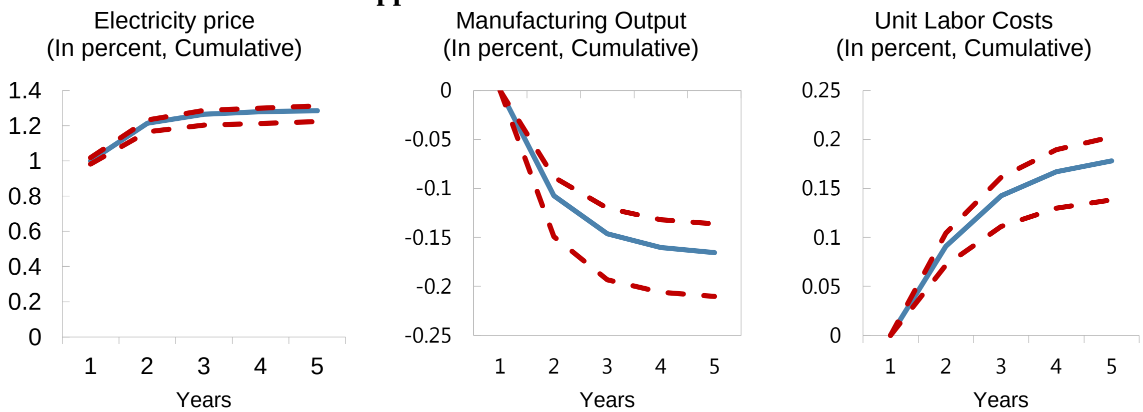
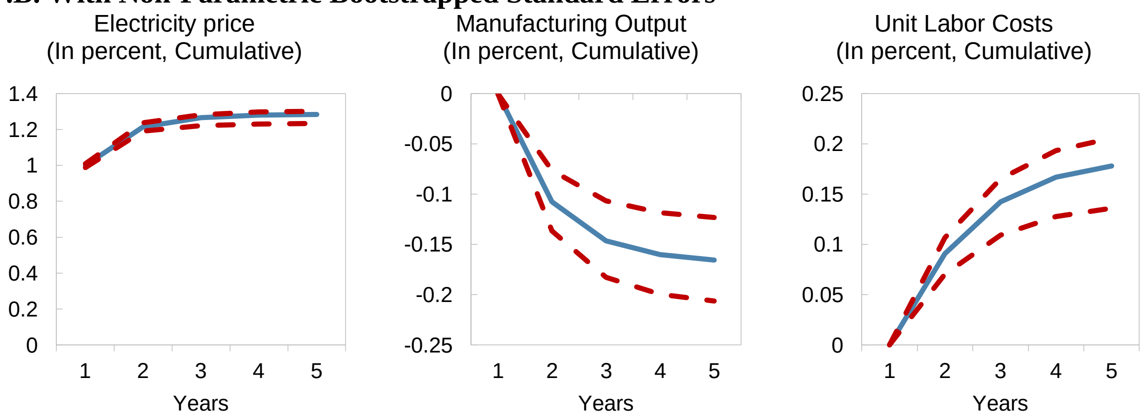
[12] Blanchard and Gali (2007) find a negative effect of oil prices on output, and a positive effect on wage inflation in the U.S. in the 1970s, though the relationship weakens in the 2000s. This is also observed in other developed economies. Kilian (2009) and Melolinna (2012) decompose demand and supply oil shocks, and conclude the supply shocks have a similar effect on output.

