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The Effects of Real Exchange Rate Shocks on Plant Decisions: The Case of Mexican Manufacturing Sector 2000-2014

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2. Abstract

The objective of this paper is to analyse how manufacturing plants respond to a real exchange rate depreciation in terms of their factor demand. To do so, an event study approach is used to analyse the response of a panel of 1,422 Mexican manufacturing plants in terms of employment and investment expenditure. The results point out that a year after the real depreciation occurs, firms increase their investment expenditure around 20% with respect to the year before the shock. In terms of the labour demand, the results depend on the type of exposition a plant suffers with respect to changes in the exchange rate.

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3. Introduction and motivation

The role of the real exchange rate on economic growth has been one of the more recent debates on the economic growth literature. A series of studies (Rodrik, 2008, Frenkel and Ros, 2006, Rapetti et al., 2012, Razmi et al., 2012, Berg and Miao, 2010, Missio et al., 2015, Couharde and Sallenave, 2013, Ros, 2015, Rapetti, 2013), points out that an undervalued real exchange rate has positive effects on economic growth. The proposed causal mechanism behind this correlation is that a depreciated real exchange rate increases the relative profitability of firms in the tradable goods sector of the economy with respect to the profitability of firms in the non-tradable goods sector, The increase in profitability leads to an expansion of such firms, either by increasing their capital stocks or by hiring more employees. Since there is evidence that the firms in the tradable goods sector are more productive than the firms in the non tradable goods sector and that the first are subject to increasing returns to scale, the growth of the tradable goods sector leads to higher rates of growth for the whole economy. However, since the literature deals with aggregated data, it has found difficulties to test the mechanism that gives origin to the relationship.

A way to test the theoretical mechanism proposed by Rodrik (2008), Ros (2015) and Rapetti (2013) is to use firm level data to analyse how firms respond to a real exchange rate depreciation in terms of their labour and capital demand. Albeit this approach is not new, due to issues of data availability most of the literature has focused on the case of developed economies, leaving aside developing economies, which would be the ones where the literature on growth has found a positive effect of real exchange rate undervaluation on growth. The present paper seeks to contribute to the closing of this gap, by providing an analysis of the effects of real exchange rate depreciations on the factor demand of a panel of Mexican manufacturing firms during the twenty first century.

The case of Mexico is of particular interest since is a middle income country that during the last two decades has faced several episodes of real exchange rate depreciations, thus it is possible to observe how firms factor demand reacts to real exchange rate undervaluations. Also, there are empirical macroeconomic studies that provide evidence that at least capital demand is positively related with real exchange rate undervaluation (Ibarra, 2015, 2010). To analyse how firms factor demand reacts after a substantial depreciation the event study approach is used, defining as events annual depreciations larger than a 10% variation in the real exchange rate value. This approach allows to analyse the behaviour of the interest variables after the events take place. To my knowledge, this methodology has not been applied before to the analysis of the effects of exchange rate shocks on factor demand.

The results of this paper suggest that manufacturing plants react to a real exchange rate depreciation by increasing their investment expenditure with respect to the level observed before the real depreciation, both if they are more exposed on their sales than in their costs and if the exposition on the cost side of their balance sheet is larger than the exposition on the revenue side. Also, positively exposed firms increase their total sales and their total revenues with respect to the levels of the year before the real depreciation. The fact that the increases in the investment expenditures occur in a once in a time increase, suggest the presence of fixed adjustment costs.

The paper consists in six sections beside this introduction. In the following section I present a brief review of the literature on the effects of a real exchange rate depreciation on the factor demand, how factor demands adjust to a real exchange rate shock and on the effects of the presence of adjustment costs. In the third section I describe some theoretical considerations to have in mind in order to interpret the results, while in the fourth section I describe the data that was used in the estimations of this paper. In the fifth section I present my empirical strategy and the suitability of the event study approach to analyse the effects of exchange rate shocks on plant decisions. In the sixth section I present the results of the estimation and one possible extension of the analysis and in the last section of the paper I present the main conclusions, limitations and possibles roads for further investigation.

4. Literature Review

To understand how an abrupt real exchange rate depreciation will affect firms factor demands, it is necessary to understand how firms adjust their factor demand to a economic shock. Traditional microeconomic theory points out that in the face of any supply or demand side economic shock, firms will adjust their factor demands to the new profit maximizing quantities, being the only restriction the technology of production that they use. This implies that for any shock that firms observe, they will adjust their factor demands accordingly. This prediction has been challenged on the ground that firms may observe costs for adjusting their factor demands. If there is some type of cost of adjusting the factor demand of a firm, the adjustment will be smaller than the required to achieve the optimal level post shock.

There are two types of costs that firms may be facing, gross or net adjustment costs. Gross adjustment costs refer to the cost that a firm faces due to the increase or decrease of a factor and are linked to the specific unit that leaves or enters the production process. They can be of administrative nature (like publicity to attract new candidates for a job) or organizational (the effect that losing a worker has on a specific team inside the production process). They have to be incurred independently of the variations that may or may not occur in the factor availability. Net adjustment costs, on the other hand, are the costs that a firm has to face due to variations in the level of the factor in the production process. They are related to the organizational adjustments that a firm has to face due to variations in the capital or labour available for the production process (Hamermesh, 1995, Hamermesh and Pfann, 1996).

Albeit the mere presence of factor adjustment costs implies a suboptimal adjustment by firms to economic shocks, the specifics of how the observed adjustment will differ from the adjustment to the optimal level (that is, the one that would occur if there were no adjustment costs) depend crucially on the functional form that is assumed that the adjustment costs have. In table 1, the principal implications of the different functional forms that in the literature have been used.

Table 4.1: Implications of different cost functions

Type of Costs	Implication
Symmetric Convex Costs	The marginal cost of increasing factor X is equal to the marginal cost of decreasing factor X by the same amount. The firm responds to all shocks but adjust less than what is necessary to reach the optimal post shock level.
Assymetric Convex Costs	The marginal cost of increasing factor X is larger or smaller than the marginal cost of decreasing factor X by the same amount. The firm responds to all shocks but adjust less than what is necessary to reach the optimal post shock level. Due to the assymetry, the gap between the observed adjustment and the optimal adjustment is larger in the type of adjustment that the function penalizes more.
Piecewise Linear Costs	The marginal cost of adjusting a factor is constant which leads to periods of no adjustment by the firms. This occurs because firms do not want to spend the marginal cost if they expect to revert it. Thus, firms only adjust to what are expected permanent cost.
Lumpy Costs	Lumpy costs imply that firms will only bear the fixed cost of adjustment in the face of large shocks. Thus, there are large periods of no adjustment by firms.

Source: Based in Hamermesh and Pfann (1996)

The most usual assumption is that adjustment costs are of a quadratic convex type. Although this assumption increases the tractability of mathematical models, they perform poorly when contrasted against the patterns observed in the data. Instead, the patterns generated by the lumpy adjustment costs fit better with the observational data (Caballero et al., 1995, Caballero, 1999, Doms and Dunne, 1998, Hamermesh and Pfann, 1996, Hamermesh, 1990, 1995, 1989, Pindyck, 1988). This implies that firms will only adjust their factor demand after large shocks that affect the prices of the factors or their incomes. In the case of open economies, exchange rate shocks are a frequent type of shocks of varying intensity. Thus it is possible to expect that firms will only react to large swings in the exchange rate between two currencies.

The effects of this type of shocks has been analyzed both at the macro and the micro scale. The literature focused on analysing the effects of a exchange rate shock at the macro level has been interested in both the short term effects and the long term effects, and forms the core of both open economy macroeconomics and development macroeconomics (Montiel, 2011, Obstfeld and Rogoff, 1996, Végh, 2013, Lizondo and Montiel, 1989, Krugman and Taylor, 1978). However, in this literature review, the attention will be centred on those analysis at the sectoral or firm level that seeks to identify how specific sectors responds to variations in the exchange rate.

Regarding the effects at a sectoral level, several studies in the literature on the effects of depreciated real exchange rate in economic growth have analysed how an undervalued real exchange rate affects the manufacturing sector in terms of employment and production. Although the literature is concerned with the levels of the real exchange rate, this can be interpreted as an interest on the medium term effects of a shock on the real exchange rate. This literature, based in panel data analysis at the sectoral level for a sample of multiple countries, has found that an undervalued real exchange rate has a positive effect on the demand for labour in the sector and on its production levels. However, such effect diminishes as the exposition of firms to debt denominated in foreign currency and to foreign inputs in the production process increases (Galindo et al., 2007, Eichengreen, 2007, Vaz and Baer, 2014, Bebczuk et al., 2006).

The increased availability of sectoral and firm level data has enabled the testing of several predictions and mechanisms proposed by the new trade theory and international economics (Tybout, 2001, 2000). Taking advantage of this, an approach to analyse how firms modify their factor demand according to variations in the real exchange rate has been to estimate structural factor demand equations, with the objective of identifying how the exchange rate affects both labour and capital demand from the revenue and the cost side of the firms balance sheet.

This literature has been interested in analysing how the market structure, the participation of imported inputs in total inputs and of exports in total sales mediate the effect of an exchange rate shock affect the demand for both labour (Burgess and Knetter, 1998, Nucci and Pozzolo, 2010, Tracy et al., 1999, Demir, 2010, Hua, 2007) and capital (Landon and Smith, 2009, Kandilov and Leblebicioğlu, 2011, Nucci and Pozzolo, 2001, Campa and Goldberg, 1995, 1999).

This literature has reached several important results. First, it has been identified that as the market power of a firm increases (or the degree of concentration of the market increases), the lower are the effects of changes in the real exchange rate on the factor demand. This implies that firms prefer to adjust their profit margins instead of modifying their factor demand. Secondly, as the theory predicts (Amiti et al., 2014), the lower is the net exposure of a firm to the world market (that is the more matched is the exposure from the revenue side with the exposure in the cost side), the lower is the response to real exchange rate variations. Related to this, the literature has identified that a real exchange rate depreciation has a positive effect on factor demand through the revenue side and a negative effect through the cost side. Although the net effect varies, several studies (Demir, 2010, Hua, 2007, Eichengreen, 2007, Frenkel and Ros, 2006, Ibarra, 2015) point out that a real depreciation has positive effects on labour and capital demand.

Another approach has been to analyse particular cases of real exchange rate depreciation or appreciation. This approach takes advantage of the fact that the real exchange rate variations can be seen as a plausible exogenous variations with respect to the firms factor demand decisions. Thus, the studies in this approach try to pinpoint the causal effect from the exchange rate variations to the changes in the demand for labour and capital of the firms, without imposing a specific structural model. Although they differ in their identification assumptions, it is possible to say that in general they use the variation on exposure to the foreign markets or in productivity as the one that allows to discern the effects of the exchange rate shock.

Although the literature on this strand is more sparse, there are several key insights from it. The first result is that a real exchange rate appreciation results in a negative effect on labour demand by firms (Gourinchas, 1999, Ekholm et al., 2012). The second result is that real exchange rate depreciations lead to increases in output by firms, particularly in exports, and to increases in labour and capital demand (Verhoogen, 2008, Berman et al., 2012, Fuentes and Ibarrarán, 2012).

Of particular interest to this paper are the studies by Verhoogen (2008) and Fuentes and Ibarrarán (2012) since they analyse how Mexican manufacturing plants responded to the 1994 real exchange rate shock and use the same data that will be used in the present paper. Although both study the same shock , they put emphasis on different aspects. Verhoogen (2008) focuses on how heterogeneous plants in terms of productivity responded to the shock in terms of export sales, quality of goods and intra plant wage distribution. On the other hand,Fuentes and Ibarrarán (2012) analyses how changes in the trade regime affected the response of plants to exchange rate shocks. The first conclusion of both studies is that the real exchange rate shock that followed the collapse of the exchange rate peg led to a increase in the export sales by exporting and high productivity plants, larger than the ones occurred before the entry of NAFTA. Secondly, the shock led to an increase in labour and capital demand by the exporting plants with respect to their demand on periods where the real exchange rate was not depreciated.

The present paper is part of this second approach to study the effects of exchange rate shocks on the factor demand of plants in a developing economy, Mexico. The difference with the aforementioned papers is that instead of studying only one depreciation shock, the object of study are the several depreciation shocks that the Mexican economy suffered from 2000 to 2014. The differences of the present study with the literature that uses structural equations are several. The present paper its the first study that uses Mexican data to analyse the effects of exchange rate shocks to factor demand for a relatively long period of time. Secondly, by taking a natural experiment approach to analyse the problem, it is possible to identify more clearly that the cause of the factor demand adjustments are the exchange rate shocks.

5. Theoretical considerations

To analyse how firms could respond to a change in the exchange it is useful to have in mind certain theoretical results given by the traditional producer theory. Firms can be exposed through two channels to a variation in the exchange rate: through its costs due to a change in the price of imported inputs, or through its sales, caused either by an increase in the volume of exports by the firm due to a more competitive price, or through an increase in the revenue in local currency obtained from exports due to a constant international price but a different local price after the depreciation. In the Mexican case, however, it is sensible to assume that the relevant case for the exposure through its sales its the one in which the international price do not changes.

In the case of a producer that faces competitive factor markets, a linear homogeneous function (constant returns to scale) and two inputs to produce (one locally available, the other one imported), the elasticities of each factor demand with respect to the change in the price of one of them are given by the following equations [1].

$$\varepsilon_{K,p_K} = -\left(\frac{p_K K}{p_Y Y}\eta + \frac{p_L L}{p_Y Y}\sigma\right) = -\left(s_K\eta + s_L\sigma\right) \tag{1}$$

$$\varepsilon_{L,p_K}) = \frac{p_K K}{p_Y Y}\left(\sigma - \eta\right) = s_K\left(\sigma - \eta\right) \tag{2}$$

Where ε_{K,p_K} is the elasticity of the demand for K with respect to changes in its own price, ε_{L,p_K} is the elasticity of the demand for L with respect to changes in the price of K, σ is the elasticity of substitution between factors, η is the elasticity of final product demand to changes in its price, s_K is the share of total receipts going to input K, s_L represents the share of total receipts going to input L, p_Y is the final product price, p_L is the price of input L and p_K is the price of input K.

The elasticities imply that a change in the price of input K leads to a contraction of its demand due to two causes: a change in aggregate demand due to the increase in the final price due to the increase in costs, and a substitution of input K for input L due to fall in the relative price of the second input. Firms that are intensive in the use of K will suffer a larger shock from the first channel, while firms that are intensive in L mainly react due to the second channel.

In the case of the demand for input L, the effect will depend on the size of the elasticity of substitution between factors (determined by the technology employed) and the size of the elasticity of final demand with respect to changes in the final output price. If the final demand is fairly inelastic, then the demand for input L will increase.

If manufacturing firms do not have the power to modify the price in dollars of their final output, nor to modify the dollar price of their imported inputs, then an exchange rate depreciation will be

[1]Full derivation of this results is provided in the appendix A

equivalent to a rise in the local price of their imported inputs, thus triggering the results analysed above, where the demand effects correspond to the effects observed in the local market if there is full pass-through of the rise in the price of imported inputs. A factor that is not contemplated is that in this context, the revenue effect of the depreciation is left aside. The increase in revenues in local currency could attenuate the substitution effects, thus leading to a smaller fall in the demand of the imported inputs. If the increase in revenues is large enough, then it may even reverse the negative effects on the demand for input K.

These elasticities consider that a firm will adjust in an continuous manner to the price shock and will reach the new optimal level independently of the size of the shock. However, if there are fixed costs, these behaviour will change. In the face of fixed costs for adjusting either one of the factors, firms may adjust in different manners, depending on the type of costs and how they relate to the technology of production.

If the costs of adjustment are of a convex type, the firms will still adjust in a continuous manner to the presence of shocks, but they will under adjust with respect to the new optimal levels. On the other hand, if costs are fixed and related to factor indivisibleness or high unit costs, then firms are likely to adjust in a discontinuous manner, adjusting only to shocks that make profitable covering the adjustment costs and not changing their behaviour in the face of smaller shocks.

6. Data

The plant level data used in this study comes from a panel of 1,422 plants which it is possible to follow on an annual basis during the period of 2000 to 2014 across three different national panel surveys conducted by the Mexican government statistics agency, the Instituto Nacional de Geografía y Estadística (INEGI) to analyse the behaviour of the Mexican Manufacturing sector. The surveys are the Encuesta Industrial Anual 1993-2003 (EIA93), the Encuesta Industrial Anual 2003-2008 (EIA03) and the Encuesta Anual de la Industria Manufacturera 2008-2014 (EAIM). These surveys share the same deterministic sampling method and part of the original sample from 1993 has been followed up to 2014, enabling to construct a balanced panel for the period of interest. Due to the original sample design "maquiladoras" are excluded from the 1,422 establishment panel, although they are part of the sample of the EAIM. The data management process of this data set is explained in Appendix B.

