The Great Russian Devaluation and Labor Demand[1]

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Abstract

Does a greater degree of integration into world markets lead to a more elastic labor demand? Often referred to as the Rodrik (1997) hypothesis, this important from both theoretical and applied policy standpoints question, is still not satisfactorily answered. In this work I investigate it by using a unique firm-level panel dataset for Russian manufacturing firms during a period of significant and rapid currency devaluation. This event made imports of final and intermediate goods more expensive while making Russian exports less expensive and acted like a tariff on imports and a subsidy on exports. In a simple, but revealing model, I specify the implications of devaluation for the labor demand and derive a set of testable predictions. I use the data to test the essence of these predictions and show that trade barriers affect labor demand elasticities. In particular, 15-30% drop in labor demand elasticity can be attributed to the devaluation.

JEL F15, F16, J23, P23

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1 Introduction

Does a greater degree of integration into world markets lead to more elastic labor demand? Why should we care about whether it does or does not? At least three good reasons to care are given by Rodrik (1997). The first relates to the incidence of taxes: when a tax is imposed on demand or supply of labor, its incidence on firms versus workers is inversely proportional to the elasticity of supply versus demand. In other words, the party with the higher elasticity would end up paying a smaller portion of the tax.

This is relevant for more than just taxation. Many policies end up acting much like taxes. Consider the effect of labor standards or legislation that makes it compulsory to offer employees health insurance. To the extent that they reduce the marginal value product of labor, they can be thought of as a tax on labor: the wage at which a given labor is hired falls. When labor demand elasticity is high, most of their costs will be borne by workers and not by firms. This has grave implications for whether voters will be in favor of policies such as safety legislation or health care reform.

The second reason is that a more elastic labor demand also lowers the bargaining power of unions, even if they have monopolistic power. The cost of any additional employee benefits in terms of employment or wages is higher when labor demand elasticity rises. Therefore, even an effective union may not be able to do much when labor demand is elastic. Thus, globalization and its impact on labor demand elasticity might at least partially explain the decline of labor unions in the last few decades.

Finally, a more elastic demand for labor has implications for volatility. As labor demand is a derived demand, shocks in demand for the final goods are transmitted to it. Even if the shocks to the final demand are unrelated to openness, their impact on employment will be greater when labor demand elasticity is higher, possibly resulting in higher volatility in employment and, hence, in earnings of workers.

For some countries and regions, such volatility can be quite challenging. For instance, in Russia there are many "company towns" that depend exclusively on one big firm; an inheritance of the Soviet Union planned economy. In the absence of an adequate social net, such fluctuations in employment can result in social disorder for entire regions.

However, everything said so far is conditional on the notion that trade openness has some impact on the labor demand elasticities. But why should it, and through which channels does it operate? As labor demand is a derived demand, it could be thought of as being the product of two components: the unit labor requirement and the demand for the final good. Increases in the varieties of imported inputs available, as well as outsourcing possibilities, could well increase labor demand elasticity through the extent to which labor is substitutable. Demand for final goods also becomes more elastic as domestic firms have to compete against both domestic and foreign competitors. All of this implies that labor demand is expected to be more elastic with more exposure to trade. This prediction is often referred to as the Rodrik hypothesis as it was popularized in Rodrik (1997), and I will follow this notational tradition.

Needless to say, there have been attempts to establish a link between trade openness and labor demand elasticity. However, there is still no consensus on the question! Some authors, (Hasan et al. (2007), Senses (2010)) find evidence in favor of the Rodrik hypothesis, while others (Slaughter (2001), Krishna et al. (2001)) claim the link to be weak or nonexistent. I argue these contradictory results are due to the use of less than optimal data (most studies use aggregated, not firm level data) and to the lack of large shocks in trade openness alone in the data. These act as major impediments to identifying the role of trade openness on labor demand elasticities.

In this paper I test the Rodrik (1997) hypothesis using very disaggregated data, a large shock for identification purposes, and a simple, yet very revealing model, which shows what to look for in the data. These features distinguish this research from the existing literature. The first key to success is in the use of a unique firm level data set on Russian manufacturing firms spanning six years ($1995 - 2000$).[1] The second is the use of a significant and rapid devaluation of Russian national currency (ruble) in August of 1998 as the "event". In its nature, this shock is equivalent to a very high ad valorem tariff on both intermediate and final goods, which suddenly closed the Russian economy to competition from imports and amplified its export opportunities. Comparing elasticities in the pre- and post- shock periods

[1] To my knowledge, this is the first study that tests this hypothesis for an ex-Soviet Union economy. As the integration of many of these states into the world economy is still in progress, this is particularly topical.

is the main identification strategy. Additionally, tariffs, shares of imported intermediate inputs and levels of competition from foreign suppliers vary sector by sector and firm by firm. This variation can be exploited to identify the role of openness on elasticities of labor demand. Finally, to understand what particular patterns to search for in the data and to guide the formulation of the estimated equation, I develop a simple theoretical model that yields testable predictions on the impact of changes in the exchange rate, tariffs, and extent of import competition on labor demand elasticities.[2]

The model yields a host of rich and varied empirically verifiable predictions for both conditional (given output) and unconditional labor demand elasticities. Almost all of these are found strongly in the data, so that overall, my findings support Rodrik's hypothesis.

First, as the model predicts, devaluation should make conditional labor demand less elastic.[3] The channel goes through the change in prices of imported materials due to the exchange rate shock. As the currency devaluates, foreign materials become more expensive and labor cost share rises via substitution channel. This reduces the conditional labor demand elasticity for both production and non-production workers. In the data, I find a significant drop in the labor demand elasticities after the 1998 devaluation for both conditional and unconditional labor demand. For different sub-samples and using a variety of estimation techniques, I find that the estimated drop in the elasticity ranges from 20 to 40% for production and from 5 to 20% for non-production workers or even more for some sectors.

Theoretically, higher tariffs on intermediates should have the same effect as an exchange rate on conditional labor demand, as they change prices of imported inputs in the same manner. I find this empirically as well.

Second, I show that the magnitude of change in the conditional labor demand elasticity for production and non-production workers due to devaluation is related to the share of imported materials used by the industry to which a firm belongs. Firms in sectors that had a high dependence on imported materials in the pre-devaluation period are among those

[2]Unlike some earlier papers in the field, I do not assume in my theoretical model that the trade policy changes parameters of the production function or of the final good demand in order to get a change in elasticity of labor demand as these are primitives of the model. All changes in elasticities depend only on the changes in exogenous variables.

[3]Under certain conditions on the labor demand elasticities at the home market and abroad, the result holds for unconditional labor demand as well.

whose elasticity falls the most. This makes sense if one thinks of the reason for a high share being that imports are cheap (in efficiency units) relative to labor and so are more vital to production. Making them hard to access dampers the firm's desire to hire labor even if its wage falls. The correlation between the percentage change in the elasticity due to devaluation and the share of imported inputs used by the sector is high, ranging between -0.7 and -0.9.

Finally, I show that greater import competition in the product market faced by firms tends to correspond in the data to higher labor demand elasticity. This is in line with theoretical predictions. Removing foreign supply from demand makes the residual final product demand more elastic. Thus, any fluctuation in wage will be magnified via change in the final demand in terms of sales.