Figure 7: Impulse response functions to a rise in electricity prices

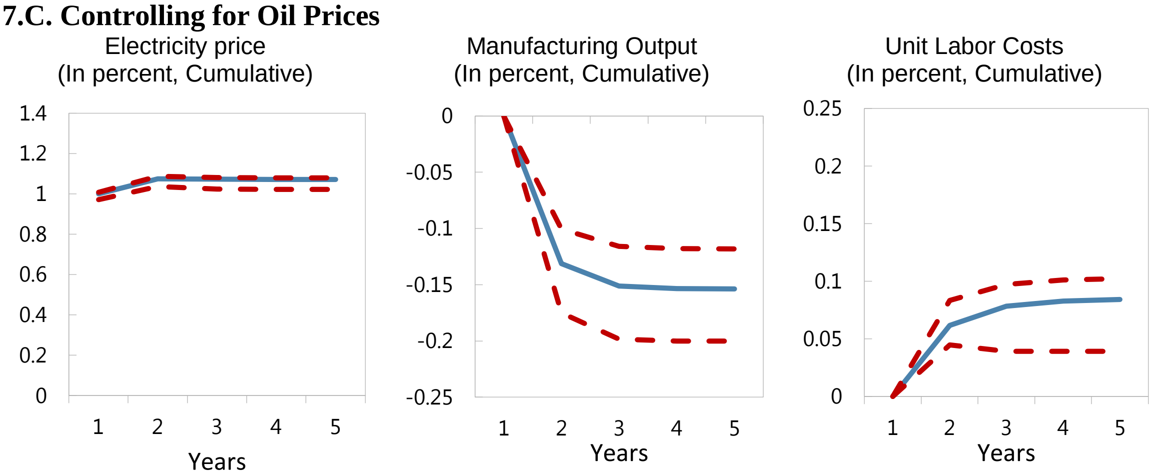
7.A. With Parametric Bootstrapped Standard Errors



7.B. With Non-Parametric Bootstrapped Standard Errors



7.C. Controlling for Oil Prices



Note: Impulse response functions (solid blue) are calculated for a period of 5 years with a shock of 1percent to electricity prices. 90percent confidence interval bands (dashed red) are based on parametric or non-parametric bootstrapped standard errors as indicated above.

Alternatively, unit labor costs may be reflecting an omitted variable effect since electricity prices are highly correlated with oil prices. To check for this we augment the VAR with oil prices and re-estimate the system.

Figure 7.C shows indeed a smaller response of unit labor costs to a change in electricity prices once oil prices are controlled for. Nevertheless, unit labor costs still respond in a statistically significant magnitude to electricity prices and amplify the impact of electricity prices on manufacturing. This exercise suggests that there is an additional indirect channel, not captured in the panel regressions shown earlier, that can potentially make the overall growth impact of lower electricity prices larger than what is suggested by its direct effect on manufacturing production.

V. Conclusion

Among all structural reforms passed in Mexico over the last 2 years, the energy reform is probably the most transformational. Assessing the growth impact of this reform is highly complex as it implies many structural changes in the sector and substantial uncertainty about how each of these changes will take place. In this paper, we focused on one particular channel, through the impact of lower energy prices on manufacturing production.

To conduct our analysis, we exploited past variation in energy prices in Mexico in a panel setting to estimate the response of manufacturing output to changes in energy prices. We found electricity prices to have the largest effect on manufacturing output among several energy prices. This elasticity, together with probable reductions in electricity prices due to substitution of fuel oil for natural gas in the generation of electricity, of around 13 percent, imply a 1.4–3.6 percent increase in manufacturing output, and 0.2–0.6 increase in real GDP. Larger increases are feasible if electricity prices converge to those seen in the U.S. Moreover, the overall impact of lower electricity prices on the economy can go beyond its impact on manufacturing as suggested by the statistically significant response of services to changes in electricity prices. Given the size of the services sector, about three times larger than manufacturing, the overall impact on GDP combining the response of manufacturing and services can be of up to four times the impact of manufacturing alone.

We then examined dynamic and feedback effects by expanding our analysis to include a VAR framework. We concluded that an additional indirect channel could operate through unit labor costs, which could further amplify the direct impact of electricity prices on manufacturing.

It is important to highlight that there may be other channels through which the reform can affect output. For instance, if the reform succeeds in modernizing oil and gas industries, attracting investment, and boosting output, this could carry benefits to other sectors, such as technology spillovers and increased foreign direct investment attracted by overall more favorable conditions to investors. However, for any of these benefits to be realized, proper implementation is critical. In particular, the newly created regulatory agencies must be effective and transparent enough to ensure an efficient opening of the energy sector.