From this dataset I recover the outcome variables of interest for this study, which are the number of employees at the plant, the total remunerations those employees receive for their labour, annual hours worked, the total investment expenditure, sales, and revenues. For the monetary variables, their values are expressed in pesos of 2012:06, deflated by producer price index. Since the interest of this paper is to analyse how the reactions of plants exposed to foreign markets to an exchange rate shock differ from the reactions of non exposed plants, a first step is to define which plants are exposed and which ones are not exposed. Thus, from the afore mentioned dataset I also recover information about the value of the total costs paid by plants, the value in national currency of imported inputs and exports.

Plants can be exposed both from the income side and the cost side of their of their balance sheet [2]. Exposure from the revenue side is defined as the participation of foreign sales on total sales, while exposure on the cost side is defined as the participation of imported inputs in total costs. Following Campa and Goldberg (1995) and Ekholm et al. (2012) net exposure is defined as the difference between exposure from the revenue side and exposure from the cost side.

Table 6.1 presents summary statistics for both exposed and non exposed plants. As it is possible to observe, plants that are exposed are substantially larger than non exposed plants. This is consistent with the evidence presented by Fuentes and Ibarrarán (2012) and Verhoogen (2008) documenting the large differences between exporting plants and non exporting plants. Exposed plants are larger in terms of sales, employ larger amounts of employees, pay a higher average labour remuneration, have a larger capital stock, and have a larger revenue.

[2] A limitation of the analysis is that I only observe exposure in terms of the value of goods both imported and exported. This implies that I do not have information on the financial exposure of plants, which can be of sizesable importance considering the degree of openness of the Mexican economy.

Table 6.1: Descriptive statistics

	Exposed	Non exposed
Total sales	999052.6	354802.1
	[7272.687]	[1172.861]
Average labour remuneration	197.245	150.7311
	[0.165]	[0.128]
Capital Stock	243299.4	79702.82
	[1615.746]	[400.437]
Total Investment	36377.56	12020.58
	[270.943]	[84.251]
Hours Worked	931.374	563.606
	[2.693]	[1.324]
Employed	386.842	230.532
	[1.098]	[0.532]
Total Remunerations	91837.68	41820.26
	[374.176]	[114.540]
Total Revenue	1001970	353392.5
	[7290.205]	[1166.440]
Exposure	-0.113	-0.001
	[0.000]	[0.000]

Notes: Exposed plants are defined as those above the median in the distribution of the net exposure measure. Average labour remuneration is the ratio between total labour remunerations and total employees by plant. Capital stock is measured through the perpetual inventories methodology, details in Appendix. Following Verhoogen (2008) total revenue is calculated as the difference between total income (composed of sales and income from subcontracting) and expenditures on subcontracting. All monetary variables deflated by the Producers Price Index.

Although plants seem to be, on average, more exposed on their cost side, a detailed examination of the distribution of the exposure variable gives a different image. As Graph 3.1 shows in panel A and in Panel B, the majority of plants are exposed on their sales side, but in a relatively small degree [3]. As can be observed, the number of plants that were exposed on the revenue side of their balance sheet increased between 2000 and 2014, reducing the number of plants exposed on their costs in net terms. For the analysis on the effects of a real exchange depreciation, this implies that the number of plants that could have been negatively affected in net terms by the real exchange depreciation has fallen, while the number of plants that could have received net benefits from a depreciation has increased.

In the identification of the episodes of large real exchange depreciation depreciations, defined as depreciations equal or above a 10% positive variation in the real exchange rate on an annual basis, I use the Multilateral Real Exchange Rate Index series calculated by Banco de México, the Mexican Central Bank. The Index is calculated as the ratio between the weighted average of the price indices of 111 countries expressed in dollars, using as weights the trade share that each country represents of Mexico's trade, and the Mexican price level in dollars. An increase in the index implies a depreciation.

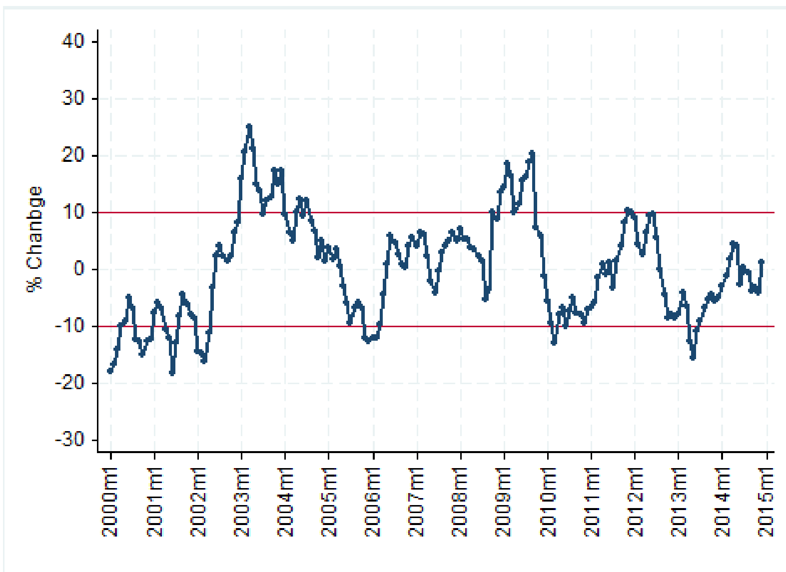
As figure 6.1 shows, episodes of depreciations equal or above a 10% variation on the exchange rate are not very common and tend to be grouped in certain periods. A year is designated as a year in which a large depreciation occurred if there at least four month in the year in which the real exchange rate depreciated 10% or more. This leaves us with two years in which the depreciations occurred: 2003 and 2009.

In the different panels of figures 6.2 and 6.3, the evolution of the outcome variables is shown. Two clear characteristics emerge. The first one is that, as described in table 6.1, exposed plants

[3]The proportion of total sales that exports represent is less that ten percentage points over the proportion that the value of imported inputs represents of their total costs. This implies that plants have an almost matched balance sheet in terms of their exchange rate exposure

Figure 6.1: Real exchange rate annual variations

(2000-2014)



Source: Banco de Mexico.

Notes: Variations of the multilateral real exchange rate index constructed using the trade shares of commercial partners as weights. The horizontal lines mark a -10% variation and a 10% variation respectively.

are substantially larger than non exposed plants in terms of employment, total revenue, total sales and capital stock. The exposed plants also pay a higher average remuneration per worker. These differences have remained almost constant for all the aforementioned characteristics. The other characteristic is that with the exemption of the behaviour of total investment and total revenues, the outcome variables behave in a very similar manner in both groups in the years before the occurrence of the exchange rate shock.

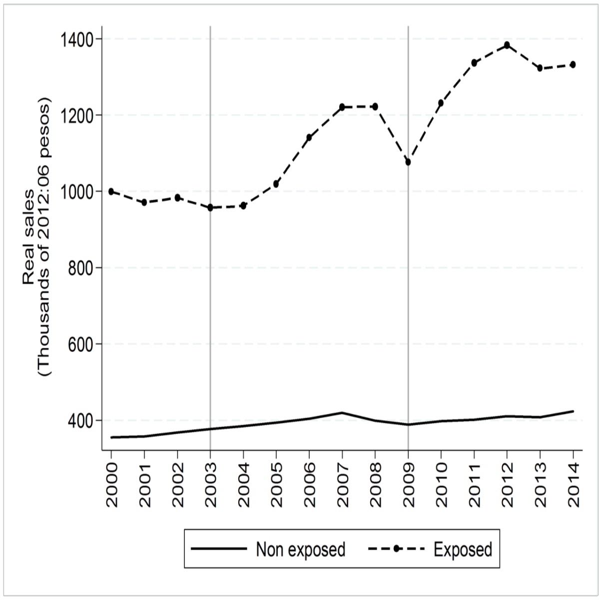
A possible reason for the divergence in behaviour between the exposed plants and the non exposed plants in terms of their revenues and their investment patterns, is that exposed plants are more likely to be linked to the behaviour of the US manufacturing sector. In graph 6.4 the behaviour of the US manufacturing sector during the period of interest is plotted. As can be seen, the behaviour of the revenues of the exposed plants follow to a certain degree the evolution of the US manufacturing production. For that reason, the baseline econometric specification controls for the behaviour of the US manufacturing sector.

7. Empirical Strategy

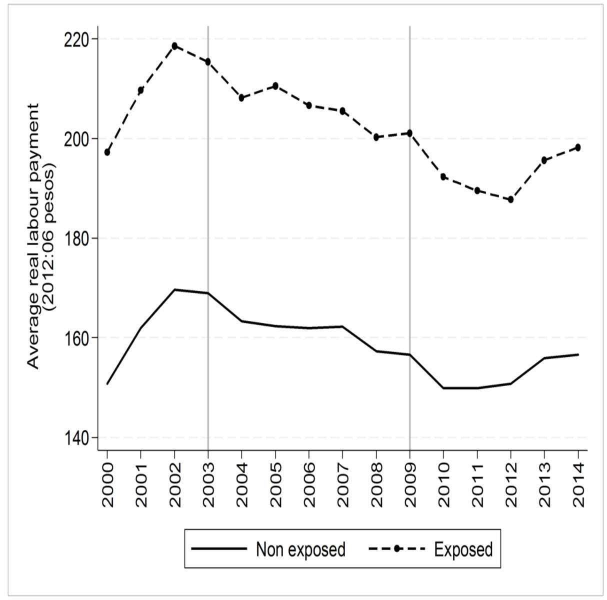
The interest of this paper is to analyse the effects of a real exchange rate depreciation shocks on factor demand decisions by plants. The literature on adjustment costs points out that establishments will adjust their factor demands in a discrete way, adjusting their demand only when large shocks occur. Thus, it is plausible to assume that a similar phenomenon occurs in terms of real exchange rate depreciations and that only in the face of large real exchange rate shocks, plants will adjust their demands. In a floating exchange rate regime, rational producers will sign contracts in which certain degree of exchange rate variability is covered, in order to deal with uncertainty on the values of the exchange rate in the future. However, if the variations are larger than expected, plants will be forced to renegotiate their contracts in the face of such shocks, and possibly adjust their factor demands.

To identify how plants respond in their factor demands to real exchange rate depreciations, I use the heterogeneity in exposure of the plants to the foreign markets, where there are plants that

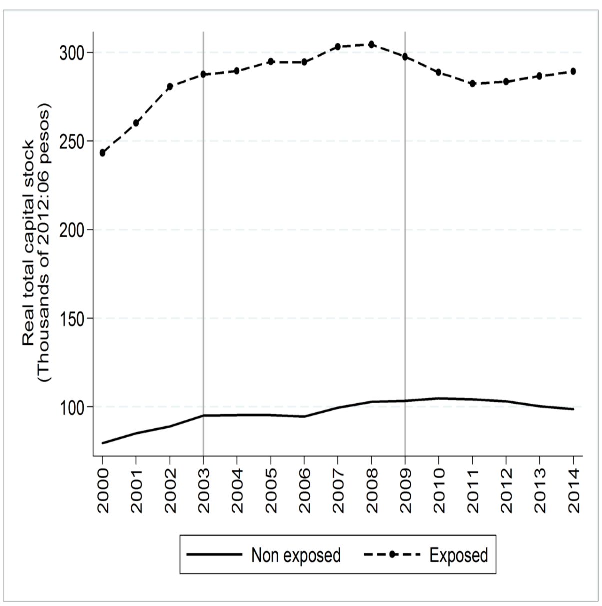
Figure 6.2: Evolution of outcome variables, 2000-2014



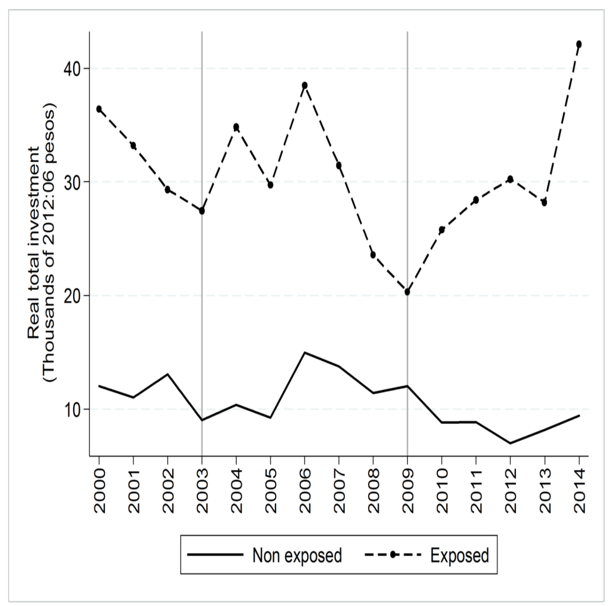
(a) Real sales, 2012:06 thousand pesos



(b) Average labour payment, 2012:06 pesos



(c) Total capital stock, 2012:06 thousand pesos

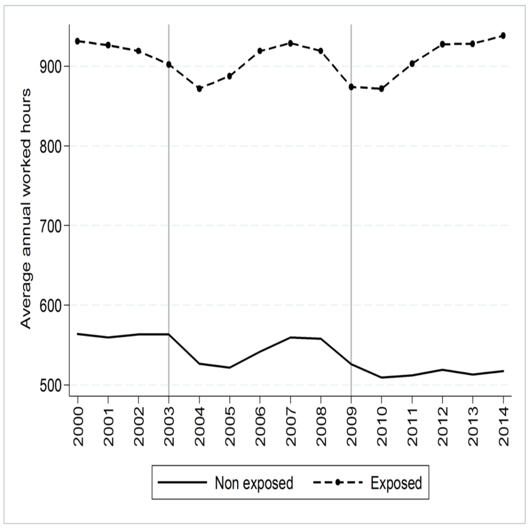


(d) Total investment, 2012:06 thousand pesos

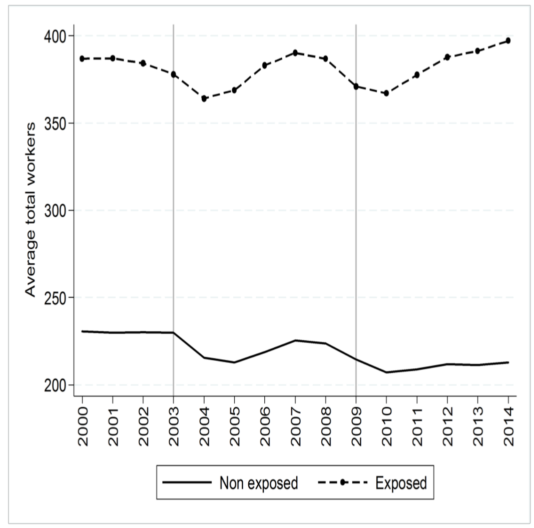
Source: Encuesta Industrial Anual Balanced Panel.

Notes: Exposed plants are defined as those above the median of the net exposure indicator distribution. All variables deflated by the Producers Price Index. Average labour payment is the ratio between total labour remunerations and total employees by plant. Capital stock is measured through the perpetual inventories methodology, details in Appendix.