The paper is structured as follows. Section 2 gives an in-depth overview of the related studies. Section 3 summarizes results of a simple theoretical model and predicts patterns to be observed in data. Data issues and data set specific estimation concerns are described in Sections 4 and 5. Section 6 describes the main results. Section 7 provides some robustness checks. Sections 8 and 9 conclude.

2 Related Work

Almost all existing related work can be classified according to the type of data used (aggregate or firm-level) and the identification strategy chosen. This strategy could be temporal (variation over long periods of time in trade policy is related to variations in elasticity), an event study (where a shock in trade policy is associated with changes in elasticity) or cross sectional (where variation in trade policy and exposure of the industry to imports across industries is related to variations in elasticity). As papers cross categories in the second dimension, I will group them according to the first dimension, i.e., by the data type used, being sure to explain the identification strategies chosen whenever relevant.

2.1 Studies Using Aggregate Data

Hamermesh (1996) contains a nice exposition of the basic idea. As labor demand is a derived demand, it can be written as the product of the unit input requirement of labor (which depends on the price of all inputs) and the output of a firm (which depends on its demand). As the wage changes, a firm substitutes other inputs for labor, reducing labor demand for a given output, which is called the substitution effect. As wages rise, so does cost, and hence price, which reduces demand in line with the price elasticity of demand for the final product. This is called the scale effect. Two forms of labor demand are commonly estimated: conditional (where the scale effect is turned off) and unconditional, where the effect via demand is incorporated.

Slaughter (2001) is among the first to relate openness to labor demand elasticity empirically. He notes that substitution possibilities between inputs are likely to be enhanced with greater openness due to an increase in the number of varieties available. In addition, final good demand will also become more elastic as an increase in price will result in losing customers to domestic *and* foreign competitors. Both factors should make the demand for labor more elastic. This prediction is often referred to as the Rodrik hypothesis as it was popularized in Rodrik (1997). Slaughter (2001) then tests this hypothesis using the US data at the 4 digit SIC level (for about 450 industries) spanning thirty four years $(1958-1991)$. His estimation procedure is a two-step one. In the first step, he estimates conditional and unconditional demand elasticities using a log-linear specification of demand. The conditional labor demand function uses output as an explanatory variable, while the unconditional demand function does not. Industry fixed effects are eliminated by using three-year, five-year, or ten-year differences. In the second step, the elasticities estimated in the first step are regressed on various trade openness measures. Even though conditional labor demand elasticity almost doubles during the thirty four year span, Slaughter concludes that "the hypothesis that trade contributed to increased elasticities has mixed support, at best." However, this sort of two stage approach could perform poorly in the absence of more disaggregated data and a major event that causes significant variation in trade. Such aggregated data also calls for an IV approach that has not been used.

Greenway et al. (1999) study uses UK industry-level data during 1979-1991 to track the effect of trade policy on employment levels. Regressing the log of labor demand on log of wages as well as interaction terms between trade measures and log wages, they find the coefficients on the latter to be insignificant, which does not support the Rodrik hypothesis. In contrast, Faini et al. (2009) find a positive Spearman rank correlation between trade openness measures and the estimated industry elasticities of labor demand for Italian data. However, unlike the work above, their identification comes from cross sector differences in trade exposure rather than from changes over time, even though they have a panel for 11 years ($1985-1995$).

Hasan et al. (2007) use data on 18 manufacturing industries over 18 years in 15 regions in India ($1980-1997$). During this period there was a substantial decrease in tariffs. In addition, a number of quantitative and license restrictions were removed. Hasan et al. (2007) estimate the conditional labor demand given output and the conditional demand given capital, with interaction terms added to account for the policy changes. They assume that there are adjustment costs so that lagged employment has to be included as an explanatory variable. This significantly complicates the estimation routine as dynamic estimation GMM methods have to be used. Hasan et al. (2007) use the Arellano and Bond (1991) GMM estimator for dynamic models as well as classical fixed effects estimation techniques. Overall, they conclude that interaction terms that control for changes in trade regimes are in favor of the Rodrik hypothesis. However, although, (as outlined by Bond (2002)), fixed effects estimates of coefficients for lagged dependent variables in dynamic panel data models tend to be downward biased, and thus, typically should be less than unbiased Arellano-Bond GMM estimates, the opposite is true in the work of Hasan et al. (2007). As Roodman (2007) points out, this is likely with weak instruments being used.

Another econometric issue in both Hasan et al. (2007) and Slaughter (2001) is the potential endogeneity of wages. For a firm-level data it might be a reasonable assumption that each particular firm faces a perfectly elastic labor supply curve. It is less so for industry-level data. To be fair, both papers explicitly acknowledge this issue, but can do little about it. Beyond that, as outlined by Hamermesh (1993), all studies using highly aggregated data are facing the problem of linear aggregation of nonlinear relationship, which is the aggregation of marginal product condition in the case of labor demand equations. In other words, it is not clear why labor demand equation derived for a single firm should hold for the whole industry or sector.

For all the reasons mentioned above, plant or firm-level data is to be preferred to aggregated and a dramatic change in trade exposure would help provide a clean test of the question at hand.

2.2 Studies Using Disaggregated Data

Krishna et al. (2001) based their research on Turkish plant-level census data covering about 600 plants in the greater Istanbul area from 1983 to 1986. Trade reform in Turkey in 1984 significantly lowered tariffs and non-tariff barriers, especially on final goods as final goods were much more protected prior to the reform. With little change in the price or availability of imported intermediates, changes in labor demand elasticity should come from changes in the elasticity of the final demand rather than from substitution between inputs. The authors, thus, only estimate the unconditional labor demand function and add an interaction term between log wage and post- liberalization period dummy.

Their log-linear specification treats labor demand as a function of factor prices alone. This creates problems from an econometric standpoint for a number of reasons. First and foremost, it is well understood that larger firms tend to pay higher wages. Without other controls, this fact alone tends to bias the wage coefficients of the demand function upwards. One way around this is to restrict attention to homogenous firms of a similar size. This would let the usual negative relationship between wage and employment emerge. This problem does not arise for conditional labor demand estimation as the firm's output (or at least capital stock) is controlled for, which is why these regressions tend to perform better. Second, the effect of the trade reform is restricted to the interaction term between wages and the indicator for a post-reform period. For example, it does not allow for differences in impact across firms with, say, different trade exposure in the form of the original import penetration or share of imported inputs. It might well be the case that only some of the firms were affected (final good producers) and that the effect of trade liberalization is just lost in the noise. Overall, Krishna et al. (2001) conclude that empirical evidence supporting higher elasticities due to trade reform is weak at best.

Senses (2010), looking at the US manufacturing plant-level data between 1972 and 2001, draws the opposite conclusion. Unlike Krishna et al. (2001), she estimates the cost share equations derived from the translog cost function and evaluates conditional own price labor demand elasticities, thereby focusing on the substitution effect. Her innovation is to use differences in the extent of outsourcing as a proxy for openness and link the latter to the labor demand. Using multiple offshoring proxies calculated or suggested by Canals (2006), Feenstra and Hanson (1996), and Bernard et al. (2006) Senses shows that increase in the extent of outsourcing significantly raises the conditional labor demand elasticities both in the short and long-run. Thus, she finds support for the Rodrik (1997) hypothesis.