Table 1. Energy consumption of the industrial sector

	2010	2011	2012
Industrial sector total (in Petajoules)	**1,381.1**	**1,492.3**	**1,530.6**
		In percent	
Electricity	34.2	33.6	34.5
Natural Gas	35.3	35.2	35.8
Oil derivatives	17.0	15.5	15.6
Others	13.5	15.8	14.0
Auto industry (in Petajoules)	**10.5**	**12.7**	**14.4**
		In percent	
Electricity	68.3	60.0	60.4
Natural Gas	19.9	28.1	28.7
Oil derivatives	11.8	11.9	10.9
Others	0.0	0.0	0.0

Source: SENER. Balance Nacional de Energía.

Table 2. Baseline Estimates

Dependent variable: Δy_{ijt} Sample period: 1996-2012	(1)	(2)	(3)	(4)
Δy_{ijt-1}	0.035 (0.037)	0.033 (0.038)	0.009 (0.041)	0.034 (0.038)
$\boldsymbol{\Delta EL_{t-1}}$	**-0.174** **(0.028)*** **			
$\boldsymbol{\Delta NG_{t-1}}$		**-0.024** **(0.008)*** **		
$\boldsymbol{\Delta OD_{t-1}}$			**0.038** **(0.022)* **	
$\boldsymbol{\Delta LPG_{t-1}}$				**-0.091** **(0.022)*** **
Δulc_{it-1}	-0.232 (0.030)***	-0.277 (0.032)***	-0.192 (0.050)***	-0.229 (0.031)***
$\Delta REER_{t-1}$	-0.033 (0.019)*	-0.088 (0.021)***	-0.065 (0.041)	-0.116 (0.023)***
$\Delta WTI\ (nominal)_{t-1}$	-0.003 (0.010)	-0.033 (0.011)***	-0.068 (0.020)***	-0.028 (0.011)**
$\Delta U.S.IP_{t-1}$	0.316 (0.056)***	0.315 (0.056)***	0.300 (0.071)***	0.329 (0.056)***
$\Delta U.S.r_{t-1}$	-0.610 (0.239)**	-0.586 (0.238)**	-0.635 (0.255)**	-0.919 (0.261)***
Constant	1.543 (0.114)***	1.292 (0.127)***	1.108 (0.090)***	1.390 (0.115)***
R^2	0.08	0.07	0.03	0.07
N	4,352	4,352	3,584	4,352

Note: Sector-State fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. EL, NG, OD, and LNG correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, oil derivatives, and liquefied natural gas respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. Sample period is 1996-2012 except for when oil derivatives are included in the regression where it goes from 1998-2012 because of data availability issues. * p<0.1; ** p<0.05.