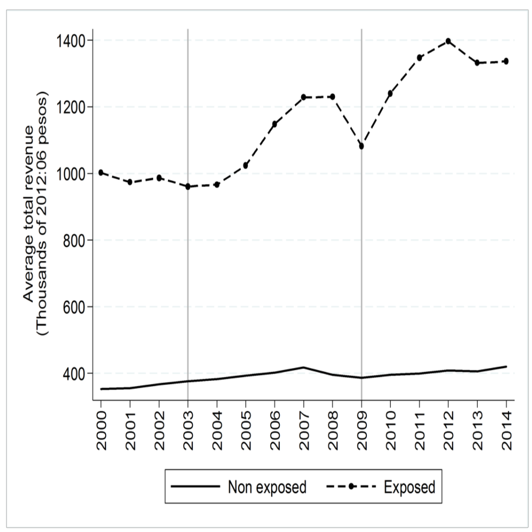
Figure 6.3: Evolution of outcome variables, 2000-2014



(a) Average annual worked hours



(b) Average total workers



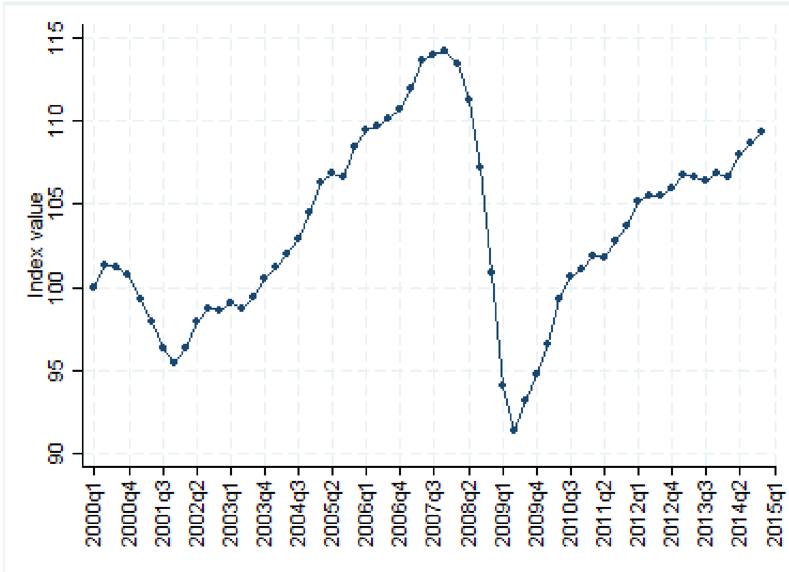
(c) Average total revenue, 2012:06 thousand pesos

Source: Encuesta Industrial Anual Balanced Panel.

Notes: Exposed plants are defined as those above the median of the net exposure indicator distribution. All variables deflated by the Producers Price Index. Following Verhoogen (2008) total revenue is calculated as the difference between total income (composed of sales and income from subcontracting) and expenditures on subcontracting.

Figure 6.4: Evolution of the US manufacturing production.

(Index 2000q1=100)



Source: Federal Reserve Economic Data.

Notes: Index corresponding to the production volume of the US manufacturing sector according to the NAICS classification.

are largely exposed on both the revenue and the cost side of their balance sheet while there are others that are no exposed. If the plant belongs to the upper half of the distribution of the absolute value of the net exposure variable, the plant is considered to be exposed. If it belongs to the lower half of the distribution, I consider the plant to be non exposed.

The data allows to follow the same sample of establishments through the whole period spanning from January of 2000 to December of 2014. This implies that it is possible to observe the history and the reaction of each plant factor demand to several large depreciations. Each one of this shocks can be seen as an event in which the response of the plant to such a shock can be analysed. My identification strategy, as stated before, implies that plants that are more exposed to the international markets will adjust their factor demand in the face of a depreciation, while plants that are no exposed will not adjust their demand. Thus, to properly estimate the effects of the exchange rate shocks, the identification hypothesis is that evolution of factor demand of exposed and non exposed plants would have been the same have the exchange rate shocks not occurred.

The interest of this paper is to identify the average effect of all large exchange rate shocks in plants factor demand. To achieve this, the strategy of Jacobson et al. (1993) is used and the data is pooled using a series of dummy variables for the number of years before and after the ocurrendce of the shock. Accordingly, the categorical variable $D_t^z = 1$ if period t is z years before or after the exchange rate shock, and zero otherwhise. For this reason, the approach followed in this article is similar to the used by Dube et al. (2010) to analyse the effects of the minimum wage on employment, Bosch and Campos-Vazquez (2014) to analyse the effects of social protection programs on labour formality, Jacobson et al. (1993) to analyse the effects of labour displacement on earnings, and Autor et al. (2006) to analyse the effects of discharge laws on employment.

The literature on adjustment costs suggest that labour demand adjust faster to shocks than capital demand. This result would imply that the pre-post shock windows of the estimation should be of different lenghts, larger for the effects on capital demand and shorter for the effects on labour demand (Hamermesh, 1990, Hamermesh and Pfann, 1996, Caballero et al., 1995). However, to allow more flexibility, I use an homogenous window of four years before and after the shock in order to capture medium run effects. This is different from what Verhoogen (2008) and Fuentes and Ibarrarán (2012) do, since they consider a window of one year post and pre shock.

As stated before, it is necessary to control for the behaviour of the US manufacturing sector, since plants could be answering not to the exchange rate shock but to a contraction of the US economy. Also, to control for state and industry invariable characteristics I include state and industry fixed effects in my baseline specification for both labour and capital demand.

$$y_{it} = \alpha + expo_i + \sum_{t=-3}^{t=3} D_{it}^z + \sum_{t=-3}^{t=3} D_{it}^z \times expo_i + \gamma_s + \lambda_{ind} + \beta_0 US\,ind_t + \epsilon_{it} \qquad (3)$$

Where y_{it} is the natural logarithm of the desired outcome variable[4], *tmin* correspond to the years before the shock and *tmax* correspond to the years after the shock, γ and λ are state and industry fixed effects and $US\,ind$ is the value of index of US manufacture activity in the year. $expo_i$ is the indicator variable of exposure (defined as in the previous section) and D are the period indicator variables defined above. The state and industry fixed effects absorb all the heterogeneity at state and industry level. Thus, the effect of the real exchange rate shocks on the outcome variables (associated to the coefficient related to the interaction between the net exposure indicator and the period dummy indicator) is identified from the variation in the net exposure measure between plants within state and industry. The effect of the shocks coming from the US industry is assumed homogeneous across states and industries.

A possible problem with this specification is that it do not controls for the pre existing trends at the state level. If exposed plants are located in specific geographical areas, for example, close to the to the border, then the state dynamics may generate a difference in the behaviour of exposed plants with respect to the behaviour of non exposed plants unrelated to their exposure. This could bias the estimators of the effects of the real exchange rate shocks on plant decisions. To control for this possible source of bias, an alternative specification adds state level linear trends to the baseline specification.

$$y_{it} = \alpha + expo_i + \sum_{t=-3}^{t=3} D^z_{it} + \sum_{t=-3}^{t=3} D^z_{it} \times expo_i + \gamma_s + \lambda_{ind} + \beta_0 US\,ind_t + \sum_{s=1}^{s=32} I_s \times T + \epsilon_{it} \tag{4}$$

Where t is the linear trend and I_s is an state indicator variable. This variable absorbs the possible linear trend existing in the outcome variables of the plants that coexist in the same state.Thus the effect of real exchange rate depreciations is identified through the variations in the exposure measure between plants within states and industries. This specification allows also to capture the

[4]The outcome variables are total employees by plant, total hours worked, total investment, total remunerations, total sales and total revenue. All monetary variables in pesos of 2012:06

effects of the US industrial sector behaviour on the manufacturing plants in each state.

A possible source of bias in all the specifications is that there will positive serial correlation in the interest variables, thus causing the OLS standard errors to be biased downwards as Bertrand et al. (2004) point out. To control for this, the standard errors are clustered at plant level.

In order to have clearer evidence on the causal mechanisms behind the results of equations 3 and 4 I estimate each of those equations distinguishing between plants with a positive net exposure and plants with a negative net exposure. To identify each group, I generated two sub samples of my main database. The fist sub sample corresponds to those plants with a net exposure equal or above zero. Thus, for this sub sample of establishments, the variable indicating if the plant is exposed or not, defines as exposed those establishments whose net exposure variable takes a value above the sub sample median value. The other sub sample corresponds to plants with a net exposure value equal or below zero. In this case, plants where considered as exposed if their net exposure value was below the median value (which implies a value above the median in absolute terms). Equations 3 and 4 are estimated for each sub sample.

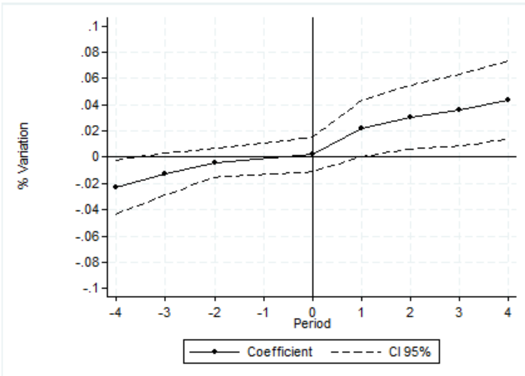
Plants that have a positive net exposure are expected to respond to an exchange rate depreciation by increasing their sales, their revenue, and to increase their factor demands. On the other hand, establishments that have a negative net exposure are expected to reduce their sales, their revenues and their factor demands.

8. Results

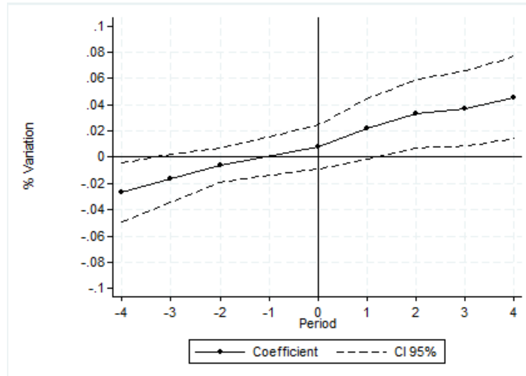
The resulting coefficients from the first regression are presented in Figure 8.2, and the results of the second are presented in figure 8.1 [5]. Each panel corresponds to a different outcome variable. A first thing to notice is that the results from the first specification are very similar to the results of the second specification.

[5] The regression tables are presented in the Appendix C

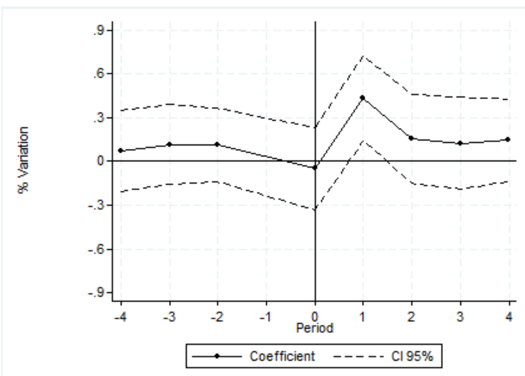
Figure 8.1: Results from first specification



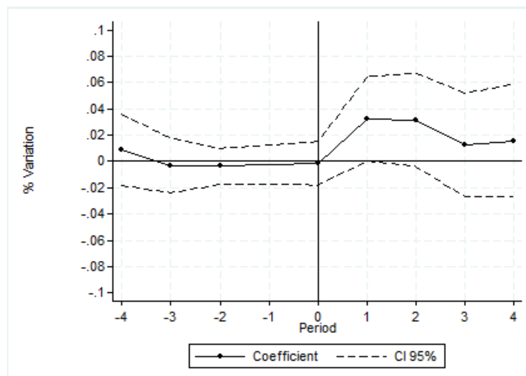
(a) Number of workers



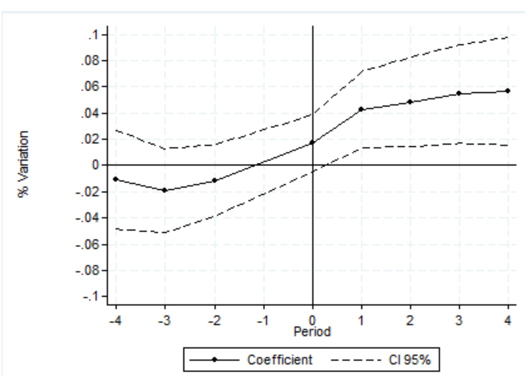
(b) Total hours worked



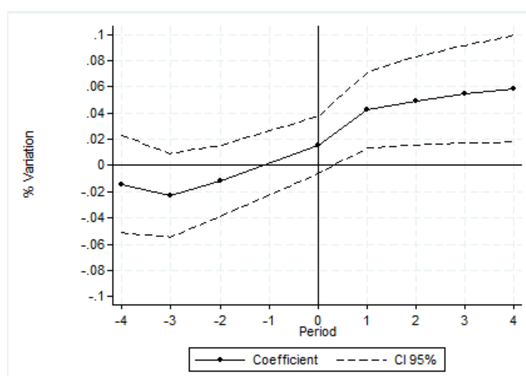
(c) Total investment



(d) Total remunerations



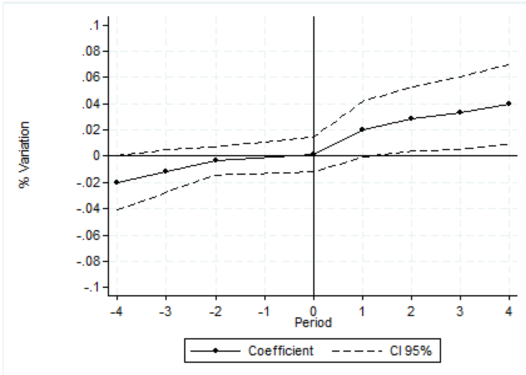
(e) Total sales



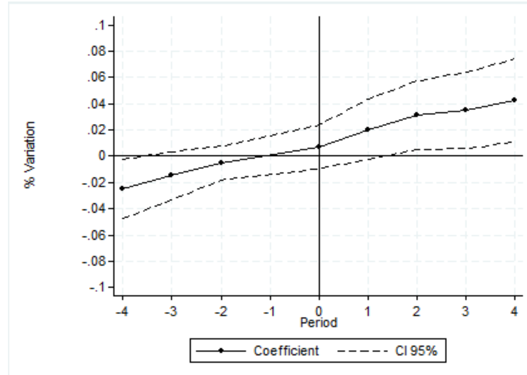
(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 1. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include state and industry fixed effects and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

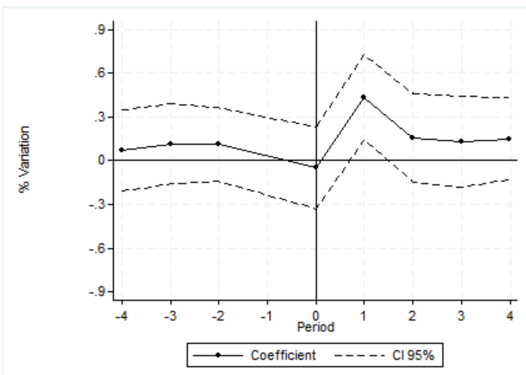
Figure 8.2: Results from second specification



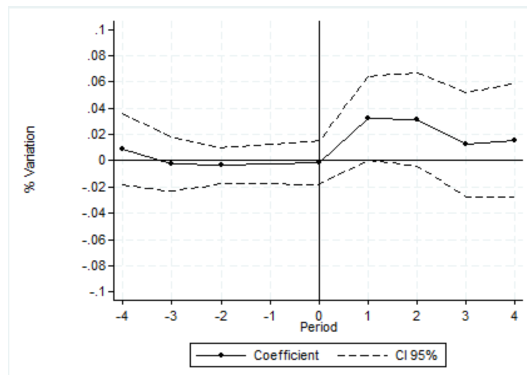
(a) Number of workers



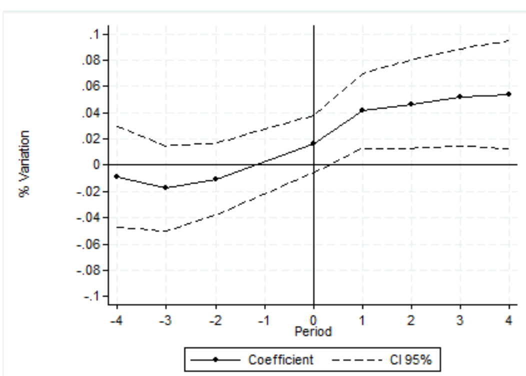
(b) Total hours worked



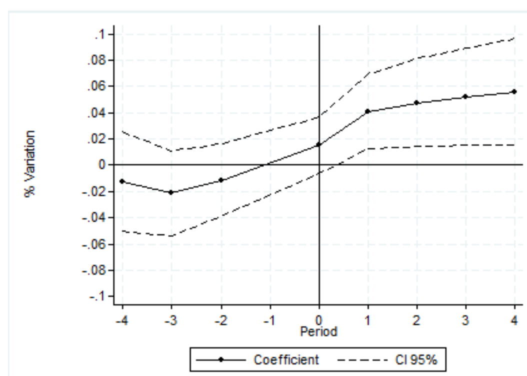
(c) Total investment



(d) Total remunerations



(e) Total sales



(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

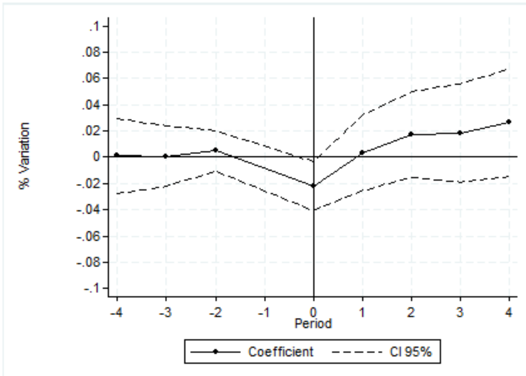
A year after a real exchange rate depreciation above the 10%, plants with a net exposure above the median suffer a positive shock in their labour demand both in the intensive (they increase worked hours by a 2%) and in the extensive margin (the number of employees increases by a 2%) with respect to their labour demand in the year before the shock. This effect increases in the second year after the exchange rate shock, reaching a level of labour demand 4% larger with respect to the labour demand of the year before the shock and remain at that level through the rest of the window of analysis. This implies that medium run effect is 2 percentage points larger than the effect observed in the immediate year after the depreciation. However, there seems to be an increasing trend in the years before the shock, although the coefficients are not statistically different from zero.