Fajnzylber and Maloney (2005), however, find little to no support for the hypothesis. Studying trade reforms in Latin America (Chile ($1979-1995$), Columbia ($1977-1991$), and Mexico ($1984 - 1990$)) they conclude that periods of less restricted trade do not coincide with periods of higher labor demand elasticities. Their estimated coefficients for tariff rates, import penetration ratios, or exchange rate interacted with log of wage are mostly insignificant or have signs inconsistent with the Rodrik (1997) hypothesis. Only for unskilled labor in Mexico do the authors find some link between higher elasticities and trade openness measures. Such weak results might be explained by multiple high frequency switches in trade regimes (from less to more open, and reverse) over the time frames studied. There are also other econometric issues that might explain their results. Their estimation equation is not the usual conditional or unconditional labor demand, as they replace the firm's output by the sector's output in their regressions and then interpret the estimated equation as the unconditional labor demand, which is unconventional.

3 Model

The basis for my work lies in the classic analysis of Marshall's on derived demand. Most work in the area does not explicitly relate the estimation to the model and, as a result, is often hard to follow. I present a simple theoretical model in the Appendix. The model explicitly traces out the effects of an exchange rate change on labor demand and its elasticity.

It has predictions for conditional (given output) and unconditional labor demand functions that are applicable to both production and non-production workers. I outline the intuition behind these predictions below, while formal proves are provided in the Appendix. It is worth noting that the model should be seen as a guide for the reduced form work in this paper rather than as a model being *structurally* estimated at this point.

3.1 Testable Predictions

The implications of the theoretical model are summarized below.

- *For conditional labor demand:*

Result C.1 **Elasticity decreases with a devaluation.** It is easy to see that conditional labor demand elasticity equals $(1-S_L)\sigma$, where S_L is a cost share of labor and σ is elasticity of substitution across factors of production. A greater share of labor makes it harder to substitute for labor in terms of other inputs when its price rises, which makes the conditional demand less elastic. A devaluation makes imported materials more expensive and labor relatively cheaper so that the firm substitutes towards labor (as long as $\sigma > 1$) and S_L rises. Thus, devaluation should reduce the conditional labor demand elasticity. If labor that a firm hires consists of both production and non-production workers, demand for *each type* of labor becomes more elastic, which also follows from the Marshall's rules of derived demand.

Result C.2 **Elasticity decreases with an increase in tariffs on intermediate inputs.** Tariffs on intermediate inputs act in the same way to raise the share of labor and reduce conditional labor demand elasticity for both types of labor.

Result C.3 **Increased dependence on imported intermediate inputs makes the conditional labor demand elasticity more responsive to devaluation or to an increase in tariffs on the imported intermediates while cost share of imported materials (S_{m^e}) is relatively low (below some cut-off level), and less so otherwise.**

Intuitively, when share of imported intermediates (S_{m^e}) is very low the impact of any change in exchange rates on labor demand is limited. Therefore, the responsiveness of labor demand elasticity to changes in the exchange rate is close to zero. As it rises, so does the responsiveness of labor demand elasticity to changes in the exchange rate. However, if this share is very high, then imported intermediates are used extensively and labor is only used where essential. In this extreme case, again, the responsiveness of labor demand elasticity to changes in the exchange rate is limited. Thus, hump shaped pattern is predicted.

- *For unconditional labor demand:*

Result U.1 **Labor demand elasticity should be higher for the sectors with greater import penetration ratios. As a result, elasticity should be lower for industries protected by higher tariffs on final goods.** With more import penetration, final demand is more elastic and so is derived labor demand for both production and non-production workers.

4 Data

There are two distinct data sets used in the paper.

The first one, complied by the Center for Economic and Financial Research in Moscow[4] from multiple data sources including "Goskomstat" (the Russian State Statistics Committee), Alba, and Gnosis accounting databases, covers all of manufacturing in Russia from 1995 to 2000. The main variables I observe at the firm level include employment by type, firm sales, total wage bill, and capital stock at the beginning and at the end of each year. For some years, the information on the share of total costs relative to sales is available as well. Unfortunately, not all firms report information to Goskomstat regularly and for many firms data on some or all variables is missing for one or more years. In principle, all firms whose assets are more than 75% privately owned and all firms with more than 100 employes

[4]Most of the data has been provided by the Center for Economic and Financial Research in Moscow (www.cefir.ru). I am particularly thankful to Irina Denisova, Natalya Volchkova, and Evguenia Bessonova for providing the data.

have to report such information and, thus, should be a part of the data set. However, as Bessonova et al. (2003) mention, due to the peculiarities of data collection, newer firms are likely to be underrepresented in the sample. The largest Russian firms are also not a part of this data set. Due to missing observations there is a significant difference between the number of observations in the balanced and the unbalanced panels that I construct from the raw data. The balanced data set contains about $6,000 - 7,000$ firm observations annually, while in the unbalanced data this number might be twice as high for some years. To avoid any concerns about possible biases, I re-estimate all equations on both the balanced and unbalanced panels and find little to no impact on the major results.[5]

The second data set is one I constructed manually using a Spark Interfax data base.[6] It contains information on the largest firms in the oil and gas, metallurgy and machinery sub-sectors. Overall, it covers about 700 of the largest firms. These firms are much larger in terms of sales and employment. The average firm in the first (Goskomstat) data set has about 300 employees, while in the second one (Spark) it has about $3,000$. As firms in the larger firm data set are more homogenous in size, this helps me with estimation of the unconditional labor demand, as variation in size produces noise that complicates the unconditional labor demand estimation.

4.1 Employment and Wage Data.

The first data set contains information on the yearly average number of production and non-production[7] firm by firm. The total wage bills are available for each of these two groups separately. The data set on the largest firms, on the other hand, reports only the total number of workers and the total wage bill. The wage paid per employee is obtained by dividing the total wage bill for each group by the number of employees in the group. To account for high inflation rates over the period, I deflate wages by industry specific producer

[5] Comparison of the results for the balanced and unbalanced data sets is available upon request. The observed differences in estimates are small. This is not surprising as data seems to be missing because of data reporting practices rather than due to endogenous entry and exit decisions.

[6] http://www.spark.interfax.ru/

[7] Note, that this is not the regular skilled/unskilled (blue/white collar) workers split as production workers include highly educated personnel as well as unskilled labor.

price indices.

4.2 Other Input Prices Proxies

In addition to data on wages, I use information on firm location, regional statistics, and law records to approximate other factor prices. First, firm specific proxies for electricity prices are obtained. These vary by firm due to institutional details of electricity pricing. For $1995 - 2000$ electricity prices were set at the regional level. To set the electricity price, each regional government had to approve price schedules for each type of consumers. All government decisions had to be documented and published. Residential consumers, small enterprises, and large firms usually faced different tariff schedules. In almost all regions the first two categories were paying for an actual consumption of electricity. Large enterprises faced a two-part tariff: a fee for connected power (measured in kW), independent of current consumption, and a charge for the actual consumption (in kWh) itself. Knowing firms connected power, electricity consumption, and having data on the regional pricing schedules, I approximate firms specific electricity prices per kWh.[8]

Second, I use Goskomstat data[9] on construction prices, which comes from regional statistics books. Though prices for commercial construction are not reported for most of the 89 regions of Russia, prices on newly constructed *residential* properties, recorded yearly, are easily available. I use these prices as a proxy for the cost of new commercial construction. It is worth saying that construction prices are also likely to reflect other unobserved materials or input prices, like fuel, cement, metals, etc., by regions. These prices might also reflect regional costs of running a business due to climate differences and remote location. I include residential construction prices into regressions as a broad proxy for local intermediate goods prices faced by firms.