Table 3. Baseline Specification with Additional Controls

Dependent variable: Δy_{ijt} Sample period: 1998-2012	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δy_{ijt-1}	0.036	0.029	0.030	0.031	0.005	0.005	0.005	0.006
	(0.040)	(0.040)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	-0.044
$\Delta \boldsymbol{EL}_{t-1}$	**-0.114**	**-0.141**	**-0.141**	**-0.167**	**-0.263**	**-0.269**	**-0.283**	**-0.323**
	(0.032)*	**(0.032)***	**(0.032)***	**(0.039)***	**(0.040)***	**(0.040)***	**(0.041)***	**(0.044)***
$\Delta \boldsymbol{NG}_{t-1}$	**-0.068**	**-0.049**	**-0.049**	**-0.045**	**-0.048**	**-0.047**	**-0.039**	**-0.027**
	(0.014)*	**(0.014)***	**(0.014)***	**(0.014)***	**(0.014)***	**(0.014)***	**(0.014)***	**(0.016)***
$\Delta \boldsymbol{OD}_{t-1}$	**0.111**	**0.094**	**0.093**	**0.074**	**0.054**	**0.048**	**0.019**	**0.006**
	(0.019)*	**(0.018)***	**(0.018)***	**(0.027)***	**(0.027)****	**(0.027)***	**(0.029)**	**-0.031**
Δulc_{it-1}		-0.228	-0.228	-0.219	-0.066	-0.060	-0.063	-0.053
		(0.045)***	(0.045)***	(0.047)***	(0.050)	(0.050)	(0.050)	-0.052
$\Delta REER_{t-1}$			-0.008	-0.044	-0.299	-0.310	-0.317	-0.340
			(0.029)	(0.046)	(0.053)***	(0.053)***	(0.054)***	(0.059)***
$\Delta WTI\ (nominal)_{t-1}$				0.022	0.046		0.074	0.087
				(0.022)	(0.022)**		(0.024)***	(0.027)***
$\Delta WTI\ (real)_{t-1}$						0.053		
						(0.022)**		
$\Delta U.S.IP_{t-1}$					0.559	0.562	0.496	0.505
					(0.074)***	(0.074)***	(0.074)***	(0.080)***
$\Delta U.S.r_{t-1}$							-0.674	-0.598
							(0.255)***	(0.276)**
Constant	0.988	1.018	1.024	1.045	0.967	1.089	0.956	1.082
	(0.124)***	(0.123)***	(0.126)***	(0.129)***	(0.130)***	(0.146)***	(0.131)***	(0.140)***
R^2	0.03	0.03	0.03	0.03	0.06	0.06	0.06	0.05
N	3,584	3,584	3,584	3,584	3,584	3,584	3,584	3,136

Note: Sector-State fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. Columns (1)-(7) include all subsectors, while column (8) excludes the chemicals, oil derivatives, rubber, and plastic products sector. EL, NG, and OD correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, and oil derivatives respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal or in constant U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. * p<0.1; ** p<0.05; *** p<0.01.

Table 4. Different Estimators

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Δy_{ijt} Sample period: 1998-2012	State-Sector FE	Random Effects	Sector FE	State FE	Arellano-Bond
Δy_{ijt-1}	0.005 (0.041)	0.081 (0.042)*	0.070 (0.043)	0.074 (0.043)*	0.069 (0.046)
$\boldsymbol{\Delta EL_{t-1}}$	**-0.283** **(0.041)***	**-0.281** **(0.042)***	**-0.284** **(0.042)***	**-0.281** **(0.042)***	**-0.278** **(0.044)***
$\boldsymbol{\Delta NG_{t-1}}$	**-0.039** **(0.014)***	**-0.036** **(0.014)**	**-0.037** **(0.014)***	**-0.036** **(0.014)**	**-0.037** **(0.017)**
$\boldsymbol{\Delta OD_{t-1}}$	**0.019** **(0.029)**	**0.014** **(0.030)**	**0.014** **(0.030)**	**0.015** **(0.030)**	**0.011** **(0.033)**
Δulc_{it-1}	-0.063 (0.050)	-0.084 (0.049)*	-0.060 (0.050)	-0.084 (0.049)*	-0.060 (0.064)
$\Delta U.S.IP_{t-1}$	49.567 (7.453)***	43.386 (7.351)***	45.343 (7.377)***	43.820 (7.378)***	44.074 (8.631)***
$\Delta WTI\ (nominal)_{t-1}$	7.408 (2.449)***	7.460 (2.514)***	7.707 (2.511)***	7.425 (2.516)***	7.611 (2.794)***
$\Delta REER_{t-1}$	-31.740 (5.421)***	-31.822 (5.426)***	-32.680 (5.456)***	-31.712 (5.443)***	-33.089 (6.420)***
$\Delta U.S.r_{t-1}$	-0.674 (0.255)***	-0.673 (0.257)***	-0.677 (0.257)***	-0.673 (0.258)***	-0.323 (0.308)
Constant	0.956 (0.131)***	0.917 (0.232)***	2.149 (0.561)***	1.558 (1.580)	1.113 (0.252)***
R^2	0.06				
N	3,584	3,584	3,584	3,584	3,584

Note: Fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. Two-step Arellano-Bond estimator based on Arellano and Bover (1995) and Blundell and Bond (1998) with robust standard errors. EL, NG, OD, and LNG correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, oil derivatives, and liquefied natural gas respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. * p<0.1; ** p<0.05; *** p<0.01