However, total remunerations do not increase with respect to the level they had at the year before the shock. The combined behaviour of this variables implies that plants are hiring more workers and paying them lower remunerations than before the shock. This suggest a movement to hiring less qualified labour.

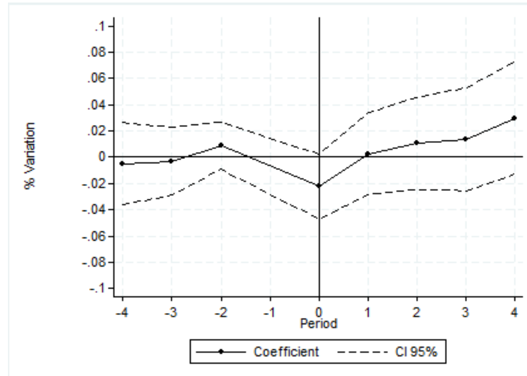
In terms of capital demand, a year after the exchange rate shock, the investment of exposed plants suffers an increase of 40%, and the effect disappears in the following years. This means that plants react to the real exchange rate shock with a one time large increase in their capital demand, instead of increasing their investment by small amounts over a long period of time.

However, this results do not allow to identify in a clear way the causal channels behind the response to the shock by the exposed plants, since positively and negatively exposed plants are grouped together in the analysis. In figures 8.3 and 8.4 the results for positively exposed establishments are presented, while the results for negatively exposed establishments are presented in figures 8.5 and 8.6 .

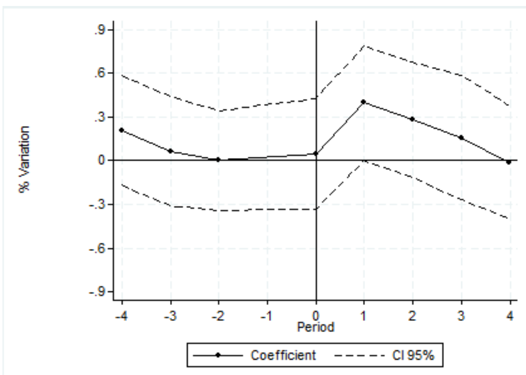
Figure 8.3: Results for positively exposed plants, first specification



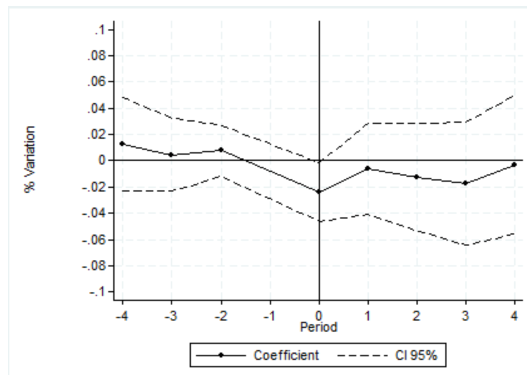
(a) Number of workers



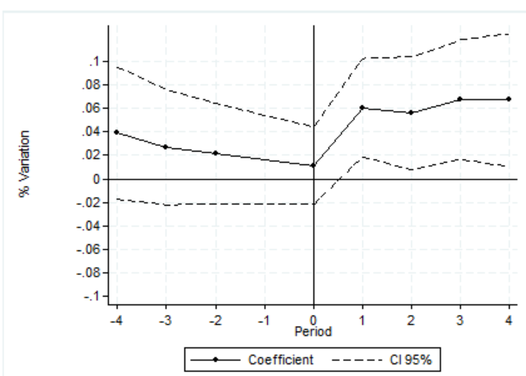
(b) Total hours worked



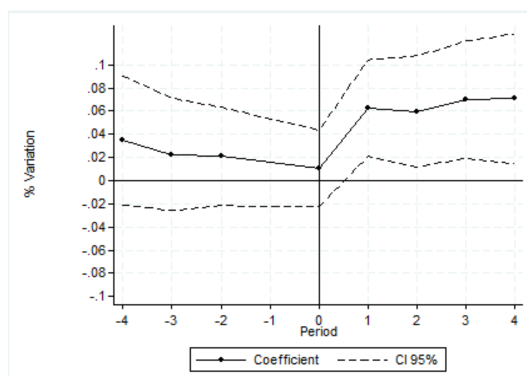
(c) Total investment



(d) Total remunerations



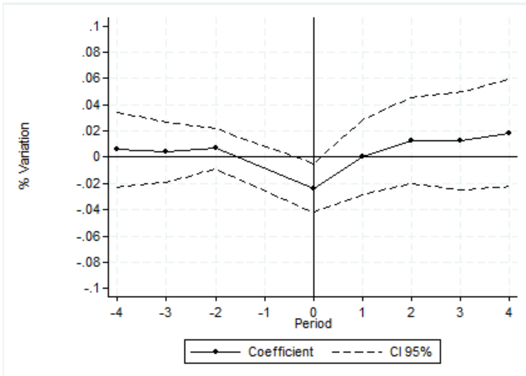
(e) Total sales



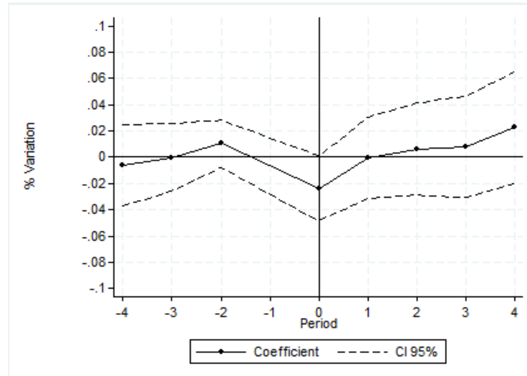
(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

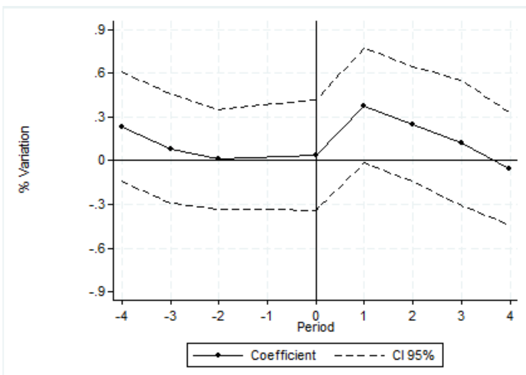
Figure 8.4: Results for positively exposed plants, second specification



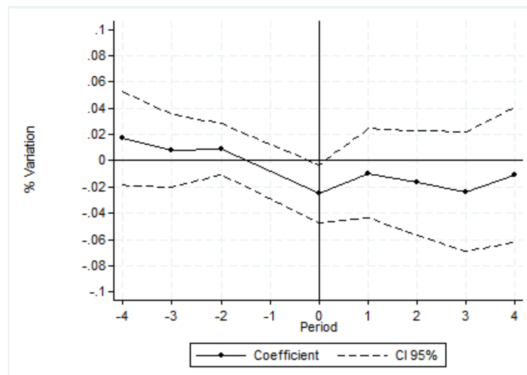
(a) Number of workers



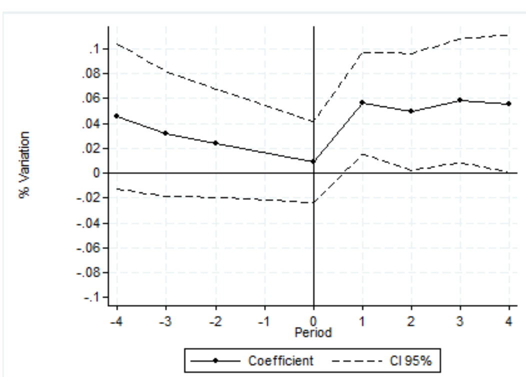
(b) Total hours worked



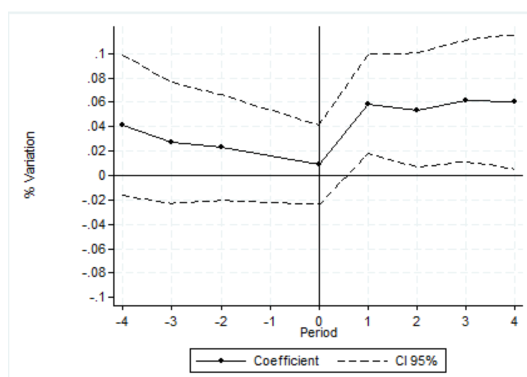
(c) Total investment



(d) Total remunerations



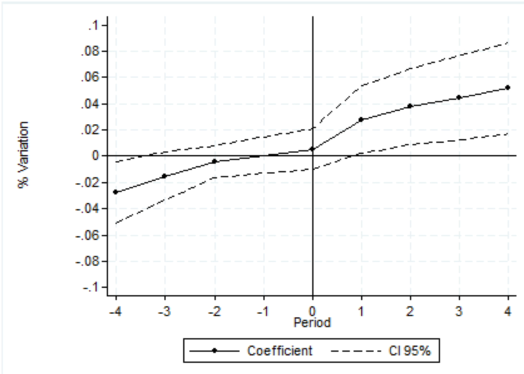
(e) Total sales



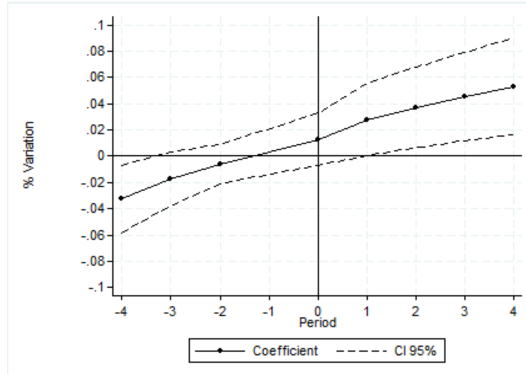
(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

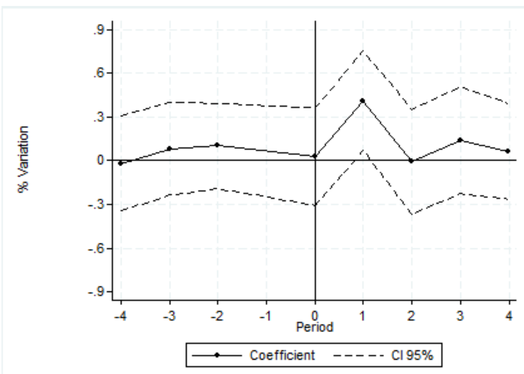
Figure 8.5: Results for negatively exposed plants, first specification



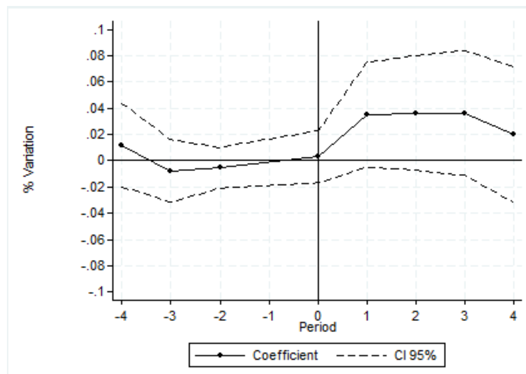
(a) Number of workers



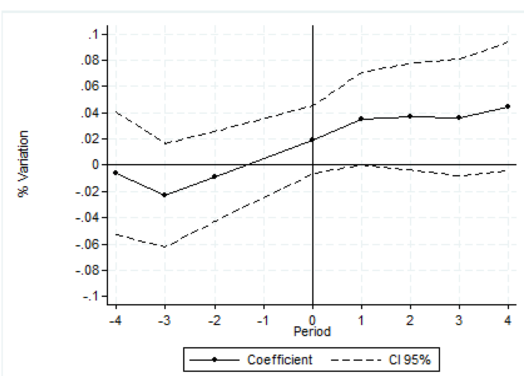
(b) Total hours worked



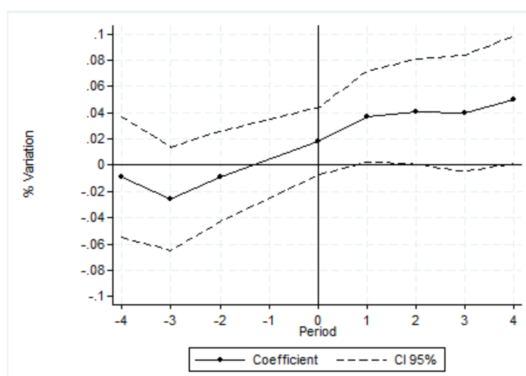
(c) Total investment



(d) Total remunerations



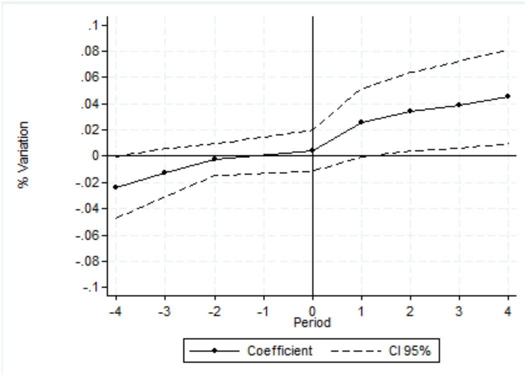
(e) Total sales



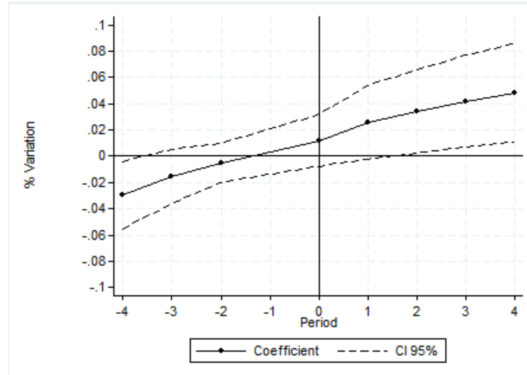
(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

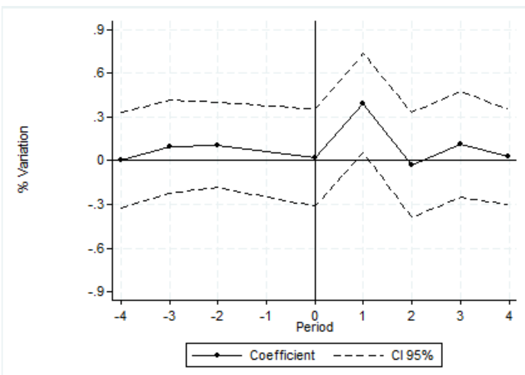
Figure 8.6: Results for negatively exposed plants, second specification



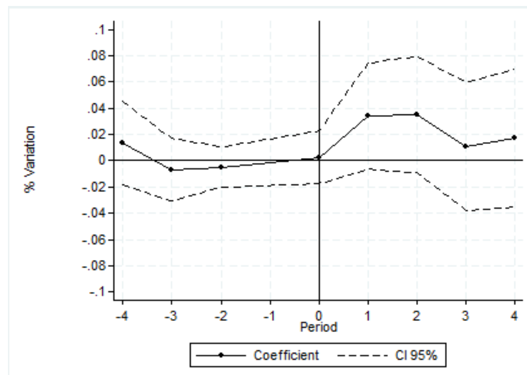
(a) Number of workers



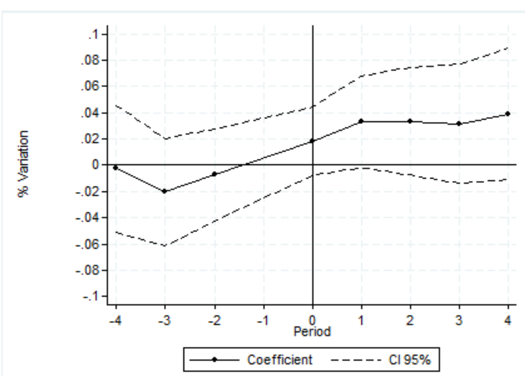
(b) Total hours worked



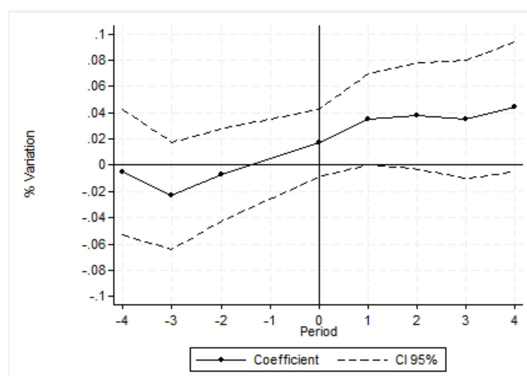
(c) Total investment



(d) Total remunerations



(e) Total sales



(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

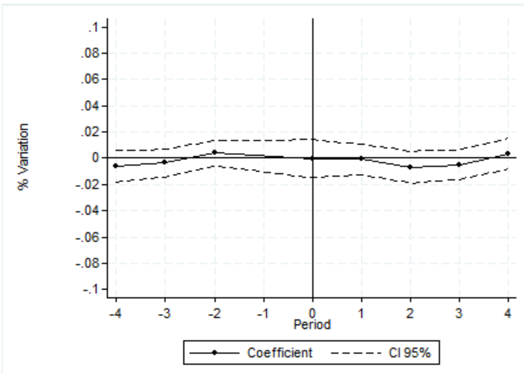
Positively exposed plants do not alter their factor demands after the shock (albeit the increase in total investment in the year following the shock is almost significant)with respect to the levels showed before the shock. Nor they increase the remunerations to labour. However, as expected, they face an increase in their total sales and in their total revenues, being that increase of about 4-4.5% with respect to the levels of the year before the shock. The fact that this increase in revenues is not translated into an increase in labour or capital demand, suggest that the profits derived from the production in each one of the positively exposed plants increased after the occurrence of a deprecation. However, the almost significant estimate for the investment demand suggest that at least some plants decide to perform expansions on their productive capacity with the increased revenues.