[8]See the Data Details section of the Appendix for further discussion.

[9]Data is coming from Goskomstat yearly statistics volumes "Russian Regions."

4.3 Sales Data

Besides price and employment data, I need output or sales data to estimate the conditional labor demand. I have information on sales of each firm net of the value added taxes. I deflate these by the industry specific producer price indices.

4.4 Tariffs

I need data on tariffs on imported materials and on final goods to test all the predictions of the theory. The data from CEFIR contains firm-specific tariffs on its final outputs. For each firm, information on its output was matched with tariff data to calculate a weighted average firm specific tariff.[10] Such a tariff reflects how well a firm is protected from competition from abroad, but says nothing about how much the firm is affected by tariffs on intermediate inputs, which are, unfortunately, not available.

However, as a significant share of industry output is consumed within the same industry[11], one could use sector tariffs as a proxy for intermediate inputs tariffs. To obtain these sector tariffs, I calculate the weighted average tariff for each of $3-$ and $5-$ digit industries of Russian "Okonh" industry classification from firm-specific tariffs.[12] I then use these sector-specific tariffs as a proxy for tariffs on intermediates.

There is substantial variation in tariffs across sectors, though not so much over time. Average sector tariffs might be as low as $0-2\%$ for medical equipment and can go up to 60% for some firms producing food or beverages.

4.5 Import Penetration Measures and Trade Orientation

I use import to production ratios calculated by Bessonova et al. (2003) as a measure of import penetration. To construct these ratios, Bessonova, et al. linked firms accounting

[10] This data has been provided by the Center for Economic and Financial Research as well.

[11] For instance, in the machinery sector 37% of output is consumed within the sector. Another way to approximate tariffs on the imported materials is to use tariffs on the final goods in conjunction with input-output tables. However, as input output tables are not detailed enough, tariffs have to be aggregated to a very widely defined sectors, such as machinery, timber, etc.

[12] In estimation I use both weighted (by sales) and unweighted average tariffs and do not see any significant differences in estimation results.

data to the Russian Customs database. It allowed them to calculate firm-specific import to production ratios accounting for the composition of goods produced by a firm, as well as import penetration proxies for the narrowly defined sectors.

The second way to differentiate between export oriented and import competing sectors is to classify them into groups. Here, again, I follow Bessonova et al. (2003) and define sectors where (1) export share is more than 30% of output, (2) import share is less than 30%, and (3) there is a low share of intra-industry trade, as export oriented. Similarly, I define sectors (1) with import share of 30% or more, (2) with export share of 30% or less, and (3) a low share of intra-industry trade, as import competing.

4.6 Exchange Rate

The data sets I use cover a period of very rapid Russian currency (ruble) devaluation. In early 1998 low oil and gas prices decreased Russian export earnings. Facing high domestic and foreign debt payments, the Russian government had to eliminate bounds on the exchange rate that had existed from 1995 to mid 1998. In August of 1998, the Central Bank's foreign currency reserves were as low as eight billion dollars (less than 2% of the 1997 GDP) and it had to allow the exchange rate to float. In just a few days, the exchange rate changed from roughly 6 rubles per US dollar ($R/\$$) to $14 - 16$ rubles. Further exchange rate correction took place later on as well. By the summer of 1999 the nominal exchange rate depreciated to 24 $R/\$$ and up to 28 $R/\$$ by the summer of 2000. Not only the nominal exchange rate, but also the real one, changed. To avoid social disorder, the government was reluctant to allow price adjustments and used administrative measures to slow down the growth of retail prices. Growth of consumer prices was also limited by the low purchasing capacity of most Russians. As a result, inflation rates were lower than rates of currency devaluation. Figure 1 illustrates this point.

Currency devaluation made some foreign goods unaffordable to consumers, either because of their high price or because of interruptions in deliveries. Devaluation caused manufacturing firms to face a significant increase in the cost of imported materials and services. In contrast to the existing literature, which mostly relies on tariff changes, the devaluation serves as a very strong shock. It works as an average increase in tariffs on imported inputs of

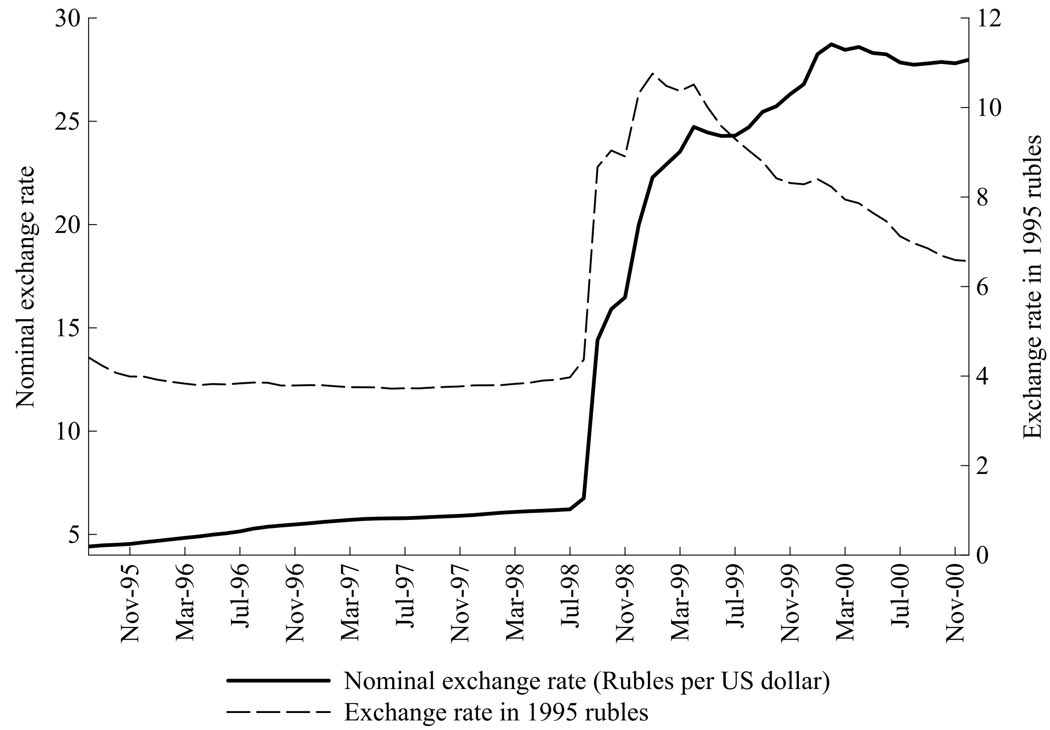

Figure 1: The Great Russian Devaluation

several hundred percent! It is hard to think of a stronger shock to trade than this. Therefore, the devaluation I observe is the event that gives Rodrik's hypothesis a chance to manifest.

4.7 Input-Output data

Unfortunately, the firm-level data sets available do not provide any information on either quantities of imported materials, services used, or whether a particular firm is using any imported materials or services in its production. The only way to outline the firms that are likely to be using significant amounts of imported materials is to use input-output tables.

Russian input-output tables are reported at very aggregated level. Only nine different sectors of manufacturing can be tracked and matched to the firm-level data. Three sectors that had the highest share of imported materials from $1995 - 2000$ were the light industry (34%), the machinery sector (16%), and the petrochemical (15%), while the lowest shares were observed for the power, oil and gas industry (6%), the construction materials sector (6%), and timber production and processing (7%).