Table 5. Including Services Subsectors in the Sample

Dependent variable: Δy_{ijt} Sample period: 1998-2012	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δy_{ijt-1}	0.040 (0.038)	0.032 (0.038)	0.032 (0.039)	0.032 (0.039)	0.007 (0.038)	0.007 (0.038)	0.007 (0.039)	0.007 (0.041)
$\Delta \boldsymbol{EL_{t-1}}$	**-0.114** **(0.022)*** **	**-0.148** **(0.023)*** **	**-0.148** **(0.023)*** **	**-0.167** **(0.027)*** **	**-0.241** **(0.028)*** **	**-0.246** **(0.028)*** **	**-0.256** **(0.028)*** **	**-0.279** **(0.029)*** **
$\Delta \boldsymbol{NG_{t-1}}$	**-0.062** **(0.010)*** **	**-0.040** **(0.009)*** **	**-0.040** **(0.009)*** **	**-0.037** **(0.010)*** **	**-0.043** **(0.010)*** **	**-0.042** **(0.010)*** **	**-0.036** **(0.010)*** **	**-0.029** **(0.010)*** **
$\Delta \boldsymbol{OD_{t-1}}$	**0.110** **(0.013)*** **	**0.089** **(0.013)*** **	**0.089** **(0.013)*** **	**0.076** **(0.018)*** **	**0.063** **(0.018)*** **	**0.057** **(0.018)*** **	**0.037** **(0.019)* **	**0.030** **(0.020)**
Δulc_{it-1}		-0.264 (0.038)***	-0.264 (0.038)***	-0.258 (0.039)***	-0.088 (0.044)**	-0.082 (0.044)*	-0.085 (0.044)*	-0.078 (0.045)*
$\Delta REER_{t-1}$			0.000 (0.002)	-0.025 (0.031)	-0.242 (0.0367)***	-0.251 (0.0367)***	-0.256 (0.037)***	-0.266 (0.0389)***
$\Delta WTI\ (nominal)_{t-1}$				0.016 (0.014)	0.035 (0.015)**		0.056 (0.017)***	0.063 (0.017)***
$\Delta WTI\ (real)_{t-1}$						0.042 (0.015)***		
$\Delta U.S.IP_{t-1}$					0.481 (0.054)***	0.484 (0.054)***	0.435 (0.054)***	0.438 (0.056)***
$\Delta U.S.r_{t-1}$							-0.504 (0.173)***	-0.439 (0.178)**
Constant	1.767 (0.093)***	1.791 (0.093)***	1.790 (0.093)***	1.805 (0.094)***	1.767 (0.093)***	1.862 (0.103)***	1.759 (0.093)***	1.913 (0.097)***
R^2	0.03	0.04	0.04	0.04	0.07	0.07	0.07	0.07
N	5,376	5,376	5,376	5,376	5,376	5,376	5,376	4,928

Note: Sector-State fixed effects regressions with robust standard errors in parenthesis, clustered at the sector-state pair. Columns (1)-(7) include all subsectors, while column (8) excludes the chemicals, oil derivatives, rubber, and plastic products sector. EL, NG, and OD correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, and oil derivatives respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal or in constant U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. * p<0.1; ** p<0.05; *** p<0.01.