On the other hand, negatively exposed plants show a barely significant increase in their total sales and in their total revenue in the first two years after the shock with respect to the values before the shock. The point value of the estimate is of 4%, which is very similar to the effect observed in the positively exposed plants. This is accompanied with a one time increase in their investment expenditure in the year following the exchange rate shock. The point value of the increase is of around 30%, which is very similar to the value observed in the total sample. This suggest that in the face of a depreciation, plants opt to increase their capital demand even when the depreciation may tighten their balance sheets. This would imply that the revenue effect of the depreciation is larger than the cost increase to which is associated, even for the case of plants that have a larger exposure in the costs side of their balance sheet than in the revenue side of it. Also, the fact that the increase in the investment expenditure is a one time increase, suggest that plants are probably facing fixed adjustment costs, such that they adjust their capital demand only in the face of large real exchange rate shocks and with the expectation of not reversing the investment in a near future.

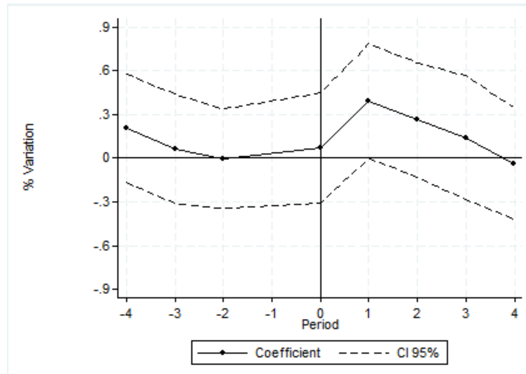
With respect to the labour demand, the results show an increase after the exchange rate shock. However, the fact that the estimates suggest a positive trend occurring before the shock and that the value of the estimate corresponding to the fourth year before the shock is statistically significant suggest that negatively exposed plants were behaving differently before the shock, and thus the effect of the shock is not identified for labour demand.

To discount this possible bias in the estimations on the behaviour of sales, labour demand in the intensive margin, revenues and capital demand, I estimate equations 3 and 4 for per worker variables. For the positively exposed plants, results are presented in figures 8.7 and 8.8. For negatively exposed plants results are presented in 8.9 and 8.10.

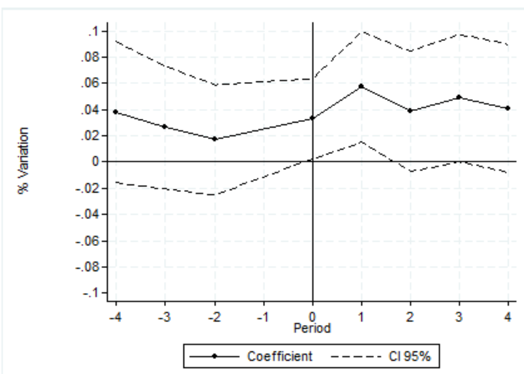
Figure 8.7: Results for positively exposed plants per worker, first specification



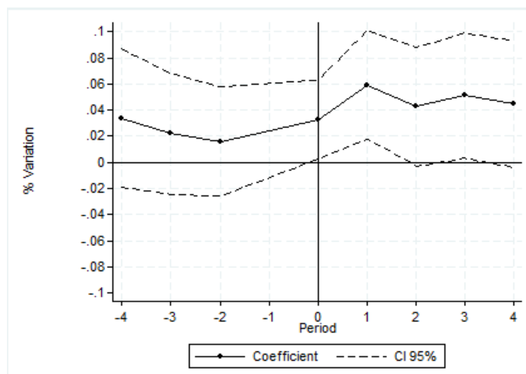
(a) Hours worked per worker.



(b) Investment per worker.



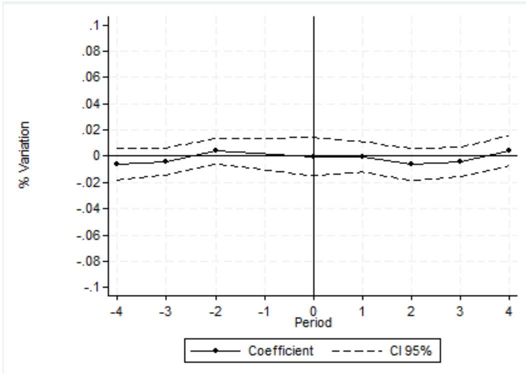
(c) sales per worker.



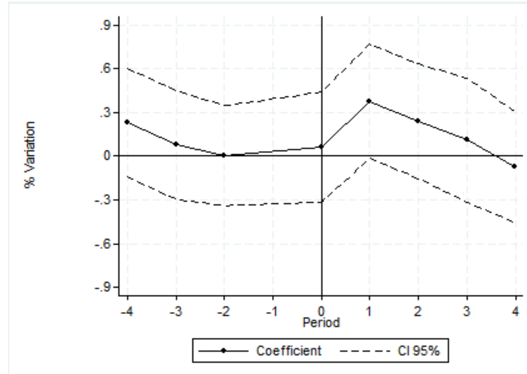
(d) Revenues per worker.

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

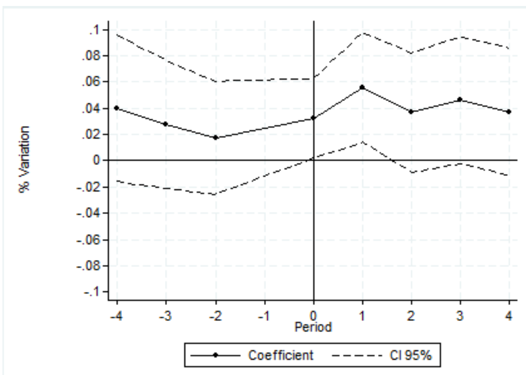
Figure 8.8: Results for positively exposed plants per worker, second specification



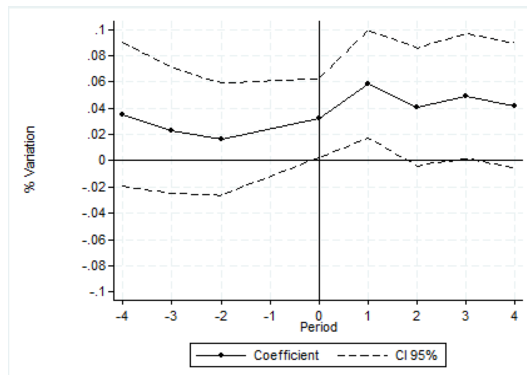
(a) Hours worked per worker



(b) Investment per worker



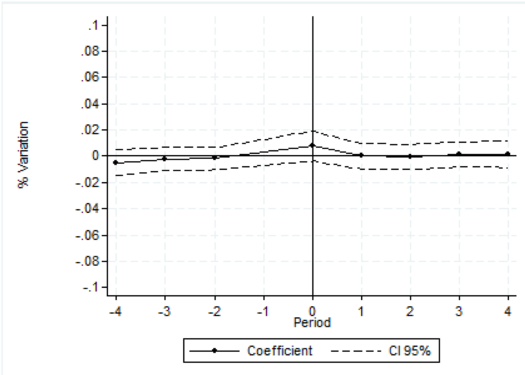
(c) Sales per worker



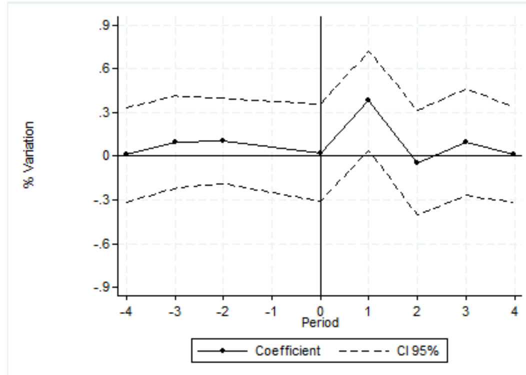
(d) Revenues per worker

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

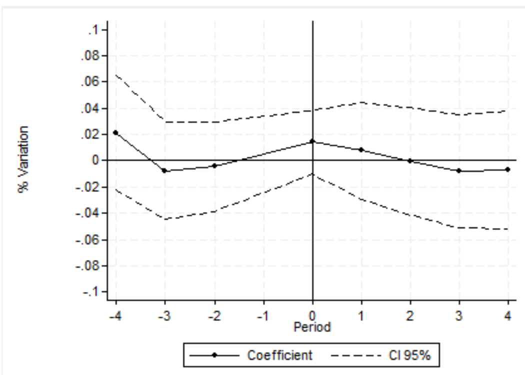
Figure 8.9: Results for negatively exposed plants per worker, first specification



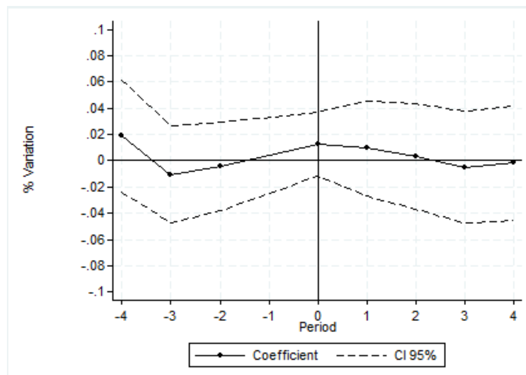
(a) Hours worked per worker



(b) Investment per worker



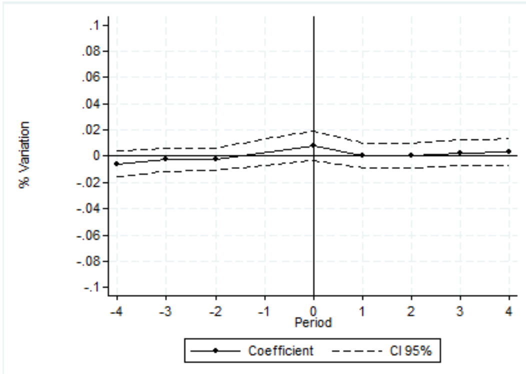
(c) Sales per worker



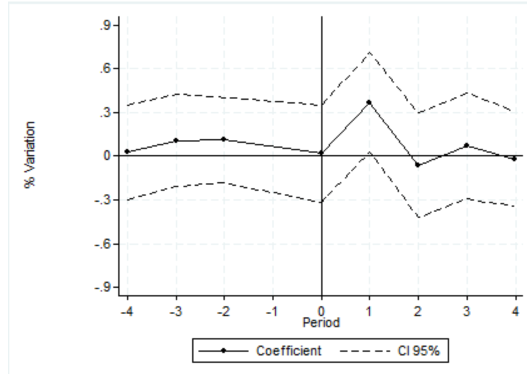
(d) Revenues per worker

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

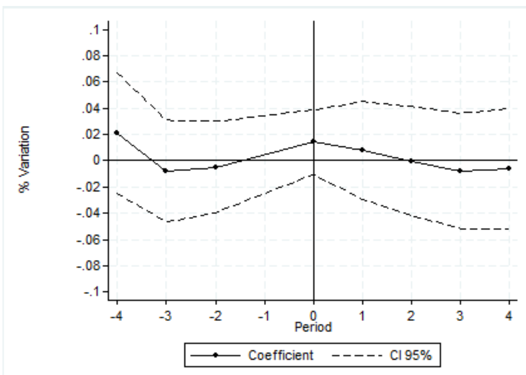
Figure 8.10: Results for negatively exposed plants per worker, second specification



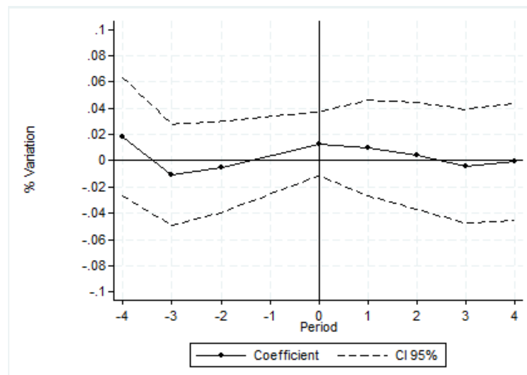
(a) Hours worked per worker



(b) Investment per worker



(c) Sales per worker



(d) Revenues per worker

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

Positively exposed plants show an increase of around 4% in their per capita sales and revenues for the first year after the shock with respect to the year before the shock, the effect disappearing in the following periods. There is no effect on the number of hours worked by employee, suggesting that plants do not increase their labour demand in the margin. They also show an almost significant increase in their investment expenditure in the first year after the shock. This confirms the idea that plants that in theory are benefited the most from the depreciation are in fact benefited, but they do not respond with a substantial increase in their capital demand nor in their demand for labour in the intensive margin.

On the other hand, plants that are negatively exposed do not show an increase in their sales per worker nor in their revenue per worker, but they show a barely significant increase in their investment expenditure per worker in the year after the shock and no increase in the number of hours worked by employee. This behaviour goes against what is expected of establishments that are facing a negative exposition to the exchange rate, since it would be expected that plants increase their demand of the domestically available input and not the demand for the input that is more probable to be imported. A possibility that may explain this results is that negatively exposed plants shift their investment demand towards locally produced goods, but more research is required in order to elucidate the reasons behind this behaviour.

It is possible that different factor intensities may modify the behaviour of the plants in the face of an exchange rate shock. A clear difficulty to asses this hypothesis is that in order to do so, it is necessary to first estimate a production function for each plant, in order to have estimates of their factor intensity and their substitution coefficients. Although this is beyond the scope of this paper, a possible criteria to determine if a plant is capital intensive or labour intensive is using the distribution of the capital-output ratio or of the labour-output ratio and considering plants in the upper mid of those distributions as capital or labour intensive.

A problem with this strategy is that the dataset does not provides with a measure of total output by each plant, so as a proxy I use the distribution of the capital stock-sales ratio and the remunerations-sales ratio. I consider a plant capital (labour) intensive if the ratio between total capital stock (total labour remunerations) and total sales in year 2000 is above the median of the distribution, in which case the capital intensiveness (labour intensiveness) indicator variable takes a value equal to one, and zero if the value is equal or below the median.

With these new variables I estimate modified versions of equations 3 and 4 for capital intensive establishments and labour intensive establishments separately. The modified versions for capital intensive plants are the following.

$$y_{it} = \alpha + expo_i + kintensive_i + \sum_{t=-3}^{t=3} D^z_{it} + \sum_{t=-3}^{t=3} D^z_{it} \times expo_i \times kintensive_i + \gamma_s + \lambda_{ind} + \beta_0 US\,ind_t + \epsilon_{it} \quad (5)$$

$$y_{it} = \alpha + expo_i + kintensive_i + \sum_{t=-3}^{t=3} D^z_{it} + \sum_{t=-3}^{t=3} D^z_{it} \times expo_i \times kintensive_i + \gamma_s + \lambda_{ind} + \beta_0 US\,ind_t + \sum_{s=1}^{s=32} I_s \times T + \epsilon_{it} \quad (6)$$

Where *kintensive* is the indicator variable for capital intensive plants. The coefficients of interests are the ones associated to the interactions between the time indicator variables, the exposed indicator variables and the capital intensive indicator variables. This implies that the effect of a depreciation is identified for the capital intensive exposed plants.