5 Estimation

The theoretical section in the appendix gives some insight on what the estimation equation should look like and what it should account for. It shows that the log of labor demand for either production and non-production labor for any firm can be written as:

$$\ln l = \ln a^L(w_P, w_{NP}, m, m^e(E,T)) + \frac{1}{\beta}\ln(A) + \frac{1}{\beta}\ln Q, \tag{1}$$

where $a^L(w_P, w_{NP}, r, m, m^e(E,T))$ is an analog of unit labor requirement,[13] A is the total factor productivity of a firm, and Q is the residual demand for the final output demand faced by a firm. For the conditional labor demand estimation, I take Q (output) as given and use sales of the firm (S) into equation as the best approximation for it.

"A unit labor requirement," $a^L(w_P, w_{NP}, m, m^e(E,T))$, is a function of factor prices, including wage of production labor (w_P), wage of non-production labor (w_{NP}), price of capital (r)[14], price of domestic (m) and price imported materials ($m^e(E,T)$), where E is the exchange rate ($R/\$$) and T is the tariff on the imported materials. Any change in these prices should affect the level of labor demand. In the data, I observe wages, electricity prices (El), and construction prices (C), which proxy for domestic materials prices. I do not observe prices of the imported materials $m^e(E,T)$. However, as assumed in the theory section, if for sector j at time t, $m^e_{jt} = m^* E_t T_{jt}$, then $\ln m^e_{jt} = \ln m^*_j + \ln E_t + \ln T_{jt}$, where m^*_j is the world price for imported materials. Thus, I allow material prices to vary sector-by-sector and over time. If prices abroad (m^*_j) are constant, then over time and across firms variation in prices of the imported materials comes from changes in the exchange rate and in tariffs on the intermediates. Differences in m^*_j across sectors will be captured by the industry-specific effects. As the exchange rate (E) in the economy is the same for all firms for a given year, its effect on the level of labor demand will be captured by the annual time-specific effects.

[13] Properly speaking, this is an amount of labor needed to produce the first unit of output for a firm with productivity level of $A = 1$.

[14] I do not include any capital price measures in my regressions. First, such data is unavailable. Second, for the period studied Russian manufacturing firms were not operating at their full capacity in all sectors! Russian State Statistics committee approximates that the average capacity load for manufacturing was in range from 27% to 44% in 1995-2000, with the highest load of about 80% in power, oil, gas, and metallurgy sectors. It means that any measure of capital price would be quite irrelevant as capital was abundant.

Hence, the empirical specification of the labor demand should include wages (w_P and w_{NP}), proxies for domestic prices of the intermediate inputs (El and C), tariffs on the imported materials (T). I denote, all factor prices, except the own wage of the labor type studied, by Z^n_{ijrt}, where $n \in$ {production; non-production}. Thus, if equation for production labor is estimated, Z^p_{ijrt} contains wage of non-production labor, w_{NP}, while for non-production labor demand Z^{np}_{ijrt} contains w_P. As the conditional labor demand elasticity $\varepsilon^L_w(w_P, w_{NP}, m, m^e(E,T))$ also depends on the same variables, I add interaction terms between Z_{ijrt} and log of the own wage.

To evaluate the impact of trade openness on the conditional labor demand elasticity, I have to estimate the labor demand function for the six years with a significant devaluation in the middle of the time period. To account for the exchange rate shock, I include the interaction terms between Z_{ijrt}, $ln(w)$ and the dummy variable for the post-1998 period ($P98$).[15]

Finally, as my data sets are pooled over different industries and regions, and firms might be heterogenous in terms of TFP, I use series of fixed effects to account for these variations. I include industry specific-fixed effects (Ind), export oriented (Exp) and import competing (Imp) subsector-specific fixed effects, region specific effects R_i (whenever applicable), firm fixed effects (μ), as well as time-specific effects (Y), into equation (2).

Collecting these pieces together, I obtain the estimation equation for the conditional labor demand for labor type n, by firm i, from industry j, from region r and at time t :

$$\ln L^n_{ijt} = \beta_0 + \beta_1 \ln w^n_{ijt} + \beta_2 (\ln w^n_{ijt}) * P98_t + \delta(\ln w^n_{ijt}) * Z^n_{ijrt} + \beta_3 \ln S_{ijt} + \\ +\gamma Z^n_{ijrt} + \theta Z^n_{ijrt} * P98 + [\eta_0 Y_t + \eta_1 Ind_j + \eta_2 Exp_j + \eta_3 Imp_j + \eta_4 R_i] + \mu_i + \varepsilon_{ijrt}, \tag{2}$$

where l^n_{ijt} is number of workers of type n (i.e. production or non-production); w^n_{ijt} is the own wage rate of these workers; matrix Z^n_{ijrt} contains $ln(T_{jt})$ which is the log of one plus the

[15] The most detailed specification can include interaction of all these terms with year specific dummies that will account for the yearly exchange rate changes. However, such approach being more general would require estimation of too many variables. Also interaction terms between factor prices $\ln C_{rt} * \ln w_{ijt}$, $\ln El_{it} * \ln w_{ijt}$, and $\ln T_{it} * \ln w_{ijt}$ might be allowed to have different effects on the employment in the pre- and post- devaluation periods. However, inclusion of these terms into the estimated equation causes multicollinearity issues as $\ln w_{ijt}$ enters in too many ways.

average sector j tariff on imported materials at time t, C_{rt} which is a proxy for construction prices in region r at time t; El_{it} which is the price of electricity for firm i at time t, and w_{ijt}^{-n} which is wage of the other type workers. S_{ijt} are the sales of the firm; $P98_t$ is an indicator function showing that an observation belongs to the post-1998 period; Exp_j is the sector fixed effect for export oriented sector j; Imp_j is the sector fixed effect for import competing sector j; Ind_j - is the industry-specific fixed effect for sector j; Y_t is a set of year specific dummy variables; R_i - is the region fixed effect for firm i, μ_i is the firm-specific effect, and ε_{ijrt} is a random employment shock.

Estimates of coefficients β_1, δ and β_2 are those of the most interest. The former two provide the estimate of the conditional labor demand elasticity with respect to its own wage. The latter shows whether elasticity changes after devaluation. Theory predicts that elasticity decreases with a devaluation (Result C.1), which implies $\hat{\beta}_2 > 0$. Elasticity decreases with an increase in tariffs on intermediate inputs (Result C.2). Thus, coefficient of the interaction term between the tariff on inputs variable $ln(T)$, which is a part of matrix Z_{ijrt}^n, and $\ln w_{ijt}^n$, must be positive.

Result (C.3) predicts that the change in the labor demand elasticity in response to an exchange rate shock will be increasing in the share of imported intermediates. Having estimates of labor demand elasticity before the shock, that depend on $\hat{\beta}_1$, $\hat{\delta}$, mean values of Z_{ijrt}^n, and the change due to devaluation, $\hat{\beta}_2$, I take a ratio of $\hat{\beta}_2$ to the overall elasticity *before* the shock to test the theoretical prediction. For those sectors that use a high share of the imported materials, this ratio has to be high in the absolute value.