Table 6. Differential effects across subsectors

Dependent variable: Δy_{ijt} Sample period: 1996-2012	(1)	(2)	(3)
Δy_{ijt-1}	0.008	0.011	0.011
	(0.040)	(0.040)	(0.040)
$\boldsymbol{\Delta EL_{t-1}}$	**-0.282**	**-0.529**	**-0.514**
	(0.041)*	**(0.075)***	**(0.080)***
$\boldsymbol{\Delta NG_{t-1}}$	**-0.116**	**-0.036**	**-0.044**
	(0.031)*	**(0.014)**	**(0.031)**
$\boldsymbol{\Delta OD_{t-1}}$	**0.020**	**0.022**	**0.022**
	(0.029)	**(0.029)**	**(0.029)**
Δulc_{it-1}	-0.077	-0.114	-0.130
	(0.052)	(0.055)**	(0.057)**
$\Delta REER_{t-1}$	-31.179	-29.622	-28.970
	(5.452)***	(5.524)***	(5.515)***
$\Delta WTI\ (nominal)_{t-1}$	7.244	6.789	6.598
	(2.460)***	(2.460)***	(2.473)***
$\Delta U.S.IP_{t-1}$	48.690	46.580	45.784
	(7.502)***	(7.502)***	(7.422)***
$\Delta U.S.r_{t-1}$	-0.672	-0.666	-0.664
	(0.255)***	(0.255)***	(0.256)***
$\boldsymbol{\Delta NG_{t-1}}$***Food, beverages, and tobacco**	**0.124**		**0.029**
	(0.029)*		**(0.031)**
$\boldsymbol{\Delta NG_{t-1}}$***Textiles**	**0.059**		**0.032**
	(0.034)*		**(0.047)**
$\boldsymbol{\Delta NG_{t-1}}$***Wood and wood products**	**0.065**		**-0.000**
	(0.035)*		**(0.041)**
$\boldsymbol{\Delta NG_{t-1}}$***Paper and paper products**	**0.084**		**0.026**
	(0.031)*		**(0.034)**
$\boldsymbol{\Delta NG_{t-1}}$***Chemicals and oil derivatives**	**0.065**		**-0.059**
	(0.033)*		**(0.033)***
$\boldsymbol{\Delta NG_{t-1}}$***Minerals, non-metals**	**0.128**		**0.061**
	(0.032)*		**(0.036)***
$\boldsymbol{\Delta NG_{t-1}}$***Other**	**0.101**		**-0.023**
	(0.041)		**(0.042)**
$\boldsymbol{\Delta EL_{t-1}}$ ***Food, beverages, and tobacco**		**0.370**	**0.317**
		(0.075)*	**(0.084)***
$\boldsymbol{\Delta EL_{t-1}}$ *** Textiles**		**0.155**	**0.097**
		(0.096)	**(0.136)**
$\boldsymbol{\Delta EL_{t-1}}$***Wood and wood products**		**0.225**	**0.228**
		(0.086)*	**(0.098)**
$\boldsymbol{\Delta EL_{t-1}}$***Paper and paper products**		**0.249**	**0.202**
		(0.080)*	**(0.087)**
$\boldsymbol{\Delta EL_{t-1}}$***Chemicals and oil derivatives**		**0.302**	**0.421**
		(0.091)*	**(0.098)***
$\boldsymbol{\Delta EL_{t-1}}$***Minerals, non-metals**		**0.345**	**0.230**
		(0.084)*	**(0.095)**
$\boldsymbol{\Delta EL_{t-1}}$***Other**		**0.366**	**0.415**
		(0.125)*	**(0.151)***
Constant	0.956	0.957	0.958
	(0.130)***	(0.130)***	(0.130)***
R^2	0.07	0.07	0.07
N	3,584	3,584	3,584

Note: Sector-state fixed effect regressions with robust standard errors in parenthesis, clustered at the sector-state pair. EL, NG, and OD correspond to the domestic prices of electricity (average of tariffs for medium and large firms), natural gas, and oil derivatives respectively, deflated by the CPI. The operator Δ corresponds to the percent change. ULC denotes unit labor costs, measured at the industry level, REER denotes the cpi-weighted real effective exchange rate, WTI denotes the price of West Texas Intermediate oil prices, measured in nominal U.S. dollars, U.S. IP denotes the United States industrial production index, and U.S. r denotes the ex-post real interest rates measured as the difference between the yield on BAA Moody's-rated corporate bonds (all industries) and core inflation. * p<0.1; ** p<0.05; *** p<0.01.
Source: Instituto Nacional de Estadística y Geografia (INEGI) de Mexico, Federal Reserve Board of Governors, Bloomberg, Secretaria de Energia de Mexico, Haver analytics, and staff's calculations.

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