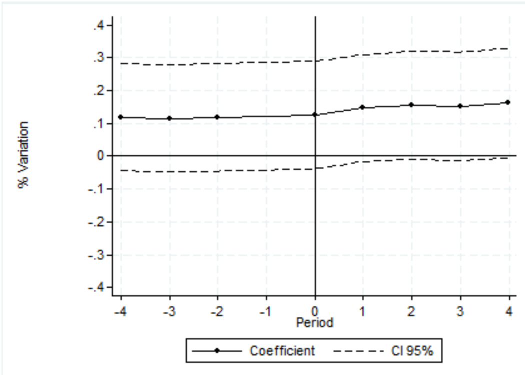
$$y_{it} = \alpha + expo_i + lintensive_i + \sum_{t=-3}^{t=3} D^z_{it} + \sum_{t=-3}^{t=3} D^z_{it} \times expo_i \times lintensive_i + \gamma_s + \lambda_{ind} + \beta_0 US\,ind_t + \epsilon_{it} \quad (7)$$

$$y_{it} = \alpha + expo_i + lintensive_i + \sum_{t=-3}^{t=3} D^z_{it} + \sum_{t=-3}^{t=3} D^z_{it} \times expo_i \times lintensive_i + \gamma_s + \lambda_{ind} + \beta_0 US\,ind_t + \sum_{s=1}^{s=32} I_s \times T + \epsilon_{it} \quad (8)$$

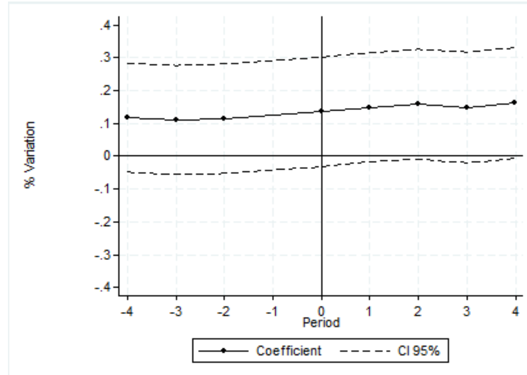
Where *lintensive* is the indicator variable for labour intensive plants. The coefficients of interests are the ones associated to the interactions between the time indicator variables, the exposed indicator variables and the labour intensive indicator variables. This implies that the effect of a depreciation is identified for the labour intensive exposed plants.

Due to considerations of space, I present only the result for equations 5 and 7, the regression tables for equations 6 and 8 are presented in appendix C.

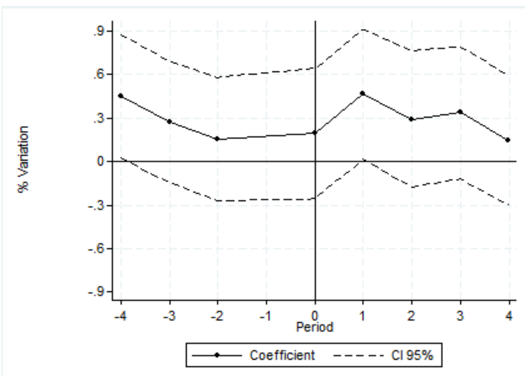
Figure 8.11: Results for capital intensive exposed plants, first specification



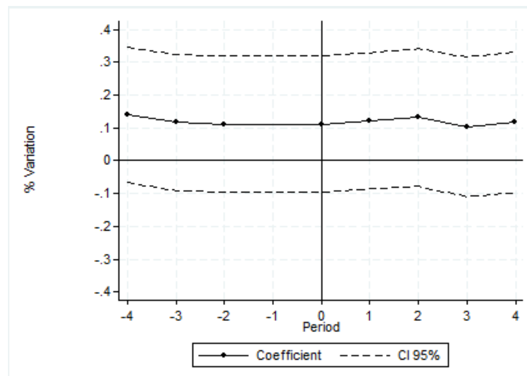
(a) Number of workers



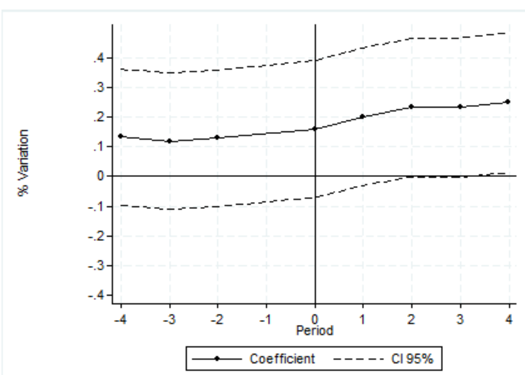
(b) Total hours worked



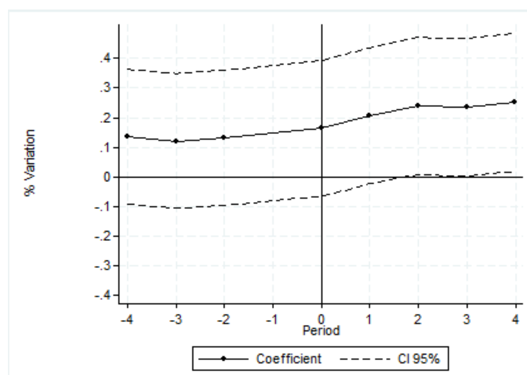
(c) Total investment



(d) Total remunerations



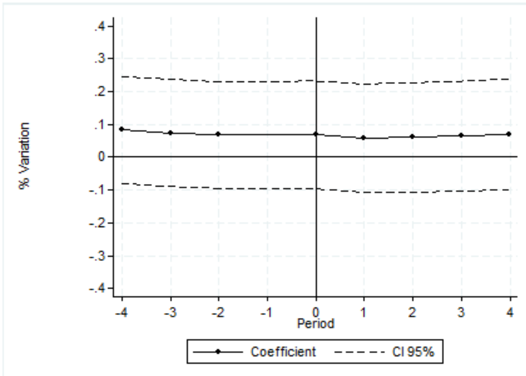
(e) Total sales



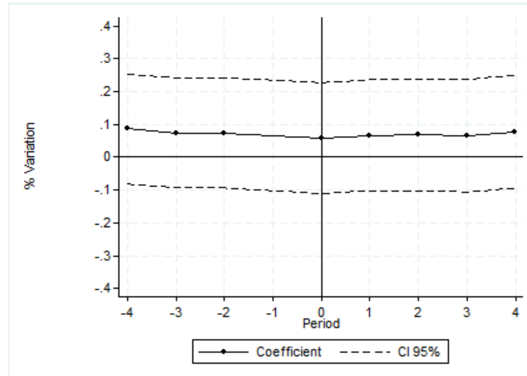
(f) Total revenues

Notes: Different panels show different dependent variables. Establishments were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -3 and 3, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

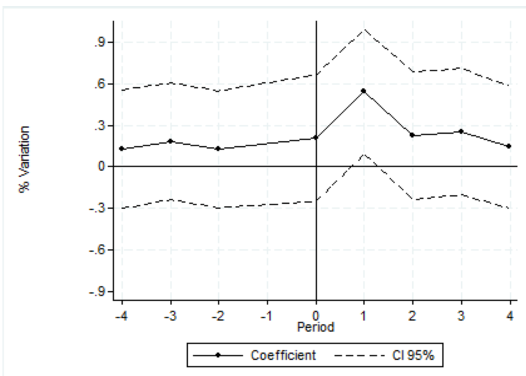
Figure 8.12: Results for labour intensive exposed plants, first specification



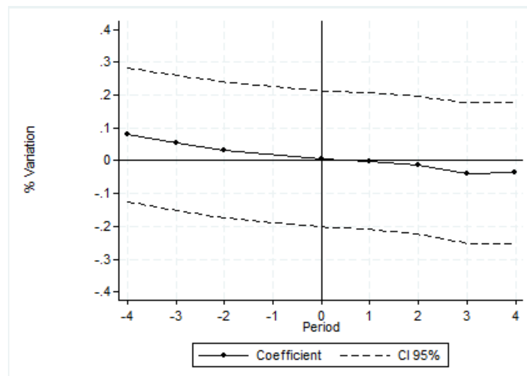
(a) Number of workers



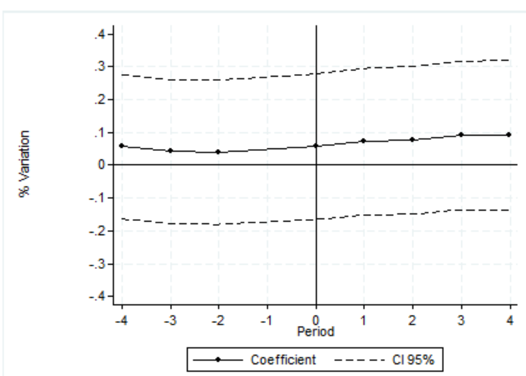
(b) Total hours worked



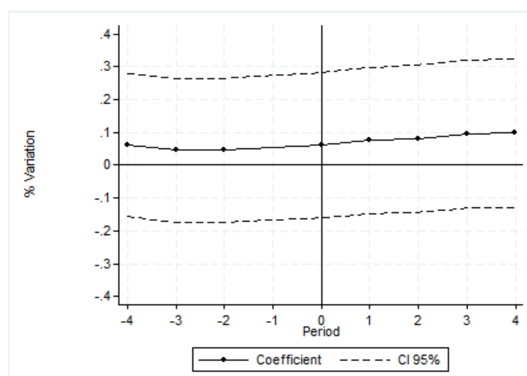
(c) Total investment



(d) Total remunerations



(e) Total sales



(f) Total revenues

Notes: Different panels show different dependent variables. Plants were considered exposed if the net exposure measure was above the median and non exposed if plant's net exposure measure was below the median. The solid line represents the coefficients of dummy variables for each year before and after treatment in an event study analysis as in specification 2. All treatment periods before and after period -3 and 3, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to period T-1. Regressions include industry fixed effects, state linear time trends and control for the industrial production in the US. Standard errors are clustered at plant level. Dashed lines represent 95 percent confidence intervals. Outcome variables in natural logarithms.

The capital intensive exposed plants present a barely significant increase in their total sales and their total revenue in the second year after the depreciation with respect to the values before the shock. Although the point estimate is of around 20%, the wide confidence intervals suggest that is estimated very imprecisely. With respect to the estimates on their factor demands, the coefficients are barely not statistically different from zero, although their behaviour suggest that plants increase their demand for both factors, instead of substituting one for another. Again, the wide confidence intervals suggest a very imprecise estimation.

In the case of labour intensive exposed plants, they do not present a change in their revenues nor in their sales with respect to the levels before the shock. They also do not adjust their labour demand. However, the results for investment suggest that in the face of the shock, labour intensive plants increase their demand for capital goods in the year after the occurrence of the depreciation. This suggest that these plants are not substituting labour with capital, but that they are increasing their capital independently of their labour demand. As before, these coefficients are estimated very imprecisely.

I is necessary to stress that this estimates are a very rough approximation to estimating the effects of different technologies on the response of a plant to a exchange rate shock and point out to the necessity of more investigation on the production functions of Mexican manufacturing plants.

9. Conclusions

In this paper the effects of a real exchange rate depreciation on the factor demand of manufacturing plants are estimated using the event study methodology, taking advantage of the fact that for the individual plant the variations in the exchange rate are exogenous. The results indicate that after a large real exchange rate depreciation firms increase their investment expenditures in about 40% with respect to the level presented before the shock. This change is a one time increase and not an accumulated change over several years, suggesting the presence of adjustment costs in the demand for capital. This results are consistent with the results observed in the macro literature for the Mexican case, in which a depreciated real exchange rate is associated with larger levels of investment (Ibarra (2015),Ibarra (2010) and Ros (2015)).

With respect to labour demand the results are less clear. For positively exposed plants there is no effect while for negatively exposed plants the effect is not as clearly identified as in the case of capital demand, although the evidence suggest that at least some firms react increasing their labour demand.

It is important to point out that due to the use of a balanced panel, the present study does not analyses the effects of variations in the number of participants in each sector of the Mexican manufacturing sector on plant factor demand. Taking into account these effects is a venue for future research. Another possible extension is to analyse with more detail how the technology of production of each plants mediates in the effect of the exchange rate shocks on the factor demand by each plant.

10. References

Allen, R. G. D. (1938). *Mathematical analysis for economists*. Macmillan London.

Amiti, M., Itskhoki, O., and Konings, J. (2014). Importers, exporters, and exchange rate disconnect. *American Economic Review*, 104(7):1942–1978.

Autor, D. H., Donohue III, J. J., and Schwab, S. J. (2006). The costs of wrongful-discharge laws. *The Review of Economics and Statistics*, 88(2):211–231.

Bebczuk, R., Galindo, A., and Panizza, U. (2006). An evaluation of the contractionary devaluation hypothesis. Technical report, Working paper//Inter-American Development Bank, Research Department.

Berg, A. and Miao, Y. (2010). The real exchange rate and growth revisited: The Washington Consensus strikes back? *IMF Working Papers*, 2010(58):1–24.

Berman, N., Martin, P., and Mayer, T. (2012). How do different exporters react to exchange rate changes? *The Quarterly Journal of Economics*, 127(1):437–492.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How much should we trust differences-in-differences estimates? *The Quarterly Journal of Economics*, 119(1):249–275.

Bosch, M. and Campos-Vazquez, R. M. (2014). The trade-offs of welfare policies in labor markets with informal jobs: the case of the "Seguro Popular" program in Mexico. *American Economic Journal: Economic Policy*, 6(4):71–99.

Burgess, S. M. and Knetter, M. M. (1998). An international comparison of employment adjustment to exchange rate fluctuations. *Review of International Economics*, 6(1):151–163.

Caballero, R. J. (1999). Aggregate investment. *Handbook of macroeconomics*, 1:813–862.

Caballero, R. J., Engel, E. M., and Haltiwanger, J. C. (1995). Plant-level adjustment and aggregate investment dynamics. *Brookings Papers on Economic Activity*, 26(2):1–54.

Campa, J. and Goldberg, L. S. (1995). Investment in manufacturing, exchange rates and external exposure. *Journal of International Economics*, 38(3):297–320.

Campa, J. M. and Goldberg, L. S. (1999). Investment, pass-through, and exchange rates: a cross-country comparison. *International Economic Review*, 40(2):287–314.

Couharde, C. and Sallenave, A. (2013). How do currency misalignments' threshold affect economic growth? *Journal of Macroeconomics*, 36:106–120.

Demir, F. (2010). Exchange rate volatility and employment growth in developing countries: Evidence from Turkey. *World Development*, 38(8):1127–1140.

Doms, M. and Dunne, T. (1998). Capital adjustment patterns in manufacturing plants. *Review of Economic Dynamics*, 1(2):409–429.

Dube, A., Lester, T. W., Reich, M., et al. (2010). Minimum wage effects across state borders: Estimates using contiguous counties. *The Review of Economics and Statistics*, 92(4):945–964.

Eichengreen, B. (2007). The real exchange rate and economic growth. *Social and Economic Studies*, 56(4):7–20.

Ekholm, K., Moxnes, A., and Ulltveit-Moe, K. H. (2012). Manufacturing restructuring and the role of real exchange rate shocks. *Journal of International Economics*, 86(1):101–117.

Frenkel, R. and Ros, J. (2006). Unemployment and the real exchange rate in Latin America. *World Development*, 34(4):631–646.

Fuentes, M. and Ibarrarán, P. (2012). Firm dynamics and real exchange rate fluctuations: Does trade openness matter? evidence from Mexico's manufacturing sector. *The Journal of International Trade & Economic Development*, 21(3):409–469.

Galindo, A., Izquierdo, A., and Montero, J. M. (2007). Real exchange rates, dollarization and industrial employment in Latin America. *Emerging Markets Review*, 8(4):284–298.

Gourinchas, P.-O. (1999). Exchange rates do matter: French job reallocation and exchange rate turbulence, 1984–1992. *European Economic Review*, 43(7):1279–1316.

Hamermesh, D. S. (1989). Labor demand and the structure of adjustment costs. *American Economic Review*, 79(4):674–89.

Hamermesh, D. S. (1990). Aggregate employment dynamics and lumpy adjustment costs. *Carnegie-Rochester Conference Series on Public Policy*, 33:93–129.