The main identification concern for the conditional labor demand estimation is endogeneity of wages. In this case, labor *supply* shifters have to be used as instruments, but are not readily available for Russia. Nevertheless, using a straightforward non-IV method should not introduce a *significant* bias in the estimates as data is very disaggregated and each firm might be safely treated as a price-taker. Hamermesh (1993) outlines that endogeneity is less of an issue when highly disaggregated data is used. His overview of the labor demand elasticity estimates shows little *systematic* variation across estimation methods used. Beyond that, as a significant share of firms in my data is located in big cities like Moscow, Saint-Petesburg, Samara, etc., the assumption of perfectly elastic labor supply for a firm is not that bad. In this respect, using firm-level data is a big advantage over non-IV estimates based on industry-level data (Slaughter (2001)) or industry/region data (Krishna et al. (2001)). However, to be on the safe side and to address the endogeneity issue formally, I perform some robustness IV checks in Section 7.

6 Main Findings

Tables $1-3$ of the appendix summarize the main results of the estimation. Tables 1.1 and 1.2 report the results for the first data set on relatively smaller firms for production and non-production workers, correspondingly. Table 2.1 and 2.2 split the sample by sectors. Table 3 provides the estimates of the conditional labor demand for largest firms (the Interfax Spark database) as well as the estimates on the sub-samples of large firms in the oil, gas, metallurgy sector and in the machinery industry.

6.1 Labor Demand Elasticity Estimates

I estimate the conditional labor demand equations using a number of methods. Doing so helps make the paper compatible with previous studies that used a full spectrum of estimation techniques. In addition, it demonstrates that while I observe some numerical differences in the estimates, the main results are *qualitatively* robust to the chosen method.

OLS and robust regressions tend to give the highest point estimates of the labor demand elasticities for the conditional labor demand for both production and non-production workers. The OLS estimate on the first data set on relatively smaller firms is about -0.72 (Table 1.1, column 1), while robust regression estimate is -0.99 (Table 1.1, column 2). For non-production workers elasticities are somewhat smaller: -0.4 according to OLS (Table 1.2., column 1) and -0.42 (Table 1.2., column 2) according to robust regression. However, the standard OLS approach does not account for existence of fixed firm effects, e.g. for productivity differences. My data is pooled across many regions, which are very heterogenous in a number of ways, including climate, infrastructure, etc. In addition, firms can be very heterogenous within a sector. This is motivation for allowing for firm fixed effects.

There are several standard ways in which firm or industry-specific effects are accounted for in the existing literature. First, differencing over time is used. This eliminates all fixed firm specific effects. It is commonplace in the labor literature to use 3, 5 or 10 year differences in data to estimate labor demand. My data covers only six years, and as I have the regime change in the middle of the period, even 3 year differences would be problematic. Nevertheless, I use one year differences to re-estimate the conditional labor demand equations. Compared with the OLS estimate, the elasticity for production workers falls substantially to -0.15 (Table 1.1, column 8), though coefficient estimate remains significant. For non-production workers, the estimate drops to -0.29.

Alternatively, one can use the classic fixed effects estimator based on the within transformation. The estimate of the labor demand elasticity is about -0.28 (Table 1.1, column 3) for production workers and -0.27 (Table 1.2, column 3) for non-production labor. The estimate of the conditional labor demand elasticity using the random effects estimator is quite close to the fixed effects one and is -0.37 (Tables 1.1 and 1.2, column 4) for both production and non-production labor. For the large firms alone the picture is similar: the fixed effects and the random effects estimates of the conditional labor demand elasticity are -0.27 and -0.32, respectively (Table 3, columns $1-2$). It should be noted that Hausman specification test rejects the random effects specification and, thus, I do not discuss random effects estimates in details below, though they are still reported in most of the tables.

An alternative labor demand estimation routine is based on the Arellano-Bond GMM estimator. This takes into account the fact that adjustment of employment to the desired level could take some time. In this case, lagged employment has to be included into the RHS of the equation, which makes it feasible to distinguish between short- and long-run elasticities. The short-run elasticity measures the immediate impact of a change in wage on employment, while the long-run elasticity captures the full effect, i.e., when optimal employment is achieved. The long-run elasticity is just the short-run one divided by one minus the coefficient for the auto-regressive term for employment. As Arellano and Bond (2002) argue, traditional estimation methods could be biased and more complicated (GMM) routines might have to be used. As Bond (2002) outlines, the OLS estimate of coefficient for lagged employment is likely to be upward biased, while the fixed effects estimate is biased downward. In this way, OLS and FE models together provide a reasonable range for the lagged employment coefficient estimate. I use OLS and FE estimates to make sure that the choice of instruments does not return an unreasonable result and that the lagged employment coefficient is within bounds. Overall, for the first data set on relatively smaller firms, the estimate of the short-run elasticity for production labor is about -0.11 (Table 1.1, column 7) and -0.31 (Table 1.2, column 7) for non-production workers. The implied long-run values would be around -0.17 for production and -0.42 for non-production labor. The employment auto-regression coefficient for non-production labor falls into the reasonable range provided by FE (0.19 (Table 1.2, column 6)) and OLS (0.80 (Table 1.2, column 5)) estimates and is 0.24 (Table 1.2, column 7). However, for production labor, the auto-regression coefficient is outside of the suggest bounds, indicating potentially weak instruments.

For the data set on the largest firms, the elasticity of demand for total labor is in the range from -0.23 (FE, Table 3, column 1) to -0.32 (RE, Table 3, column 2). The random effect specification is rejected by Hausman test. The Arellano and Bond short-run estimate is -0.29.

Overall, based on specifications that account for firm-specific effects, it is safe to conclude that for production labor, the conditional labor demand elasticity lies in the range from approximately -0.15 to -0.3, while for non-production labor the own price labor demand elasticity is close to -0.3. All these estimates are in the typical range specified by Daniel Hamermesh (1993), based on his literature survey.

6.2 Effects of the Devaluation.

I use the devaluation of 1998 to see how the conditional labor demand elasticity is affected by the exchange rate shock. The interaction term between log of wage and the dummy for the post 1998 period is positive for both production and non-production, as suggested by the theory.[16]

For the first data set on the relatively smaller firms, the overall change in elasticity for production labor varies from 17% (OLS in one year differences, Table 1.1, column 8) to

[16] There is one seeming exception. In one of the OLS specifications that I use solely to check my Arellano-Bond estimates (Tables 1.1. and 1.2, column 5) the coefficients of the interaction term are negative. However, these specification are biased as they include lagged employment coefficient.

29% (fixed effects, Table 1.1, column 3). The Arellano-Bond estimate of the change is in between: 23% (Table 1, Column 7). For non-production labor the change in labor demand elasticity ranges from 14% (OLS in one year differences, Table 1.2, column 8) to 20.5% (Fixed Effects, Table 1.2, Column 3). It is worthwhile noting, that the point estimates of labor demand elasticity changes are larger for production than for non-production workers. The only exception is the robust regression estimate, that does not account for firm-specific effects.

On the second data set for the largest firms, the fixed effects estimate of change in the conditional labor demand elasticity for all labor is 24% (Table 3, Columns 1) for the full sample, 25% for the oil, gas and metallurgy (Table 3, columns 4), and 27% for the machinery sector (Table 3, columns 6). For the machinery sector all estimation methods imply significant changes in elasticity after devaluation (from 27% to 34%, Table 3, columns $6-9$), while for oil, gas and metallurgy sector all estimates are insignificant, except fixed effects ones.