Hamermesh, D. S. (1995). Labour demand and the source of adjustment costs. *The Economic Journal*, 105(430):620–634.

Hamermesh, D. S. and Pfann, G. A. (1996). Adjustment costs in factor demand. *Journal of Economic Literature*, 34(3):1264–1292.

Hua, P. (2007). Real exchange rate and manufacturing employment in China. *China Economic Review*, 18(3):335–353.

Ibarra, C. A. (2010). Exporting without growing: investment, real currency appreciation, and export-led growth in Mexico. *The Journal of International Trade & Economic Development*, 19(3):439–464.

Ibarra, C. A. (2015). Investment and the real exchange rate's profitability channel in Mexico. *International Review of Applied Economics*, 29(5):716–739.

Jacobson, L. S., LaLonde, R., and Sullivan, D. (1993). Earnings losses of displaced workers. *American Economic Review*, 83(4):685–709.

Kandilov, I. T. and Leblebicioğlu, A. (2011). The impact of exchange rate volatility on plant-level investment: Evidence from Colombia. *Journal of Development Economics*, 94(2):220–230.

Krugman, P. and Taylor, L. (1978). Contractionary effects of devaluation. *Journal of International Economics*, 8(3):445–456.

Landon, S. and Smith, C. E. (2009). Investment and the exchange rate: Short run and long run aggregate and sector-level estimates. *Journal of International Money and Finance*, 28(5):813–835.

Lizondo, J. S. and Montiel, P. J. (1989). Contractionary devaluation in developing countries: an analytical overview. *Staff Papers*, 36(1):182–227.

Missio, F. J., Jayme, F. G., Britto, G., and Luis Oreiro, J. (2015). Real exchange rate and economic growth: New empirical evidence. *Metroeconomica*, 66(4):686–714.

Montiel, P. J. (2011). *Macroeconomics in emerging markets*. Cambridge University Press.

Nucci, F. and Pozzolo, A. F. (2001). Investment and the exchange rate: An analysis with firm-level panel data. *European Economic Review*, 45(2):259–283.

Nucci, F. and Pozzolo, A. F. (2010). The exchange rate, employment and hours: What firm-level data say. *Journal of International Economics*, 82(2):112–123.

Obstfeld, M. and Rogoff, K. S. (1996). *Foundations of International Macroeconomics*. The MIT Press.

Pindyck, R. S. (1988). Irreversible investment, capacity choice, and the value of the firm. *American Economic Review*, 78(5):969–85.

Rapetti, M. (2013). The Real Exchange Rate and Economic Growth: Some Observations on the Possible Channels. UMASS Amherst Economics Working Papers 2013-11, University of Massachusetts Amherst, Department of Economics.

Rapetti, M., Skott, P., and Razmi, A. (2012). The real exchange rate and economic growth: are developing countries different? *International Review of Applied Economics*, 26(6):735–753.

Razmi, A., Rapetti, M., and Skott, P. (2012). The real exchange rate and economic development. *Structural Change and Economic Dynamics*, 23(2):151–169.

Rodrik, D. (2008). The real exchange rate and economic growth. *Brookings Papers on Economic Activity*, 2008(2):365–412.

Ros, J. (2015). The real exchange rate, the real wage, and growth: A formal analysis of the "development channel". In *Development Macroeconomics in Latin America and Mexico*, pages 55–75. Springer.

Tracy, J., Goldberg, L., and Aaronson, S. (1999). Exchange rates and employment instability: Evidence from matched cps data. *American Economic Review*, 89(2):204–210.

Tybout, J. R. (2000). Manufacturing firms in developing countries: How well do they do, and why? *Journal of Economic Literature*, 38(1):11–44.

Tybout, J. R. (2001). Plant-and firm-level evidence on" new" trade theories. Technical report, National Bureau of Economic Research.

Vaz, P. H. and Baer, W. (2014). Real exchange rate and manufacturing growth in Latin America. *Latin American Economic Review*, 23(1):1–17.

Végh, C. A. (2013). *Open Economy Macroeconomics in Developing Countries*. The MIT Press.

Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the Mexican manufacturing sector*. *The Quarterly Journal of Economics*, 123(2):489–530.

A. Derivation of price elasticities

Following Allen (1938) it is known that for a linear homogenous productin funcion of the type $y = f(l,k)$, we have

$$f_{KK} = -\frac{l}{k} f_{kl} \quad and \quad f_{ll} = -\frac{k}{l} f_{kl} \tag{A.1}$$

And that the elasticity of substitution between factors is given by $\sigma = \frac{f_k f_l}{y f_{kl}}$. Thus, we have:

$$f_{KK} = -\frac{l}{K} \frac{f_k f_l}{y f_{kl}} \quad and \quad f_{ll} = -\frac{k}{l} \frac{f_k f_l}{y f_{kl}} \tag{A.2}$$

From the optimization problem of the producer we know that $f(k,l) = \phi(p_y)$, $pf_k = p_k$ and that $pf_l = p_l$. Deriving each one of these results with respect to the p_k gives the following three equations:

$$\frac{\partial f(k,l)}{\partial p_k} = f_k \frac{\partial k}{\partial p_k} + f_l \frac{\partial l}{\partial p_k} = \phi'(p) \frac{\partial p}{\partial p_k} = -\eta \frac{y}{p} \frac{\partial p}{\partial p_k} \tag{A.3}$$

Where $\eta = -\frac{p}{y} \frac{\mathrm{d}y}{\mathrm{d}p}$.

$$1 = f_k \frac{\partial p}{\partial p_k} + p \left(f_{kk} \frac{\partial k}{\partial p_k} + f_{kl} \frac{\partial l}{\partial p_k} \right) \tag{A.4}$$

$$0 = f_l \frac{\partial p}{\partial p_k} + p \left(f_{kl} \frac{\partial k}{\partial p_k} + f_{ll} \frac{\partial l}{\partial p_k} \right) \tag{A.5}$$

Doing some algebra and using $pf_l = p_l$, $pf_k = p_k$ and $f_{kl} = \frac{f_k f_l}{y\sigma}$ we arrive to the following system of equations.

$$y\eta\frac{\partial p}{\partial p_k} + p_k\frac{\partial k}{\partial p_k} + p_l\frac{\partial l}{\partial p_k} = 0 \tag{A.6}$$

$$y\sigma\frac{\partial p}{\partial p_k} - \frac{l}{k}p_l\frac{\partial k}{\partial p_k} + p_l\frac{\partial l}{\partial p_k} = \frac{yp}{p_k}\sigma \tag{A.7}$$

$$y\sigma\frac{\partial p}{\partial p_k} - \frac{k}{l}p_k\frac{\partial l}{\partial p_k} + p_k\frac{\partial k}{\partial p_k} = 0 \tag{A.8}$$

Solving the system we arrive to the following expressions:

$$\frac{\partial k}{\partial p_k} = -\frac{k}{p_k}\left(\frac{kp_k}{yp}\eta + \frac{lp_l}{yp}\sigma\right) \tag{A.9}$$

$$\frac{\partial l}{\partial p_k} = -\frac{k}{yp}\left(\eta - \sigma\right) \tag{A.10}$$

Multiplying both sides of equation A.9 by $\frac{p_k}{k}$ and both sides of equation A.10 by $\frac{p_k}{l}$ we arrive to the equations corresponding to the price elasticities of both factor demands.

$$\varepsilon_{K,p_K} = -\left(\frac{p_K K}{p_Y Y}\eta + \frac{p_L L}{p_Y Y}\sigma\right) = -\left(s_K\eta + s_L\sigma\right) \tag{A.11}$$

$$\varepsilon_{L,p_K}) = \frac{p_K K}{p_Y Y}\left(\sigma - \eta\right) = s_K\left(\sigma - \eta\right) \tag{A.12}$$

B. Data processing

The data used in the present study comes from a subsample of plants from the Encuesta Industrial Anual (1993-2003), the Encuesta Industrial Anual (2003-2009) and the Encuesta Anual de la Industria Manufacturera (2008-2014). All the surveys share a deterministic sampling design, thus allowing to follow a subset of plants through all the period from 1994 to 2014. The main difference between the different surveys is that the Mexican statistics office (INEGI) changed in 2001 and 2009 the industrial classification used, due to the adoption of the North American Industrial Classification System (NAICS) at the end of the nineties and the update of the NAICS at the end of the first decade of the XXIst century. The subsample consist of all the establishments that is possible to follow from 1994 to 2014, and was provided by INEGI to the author of the text.

The cleaning procedure for the data was very similar to the one used by Verhoogen (2008) and is the following:

1 I eliminated plants that report their data on another plants information, being them plants with only zeros in their registries.

2 I eliminated plants that subcontract all of their labour force.

3 Although by sampling design there should not be any *maquiladoras* in the sample, it is possible that some of them were included by mistake. To eliminate them I used to criteria. I eliminated plants that either:

   a Derive 95% or more of its sales from exports.

   b Derive 95% or more of its total revenue from subcontracting services which are not reported as sales

4 I set to missing the values of the dependent variables that changed by more than a factor of five.

5 I imputed values using the sequential regression multivariate imputation technique implement by Verhoogen (2008). The steps were the following:

a I classified variables into 3 groups:

Group 1: Total employment, total hours, total remuneration, total sales.

Group 2: Material cost, electricity cost, revenues, capital stock.

Group 3: Investment in machinery and equipment, investment in land and buildings, investment in transportation equipment and other assets.

b For Group 1: I regressed each variable (in the order given) on the other variables i nthe group, a lead and a lag of the same variable, and year dummies, using the plants that remained in the sample after the steps above (All variables in logs, deflated by the 2012:06 National Index of Producer Prices). The predicted values from this regression were imputed for the missing values.

c For Group 2: I regressed each variable on the other variables of group 1-2, a lead and a lag of the same variable, and a year dummies, and imputed with the predicted values.

d For variables in group 3 a different procedure was followed. For each of the investment variables I first imputed if investment was zero or positive, estimating a probit on Group 1-2 variables and then drawing randomly from a Bernoulli distribution with probability of success equal to the predicted probability of the probit. For each investment variable I then took predicted values from a regression of investment on the variables of groups 1-2 to replace the missing values.

6 I checked again the imputed values from the previous steps to identify if there where values that changed by more than a factor of five. If so, I set them again to missing.

7 I removed the establishment that were missing data on the dependent variables after the previous steps were performed. The final sample consists of 1,422 plants with observations for all the years from 2000 to 2014

C. Regression Tables

Table C.1: Results for the first specification, full sample

	Total workers	Total investment	Total hours worked	Total sales	Total revenues	Total remunerations
4 years before shock	-0.0227**	0.0707	-0.0268**	-0.0109	-0.0143	0.0085
	[0.0105]	[0.1409]	[0.0114]	[0.0192]	[0.0189]	[0.0138]
3 years before shock	-0.0129	0.1168	-0.0161	-0.0191	-0.0226	-0.0029
	[0.0082]	[0.1398]	[0.0093]	[0.0163]	[0.0162]	[0.0105]
2 years before shock	-0.0043	0.1117	-0.0060	-0.0114	-0.0119	-0.0038
	[0.0055]	[0.1284]	[0.0066]	[0.0139]	[0.0138]	[0.0070]
Occurence of shock	0.002	-0.0498	0.0077	0.0168	0.0156	-0.0014
	[0.0067]	[0.1434]	[0.0085]	[0.0111]	[0.0111]	[0.0084]
1 year after the shock	0.0220**	0.4311***	0.0216	0.0427**	0.0422***	0.0324
	[0.0109]	[0.1486]	[0.0188]	[0.0148]	[0.0147]	[0.0163]
2 years after the shock	0.0305**	0.1549	0.0330**	0.0484**	0.0494***	0.0316
	[0.0124]	[0.1550]	[0.0132]	[0.0174]	[0.0172]	[0.0181]
3 years after the shock	0.0359**	0.1249	0.0370**	0.0543**	0.0543***	0.0125
	[0.0139]	[0.1603]	[0.0146]	[0.0191]	[0.0189]	[0.0201]
4 years after the shock	0.0435**	0.1452	0.0454**	0.0568***	0.0586***	0.0158
	[0.0152]	[0.1435]	[0.0160]	[0.0210]	[0.0208]	[0.0219]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.2: Results for the second specification, full sample

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years before	-0204**	0.0678	-0.0252**	-0.0089	-0.0126	0.0087
shock	[0.0105]	[0.1414]	[0.0114]	[0.0195]	[0.0193]	[0.0183]
3 years before	-0.0113	0.1149	-0.0149	-0.0178	-0.0214	-0.0028
shock	[0.0083]	[0.1400]	[0.0093]	[0.0166]	[0.0165]	[0.0105]
2 years before	-0.0035	0.1107	-0.0054	-0.0107	-0.0113	-0.0038
shock	[0.0055]	[0.1285]	[0.0066]	[0.0140]	[0.0140]	[0.0070]
Occurence of	0.0012	-0.0488	0.0071	0.0162	0.0150	-0.0015
shock	[0.0067]	[0.1433]	[0.0085]	[0.0111]	[0.0110]	[0.0084]
1 year after	0.0205	0.4329***	0.0204	0.0414**	0.0410***	0.0323
the shock	[0.0109]	[0.1483]	[0.0118]	[0.0146]	[0.0145]	[0.0163]
2 years after	0.0282**	0.1578	0.0313**	0.0465**	0.0476**	0.0314
the shock	[0.0125]	[0.1547]	[0.0133]	[0.0172]	[0.0171]	[0.0181]
3 years after	0.0328**	0.1287	0.0348**	0.0517**	0.0520**	0.0123
the shock	[0.0141]	[0.1597]	[0.0148]	[0.0189]	[0.0188]	[0.0202]
4 years after	0.0396**	0.1500	0.0426**	0.0535**	0.0557**	0.0207
the shock	[0.0154]	[0.1428]	[0.0162]	[0.0209]	[0.0207]	[0.0156]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.3: Results for the first specification, positively exposed plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years before shock	-0204**	0.0678	-0.0252**	-0.0089	-0.0126	0.0087
	[0.0105]	[0.1414]	[0.0114]	[0.0195]	[0.0193]	[0.0183]
3 years before shock	-0.0113	0.1149	-0.0149	-0.0178	-0.0214	-0.0028
	[0.0083]	[0.1400]	[0.0093]	[0.0166]	[0.0165]	[0.0105]
2 years before shock	-0.0035	0.1107	-0.0054	-0.0107	-0.0113	-0.0038
	[0.0055]	[0.1285]	[0.0066]	[0.0140]	[0.0140]	[0.0070]
Occurence of shock	0.0012	-0.0488	0.0071	0.0162	0.0150	-0.0015
	[0.0067]	[0.1433]	[0.0085]	[0.0111]	[0.0110]	[0.0084]
1 year after the shock	0.0205	0.4329***	0.0204	0.0414**	0.0410***	0.0323
	[0.0109]	[0.1483]	[0.0118]	[0.0146]	[0.0145]	[0.0163]
2 years after the shock	0.0282**	0.1578	0.0313**	0.0465**	0.0476**	0.0314
	[0.0125]	[0.1547]	[0.0133]	[0.0172]	[0.0171]	[0.0181]
3 years after the shock	0.0328**	0.1287	0.0348**	0.0517**	0.0520**	0.0123
	[0.0141]	[0.1597]	[0.0148]	[0.0189]	[0.0188]	[0.0202]
4 years after the shock	0.0396**	0.1500	0.0426**	0.0535**	0.0557**	0.0207
	[0.0154]	[0.1428]	[0.0162]	[0.0209]	[0.0207]	[0.0156]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.4: Results for the second specification, positively exposed plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years before	0.0058	0.2338	-0.0006	0.0457	0.0411	0.0169
shock	[0.0145]	[0.1911]	[0.0158]	[0.0297]	[0.0294]	[0.0181]
3 years before	0.0039	0.0835	-0.0002	0.0315	0.0269	0.0076
shock	[0.0117]	[0.1909]	[0.0131]	[0.0256]	[0.0253]	[0.0142]
2 years before	0.0065	0.0098	0.0103	0.0241	0.0229	0.0090
shock	[0.0078]	[0.1744]	[0.0092]	[0.0222]	[0.0221]	[0.0099]
Occurence of	-0.0235**	0.0392	-0.0238*	0.0088	0.0089	-0.0253**
shock	[0.0095]	[0.1927]	[0.0126]	[0.0166]	[0.0166]	[0.0113]
1 year after	0.0002	0.3774*	-0.0003	0.0561**	0.0585**	-0.0095
the shock	[0.0145]	[0.2006]	[0.0158]	[0.0208]	[0.0208]	[0.0173]
2 years after	0.0127	0.2519	0.0062	0.0493**	0.0537**	-0.0169
the shock	[0.0167]	[0.2013]	[0.0178]	[0.0239]	[0.0238]	[0.0203]
3 years after	0.0123	0.1225	0.0080	0.0583**	0.0614**	-0.0235
the shock	[0.0190]	[0.2182]	[0.0198]	[0.0254]	[0.0254]	[0.0232]
4 years after	0.0185	-0553	0.0226	0.0558**	0.0604**	-0.0104
the shock	[0.0208]	[0.1963]	[0.0216]	[0.0282]	[0.0280]	[0.0262]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.5: Results for the first specification, negatively exposed plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years before	-0.0275**	-.0183	-0.0324**	-0.0062	-0.0088	0.0119
shock	[0.0120]	[0.1662]	[0.0131]	[0.0237]	[0.0235]	[0.0162]
3 years before	-0.0152	0.0813	-0.0173	-0.0229	-0.0256	-0.0078
shock	[0.0093]	[0.1620]	[0.0105]	[0.0202]	[0.0201]	[0.0121]
2 years before	-0.0040	0.1005	-0.0059	-0.0087	-0.0086	-0.0053
shock	[0.0062]	[0.1493]	[0.0076]	[0.0175]	[0.0175]	[0.0079]
Occurence	0.0054	0.0288	-0.0130	0.0193	0.0181	0.0030
of shock	[0.0079]	[0.1696]	[0.0101]	[0.0132]	[0.0131]	[0.0101]
1 year after	0.0279**	0.4091**	0.0279	0.0354**	0.0371**	0.0349*
the shock	[0.0131]	[0.1736]	[0.0141]	[0.0179]	[0.0176]	[0.0204]
2 years after	0.0377**	-0.0070	0.0371**	0.0370*	0.0408**	0.0364
the shock	[0.0148]	[0.1834]	[0.0157]	[0.0207]	[0.0204]	[0.0222]
3 years after	0.0444**	0.1396	0.0457**	0.0363*	0.0394*	0.0364
the shock	[0.0164]	[0.1861]	[0.0172]	[0.0228]	[0.0226]	[0.0243]
4 years after	0.0517***	-0.0634	0.0532**	0.0447*	0.0500**	0.0196
the shock	[0.0177]	[0.1675]	[0.0187]	[0.0251]	[0.0248]	[0.0262]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.6: Results for the second specification, negatively exposed plants