Based on these estimates, it is fair to conclude that, on average, a $17-29\%$ drop in the conditional labor demand elasticity for production labor and $14-20\%$ drop in the conditional labor demand elasticity for non-production occurs in the post devaluation period! The overall change in elasticity of labor demand for all types of labor is somewhere in-between: around $24\%-27\%$. This finding is robust and provides a strong support for the theoretical prediction (Result C.1) that a devaluation causes a drop in the conditional labor demand elasticity for both types of labor.

6.3 Tariffs and Elasticity Estimates

Tariffs on intermediate inputs should have the same impact on the conditional labor demand elasticity as a devaluation (Result C.2), i.e. the coefficient of the interaction term between log of wage and tariff measure should be positive.

For the first data set on relatively smaller firms, all specifications, except those estimated by OLS, return positive and significant estimates of the interaction term coefficient (Table 1.1 and 1.2, columns $2-4$, $6-8$), while OLS estimates are negative or significant (Tables 1.1

and 1.2, columns $1, 5$).[17] For the second data set on the larger firms, fixed effects specification gives a positive coefficient (Table 3, Column 1), while Arellano and Bond (Table 3, column 3) estimate is negative.[18]

When the model is estimated sector by sector on the first data set for relatively smaller firms, the interaction term can not be included into model specifications in practice, as it turns out to be very highly correlated with the wage variable and collinearity issues arise.[19] At the same time at the data set on larger firms, where more sub-sectors are combined into one sample, I can estimate the coefficients of the interaction terms. For oil, gas and metallurgy the interaction term turns out positive and significant (Table 3, columns $4-6$), while for machinery the estimate is negative and insignificant at 10% level (Table 3, columns $7-9$).

Even though the findings for the tariff variable are not as robust as those for the exchange rate, they are by and large consistent with the Result C.2 of the model.

6.4 Sector by Sector Results

Here, I test the Result C.3 of the theory section, showing that there is a strong correlation between the share of imported materials used by a sector and the change in the elasticity of labor demand for both production and non-production workers.

Table 2.1 and 2.2 give sector-by-sector estimates of the conditional labor demand elasticities for nine distinct sectors of manufacturing for production and non-production workers, using the data set on relatively smaller firms. The highest elasticity estimate of labor demand for production workers, -0.27 is observed for the timber and light manufacturing sectors. One sector, oil, gas and power production, has the estimated elasticity of demand for production labor that is insignificantly different from zero. For machinery sector, petrochemical

[17] OLS yields negative and significant coefficient for the variable, but it does not allow for firm fixed effects, which my preferred specifications should include.

[18] It should be noted, that the data set on the larger firms is smaller and as a result Arellano and Bond estimates are not very robust across alternative specifications

[19] This happens because tariffs are calculated at sub-sector level. There are not that many different sub-sectors within a sector, thus not much variation in tariffs for the same year. Tariffs are also very stable across years. When tariffs are interacted with wage at the sector level, most of the variance of this interaction term is driven by differences in wages.

sector, construction materials sector, food and food processing sector, and for "other manufacturing sectors" the elasticities of demand for production labor are quite similar and are in range from -0.17 to -0.24. For non-production labor elasticities of labor demand are more homogenous: they vary from -0.24 to -0.30 and are all but one significant at 1% level.

The interaction term for the log of wage and the post-1998 dummy is positive and significant for production labor for all sectors except power, oil, and gas sector. For the latter, I do not find a statistically significant change in elasticity. The largest percentage change in labor demand elasticity for production workers is measured for metallurgy (-55.3%), food and food processing sector (-44.4%), and for machinery and metal working sector (-41.8%). For non-production labor the interaction term is insignificant for oil, gas and power production sector, construction sector and for "other manufacturing sectors". The largest percentage change in elasticity of labor demand for non-production workers has been recorded for petrochemical sector (-35.9%), metallurgy (-27.6%), and for machinery and metal working sector (-24%).

According to the input-output tables, the three sectors with the highest share of imported materials are the light industry, the machinery, and the petrochemical sector. For these sectors, the observed percentage changes in elasticities of demand for production labor are -28.7%, 41.8% and -32.9%,[20] respectively. Sectors which have the lowest share of imported inputs - power, oil, and gas, construction materials, and timber industry - demonstrate fairly low elasticity changes: those changes are -17.9% (insignificant) for power, oil, and gas firms, -32.3% for construction firms, and -24.8% for timber sector. Overall, sectors which use *more* imported intermediate inputs tend to have *higher* conditional labor demand elasticity changes due to the devaluation. The correlation coefficient between shares of imported materials used by a sector and point estimates of changes in elasticities of demand for production workers is -0.86, if I omit light industry from calculation. For non-production workers, the corresponding correlation is -0.67. The light industry is omitted because it has the highest share of imported materials 34% - two times more than the second largest! The theory section predicts that the relationship between the extent of elasticity change and

[20] For the petrochemical sector, the elasticity change is not precisely measured and the elasticity estimate is insignificantly different from zero.

share of imported material has to be U-shaped. If share is very high, the change in elasticity might be small. This is exactly what I see in the data! While for other sectors, the change in elasticity and share of imported materials are almost perfectly linearly related, the food sector is an obvious outlier, as demonstrated at Figure 2 for production workers.[21]

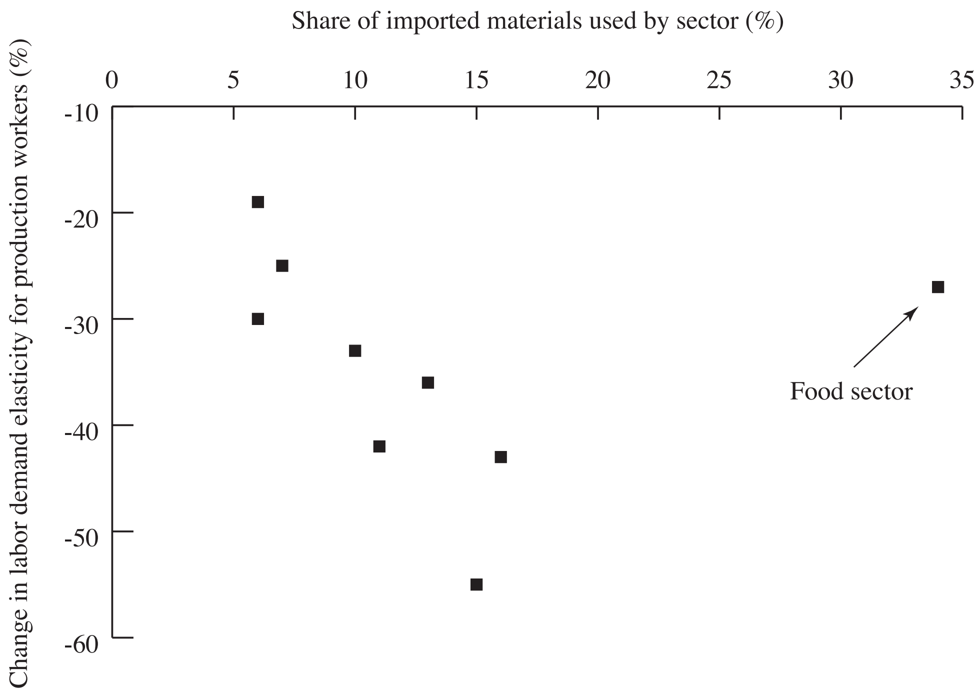

Figure 2: Share of imported materials and change in labor demand elasticity

For the largest firms I do not have enough data for a detailed cross-sector analysis, though I am able to estimate the conditional labor demand equation separately for two sub-samples: for oil, gas, and metallurgy firms altogether and for the machinery sector. The fixed effects estimates of the percentage elasticity change for the latter sub-sample are somewhat higher than for the latter, 27.2% vs. 25.2% (Table 3, columns 4, and 6), though the difference is not statistically significant. Random effects and Arellano and Bond point estimates are higher for machinery sector, that uses more imported materials.