	Total workers	Total investment	Total hours worked	Total sales	Total revenues	Total remunerations
4 years before	-0.0236**	0.0037	-0.0296**	-0.0027	-0.0054	0.0133
shock	[0.0120]	[0.1667]	[0.0131]	[0.0247]	[0.0244]	[0.0161]
3 years before	-0.0126	0.0959	-0.0154	-0.0206	-0.0233	-0.0069
shock	[0.0093]	[0.1623]	[0.0105]	[0.0209]	[0.0208]	[0.0121]
2 years before	-0.0027	0.1078	-0.0050	-0.0075	-0.0075	-0.0048
shock	[0.0062]	[0.1495]	[0.0076]	[0.0179]	[0.0179]	[0.0079]
Occurence	0.0041	0.0215	0.0120	0.0182	0.0169	0.0025
of shock	[0.0079]	[0.1695]	[0.0101]	[0.0133]	[0.0132]	[0.0102]
1 year after	0.0253**	0.3945**	0.0260	0.0330*	0.0349*	0.0339*
the shock	[0.0133]	[0.1734]	[0.0143]	[0.0178]	[0.0176]	[0.0206]
2 years after	0.0338**	-0.0290	0.0342**	0.0335*	0.0374*	0.0350*
the shock	[0.0152]	[0.1827]	[0.0162]	[0.0209]	[0.0206]	[0.0226]
3 years after	0.0392**	0.1103	0.0419**	0.0316	0.0349*	0.0108
the shock	[0.0169]	[0.1853]	[0.0178]	[0.0231]	[0.0230]	[0.0248]
4 years after	0.0452**	0.0268	0.0484**	0.0389*	0.0444*	0.0172
the shock	[0.0183]	[0.1664]	[0.0192]	[0.0255]	[0.0252]	[0.0268]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.7: Results for the first specification for positively exposed plants, per worker variables

	Total investment	**Total hours worked**	**Total sales**	**Total revenues**
4 years before	0.02055	-0.0059	0.0379	0.0339
shock	[0.1896]	[0.0061]	[0.0274]	[0.0269]
3 years before	0.0646	-0.0038	0.0263	0.0220
shock	[0.1905]	[0.0053]	[0.0239]	[0.0239]
2 years before	-0.0043	0.0038	0.0168	0.0159
shock	[0.1741]	[0.0049]	[0.0214]	[0.0213]
Occurence of	0.0702	-0.0004	0.0330**	0.0329**
shock	[0.1922]	[0.0074]	[0.0156]	[0.0154]
1 year after	0.3923**	-0.0008	0.0573**	0.0593**
the shock	[0.1998]	[0.0059]	[0.0214]	[0.0211]
2 years after	0.2618	-0.0068	0.0386*	0.0425*
the shock	[0.1997]	[0.0062]	[0.0234]	[0.0231]
3 years after	0.1403	-0.0048	0.0487**	0.0511**
the shock	[0.2165]	[0.0057]	[0.0248]	[0.0245]
4 years after	-0.0362	0.0035	0.0407*	0.0444*
the shock	[0.1945]	[0.0059]	[0.0250]	[0.0246]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.8: Results for the second specification positively exposed plants, per worker variables

	Total investment	**Total hours worked**	**Total sales**	**Total revenues**
4 years	0.2280	-0.0063	0.0399	0.0354
before shock	[0.1896]	[0.0061]	[0.0285]	[0.0280]
3 years	0.0796	-0.0040	0.0276	0.0230
before shock	[0.1904]	[0.0053]	[0.0248]	[0.0244]
2 years	0.0032	0.0037	0.0175	0.0164
before shock	[0.1743]	[0.0049]	[0.0219]	[0.0218]
Occurence	0.0627	-0.0003	0.0323**	0.0324
of shock	[0.1922]	[0.0074]	[0.0155]	[0.0153]
1 year after	0.3772**	-0.0005	0.0559**	0.0583**
the shock	[0.2001]	[0.0059]	[0.0213]	[0.0210]
2 years after	0.2392	-0.0065	0.0366*	0.0410*
the shock	[0.2001]	[0.0062]	[0.0232]	[0.0229]
3 years after	0.1102	-0.0043	0.0460*	0.0492**
the shock	[0.2167]	[0.0057]	[0.0246]	[0.0242]
4 years after	-0.0738	0.0041	0.0373*	0.0419*
the shock	[0.1944]	[0.0059]	[0.0248]	[0.0243]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.9: Results for the first specification for negatively exposed plants, per worker variables

	Total investment	**Total hours worked**	**Total sales**	**Total revenues**
4 years before	-0.0093	-0.0049	0.0214	0.0187
shock	[0.1650]	[0.0050]	[0.0223]	[0.0219]
3 years before	0.0964	-0.0021	-0.0077	-0.0104
shock	[0.1613]	[0.0045]	[0.0019]	[0.0188]
2 years before	0.1046	-0.0019	-0.0046	-0.0046
shock	[0.1491]	[0.0043]	[0.0173]	[0.0172]
Occurence of	0.0234	0.0076	0.0140	0.0127
shock	[0.1695]	[0.0058]	[0.0124]	[0.0124]
1 year after	0.3813**	0.0000	0.0075	0.0093
the shock	[0.1735]	[0.0049]	[0.0188]	[0.0185]
2 years after	-0.0447	-0.0006	-0.0006	0.0031
the shock	[0.1834]	[0.0049]	[0.0208]	[0.0205]
3 years after	0.0952	0.0013	-0.0081	-0.0050
the shock	[0.1857]	[0.0049]	[0.0220]	[0.0217]
4 years after	0.0117	0.0015	-0.0070	-0.0017
the shock	[0.1671]	[0.0051]	[0.0228]	[0.0223]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.10: Results for the second specification negatively exposed plants, per worker variables

	Total investment	**Total hours worked**	**Total sales**	**Total revenues**
4 years before	0.0273	-0.0060	0.0210	0.0182
shock	[0.1656]	[0.0050]	[0.0233]	[0.0230]
3 years before	0.1085	-0.0028	-0.0080	-0.0107
shock	[0.1616]	[0.0045]	[0.0198]	[0.0197]
2 years before	0.1105	0.0022	-0.0048	-0.0048
shock	[0.1493]	[0.0043]	[0.0177]	[0.0177]
Occurence	0.0174	0.0080	0.0141	0.0129
of shock	[0.1694]	[0.0058]	[0.0125]	[0.0124]
1 year after	0.3692**	0.0007	0.0078	0.0096
the shock	[0.1733]	[0.0048]	[0.0190]	[0.0186]
2 years after	-0.0627	0.0004	-0.0002	0.0037
the shock	[0.1828]	[0.0049]	[0.0212]	[0.0208]
3 years after	0.0711	0.0027	-0.0076	-0.0043
the shock	[0.1848]	[0.0049]	[0.0224]	[0.0221]
4 years after	-0.0184	0.0033	-0.0063	-0.0008
the shock	[0.1661]	[0.0051]	[0.0234]	[0.0228]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.11: Results for the first specification, labour intensive plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years before	0.0827	0.1289	0.0860	0.0567	0.0615	0.0792
shock	[0.0832]	[0.2180]	[0.0851]	[0.1118]	[0.1114]	[0.1040]
3 years before	0.0742	0.1823	0.0741	0.0413	0.0449	0.0545
shock	[0.0835]	[0.2140]	[0.0854]	[0.1119]	[0.1116]	[0.1050]
2 years before	0.0678	0.1269	0.0741	0.0396	0.0456	0.0326
shock	[0.0835]	[0.2145]	[0.0856]	[0.1121]	[0.1118]	[0.1054]
Occurence	0.0521	0.2062	0.0582	0.0563	0.0606	0.0056
of shock	[0.0842]	[0.2316]	[0.0861]	[0.1129]	[0.1126]	[0.1058]
1 year after	0.0581	0.5417**	0.0669	0.0717	0.0747	-0.0004
the shock	[0.0842]	[0.2284]	[0.0862]	[0.1138]	[0.1135]	[0.1059]
2 years after	0.0605	0.2252	0.0870	0.0761	0.0810	-0.0137
the shock	[0.0850]	[0.2338]	[0.0761]	[0.1149]	[0.1145]	[0.1071]
3 years after	0.0639	0.2530	0.0659	0.0904	0.0946	-0.0379
the shock	[0.0856]	[0.2319]	[0.0875]	[0.1154]	[0.1150]	[0.1090]
4 years after	0.0700	0.1415	0.0774	0.0914	0.0972	-0.0367
the shock	[0.0860]	[0.2237]	[0.0878]	[0.1162]	[0.1157]	[0.1100]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.12: Results for the second specification, labour intensive plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years	0.0833	0.1141	0.0860	0.0550	0.0592	0.0773
before shock	[0.0830]	[0.2173]	[0.0849]	[0.1116]	[0.1112]	[0.1039]
3 years	0.0747	0.1714	0.0740	0.0400	0.0432	0.0531
before shock	[0.0834]	[0.2137]	[0.0853]	[0.1118]	[0.1115]	[0.1050]
2 years	0.0680	0.1199	0.0740	0.0387	0.0445	0.0317
before shock	[0.0837]	[0.2141]	[0.0855]	[0.1121]	[0.1118]	[0.1054]
Occurence	0.0521	0.2070	0.0582	0.0564	0.0607	0.0057
of shock	[0.0843]	[0.2318]	[0.0862]	[0.0130]	[0.1126]	[0.1059]
1 year	0.0579	0.5464**	0.0670	0.0723	0.0755	0.0002
after the shock	[0.0843]	[0.2288]	[0.0863]	[0.1139]	[0.1136]	[0.1061]
2 years	0.0601	0.2338	0.0686	0.0772	0.0823	-0.0126
after the shock	[0.0852]	[0.2345]	[0.0872]	[0.1151]	[0.1147]	[0.1073]
3 years	0.0634	0.2656	0.0659	0.0919	0.0965	-0.0363
after the shock	[0.0859]	[0.2325]	[0.0878]	[0.1156]	[0.1153]	[0.1092]
4 years	0.0693	0.1579	0.0775	0.0934	0.0997	-0.0346
after the shock	[0.0863]	[0.2249]	[0.0882]	[0.1166]	[0.1161]	[0.1102]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.13: Results for the first specification, capital intensive plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years	0.1192	0.4513**	0.1178	0.1324	0.1364	0.1395
before shock	[0.0829]	[0.2176]	[0.0845]	[0.1167]	[0.1159]	[0.1048]
3 years before	0.1151	0.2745	0.1101	0.1191	0.1217	0.1165
shock	[0.0833]	[0.2138]	[0.0849]	[0.1169]	[0.1163]	[0.1055]
2 years before	0.1185	0.1562	0.1141	0.1286	0.1322	0.1113
shock	[0.0835]	[0.2172]	[0.0850]	[0.1168]	[0.1163]	[0.1058]
Occurence	0.1256	0.1932	0.1349	0.1599	0.1641	0.1117
of shock	[0.0837]	[0.2294]	[0.0851]	[0.1175]	[0.1169]	[0.1059]
1 year after	0.1256*	0.4651**	0.1493*	0.2014*	0.2066*	0.1212
the shock	[0.0837]	[0.2283]	[0.0845]	[0.1178]	[0.1172]	[0.1057]
2 years after	0.1555*	0.2935	0.1581*	0.2322**	0.2394**	0.1314
the shock	[0.0837]	[0.2399]	[0.0853]	[0.1185]	[0.1178]	[0.1067]
3 years after	0.1517*	0.3371	0.1486*	0.2316**	0.2352**	0.1035
the shock	[0.0845]	[0.2333]	[0.0860]	[0.1193]	[0.1187]	[0.1085]
4 years after	0.1622*	0.1451	0.1617*	0.2480**	0.2527**	0.1165
the shock	[0.0849]	[0.2276]	[0.0864]	[0.1199]	[0.1193]	[0.1094]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects and control for the industrial production in the US. Outcome variables in natural logarithms.

Table C.14: Results for the second specification, capital intensive plants

	Total workers	**Total investment**	**Total hours worked**	**Total sales**	**Total revenues**	**Total remunerations**
4 years before	0.1218	0.4613**	0.1200	0.1389	0.1427	0.1410
shock	[0.0827]	[0.2168]	[0.0843]	[0.1164]	[0.1157]	[0.1046]
3 years before	0.1170	0.2819	0.1118	0.1329	0.1264	0.1177
shock	[0.0832]	[0.2134]	[0.0848]	[0.1167]	[0.1161]	[0.1054]
2 years before	0.1197	0.1609	0.1152	0.1317	0.1352	0.1121
shock	[0.0835]	[0.2168]	[0.0849]	[0.1168]	[0.1163]	[0.1057]
Occurence	0.1255	0.1927	0.1348	0.1596	0.1637	0.1116
of shock	[0.0837]	[0.2296]	[0.0851]	[0.1176]	[0.1170]	[0.1060]
1 year after	0.1452*	0.4619**	0.1485*	0.1994*	0.2046*	0.1207
the shock	[0.0831]	[0.2286]	[0.0846]	[0.1179]	[0.1173]	[0.1058]
2 years after	0.1540*	0.2877	0.1567*	0.2284**	0.2357**	0.1304
the shock	[0.0839]	[0.2403]	[0.0855]	[0.1187]	[0.1181]	[0.1069]
3 years after	0.1495*	0.3287	0.1467*	0.2261*	0.2299*	0.1021
the shock	[0.0847]	[0.2335]	[0.0862]	[0.1196]	[0.1190]	[0.1087]
4 years after	0.1593*	0.1340	0.1592*	0.2407**	0.2457**	0.1148
the shock	[0.0852]	[0.2284]	[0.0867]	[0.1203]	[0.1196]	[0.1097]

[a] Standard errors are clustered at the plant level

[b] * implies significance at the 90% confidence level, ** implies significance at the 95% level, *** implies significance at the 99% level.

[c] All treatment periods before and after period -4 and 4, respectively, are set to 1. Omitted category is one year before treatment, hence all coefficients are interpreted with respect to a period before the shock.

[d] All regressions include state and industry fixed effects, state linear trends and control for the industrial production in the US. Outcome variables in natural logarithms.