Overall, sectors with higher shares of imported materials demonstrate larger (in absolute value) changes in elasticity, confirming theoretical Result C.3.

[21]The OLS regression where the dependent variable is the change in the labor demand elasticity and independent variables are share of imported materials and share of imported materials squared can explain up to 97% of variance in the data.

7 Alternative Specifications and Robustness Check

In this section I provide results robustness checks. I start with estimation of unconditional labor demand function, and then discuss endogeneity concerns.

7.1 Unconditional Labor Demand

The unconditional labor demand equation specification differs from the conditional one in a number of ways. The major difference is that output (sales) is not controlled for. It is assumed that sales is a function of factor prices that a firm has to pay, as well as on the exchange rate, and tariffs on the final goods. The unconditional labor demand, suggested by equation (21) of the model is:

$$\begin{aligned}\ln L^n_{ijt} = \alpha_0 + \alpha_1 \ln w^n_{ijt} + \alpha_2(\ln w^n_{ijt}) * P98_t + \alpha_3 \left[1 - I^{jt}_{trade,home}\right]^{-1} \ln w^n_{ijt} + \delta(\ln w^n_{ijt}) * Z^n_{ijrt} \\ +\gamma Z^n_{ijrt} + \theta Z^n_{ijrt} * P98 + \alpha_4 Exp_j * P98 + \alpha_5 Imp_j * P98 + \alpha_6 T^f \\ +[\eta_0 Y_t + \eta_1 Ind_j + \eta_2 Exp_j + \eta_3 Imp_j + \eta_4 R_i] + \mu_i + \varepsilon_{ijrt}\end{aligned} \tag{3}$$

where l^n_{ijt} is number of workers of type n; w^n_{ijt} is the own wage of these workers; matrix Z^n_{ijrt} contains $ln(T_{jt})$, which is a log of one plus the average sector j tariff on imported materials at time t, C_{rt}, which is a proxy for construction prices in region r at time t, El_{it} which is the price of electricity for firm i at time t and w^{-n}_{ijt} which is the wage of the other type workers. $P98_t$ is an indicator function showing that observation is for the post-1998 period; Exp_j is the sector fixed effect for export oriented sector j; Imp_j is the sector-fixed effect for import competing sector j; $I^{jt}_{trade,home}$ is import to import plus production ratio for sub-sector j at time t; Ind_j - is the industry-specific fixed effect for sector j; Y_t is a set of year-specific dummy variables; R_i - is the region fixed effect for firm i; μ_i is the firm-specific effect and ε_{ijrt} is a random employment shock.

Estimates of the coefficients of the conditional and unconditional labor demand are not directly comparable. For the conditional labor demand, coefficients reflect properties of the unit labor requirement and those of the production function (i.e. substitution effect), while they also capture an effect of the final demand channel for the unconditional labor demand (scale effect). In addition to these common variables, the level of sales also depends on the tariffs on the final good $\left(T^f\right)$, on the income of consumers at home I (in Rubles), and abroad, I^*. If I and I^* are the same for all firms in a given year, they will be captured by time specific effects and this is assumed here. I also do not have separate measures for tariffs on intermediate and final goods. For the reasons described in the data section, I use sector tariffs on the final goods as proxies for the tariffs on intermediates. Consequently I cannot estimate the effect of tariffs on the intermediate goods ($\ln T_{jt}$, which is the part of Z^n_{ijrt}), and of tariffs on the final goods ($\ln T^f_{it}$) separately. The best I can do is to assume that tariffs on final on intermediate goods have the same effect on the employment level.

Result U.1 suggests that if I look at the firms over a *cross-section,* then those in sectors with higher import penetration should demonstrate higher elasticity of the labor demand. On these grounds, I include import penetration, $I_{trade,home}$, interacted with the log of wage into the estimating equation.

Before turning to the results, it is important to notice that there is a serious identification problem with the unconditional labor demand and several sources of it. In the first place, keeping sales on the RHS of the conditional labor demand equation controls for shocks in the level of demand that each firm faces in a given period. When sales are omitted from the estimation, as in the unconditional demand, movements of the final demand prevent the relationship between wages and employment from manifesting. Although, instruments[22] can be used to predict the state of demand, their performance is substantially inferior to sales variable. In the second place, large firms tend to pay higher wages. If a firm size is not accounted for, the estimates of the elasticity might be upward biased or even positive! To avoid this, one would need to use a large number of instruments that not only reflect the state of demand for each firm, but also the quality of the labor used, which are unavailable. All these concerns provide rationale for using the second data set covering only the largest firms.[23] Firms in this data set are more homogenous in terms of their employment and sales.

[22]I use dummy variables for the export-oriented and import-competing sectors interacted with the post-1998 dummy to capture demand shifts.

[23]I tried estimating the unconditional labor demand on the full data set. Results are unsatisfactory. The coefficient for log of wage is insignificant in most specifications. The expected negative relationship between wages and employment is completely noised out by variations in sales that I am not able to control for with a limited number of instruments I have.

I estimate the unconditional labor demand function for oil, gas, metallurgy firms, lumped together, and for the machinery sector as a whole.[24]

Table 4 reports the unconditional labor demand estimates for the largest firms. To account for a cross sector and over time differences in the state of the final demand for a firm, I use prices of other inputs, a full set of industry specific dummy variables (20 dummies), time specific effects (all relative to 1995), dummy variables outlining whether the sector the firm belongs to is export oriented or import competing, as well as these dummies interacted with post 1998 dummy. For both sectors estimates of unconditional labor demand elasticities are approximately of the same size as the conditional estimates. For oil, gas and metallurgy sector, the elasticity estimates vary from -0.3 to -0.5 (Table 4, Columns $1-4$), depending on the extent of export orientation and import competition that a firm faces. For machinery sector, the best guideline number for the unconditional labor demand elasticity is -0.4 (Table 4, columns $5-8$). In all regressions interaction term between wage coefficient and post-98 dummy is positive and statistically significant, confirming that there was a substantial drop in elasticity after devaluation. The magnitude of this coefficient is also in-line with the conditional demand estimates.

There is one specific prediction of the theory to be tested for the unconditional labor demand: Result U.1 says the firms protected with higher tariffs on the final goods are likely to have a lower import penetration ratio, and therefore, a less elastic labor demand. I test for it in two ways by running two distinct set of regressions. In the first set of regression, I include an interaction term between the proxy for the import penetration ratio $(1/\left(1-I^{jt}_{trade,home}\right))$ and the log of wage (this is a continuos measure of the foreign competition). I expect the coefficient for this interaction to be negative. It is actually negative in all specifications that I estimate for oil, gas and metallurgy sector (Table 4, columns $1-4$), but is insignificant or positive for machinery sector (Table 4, columns $5-8$).

In the second set regression, I use interaction terms between the *dummies* for export-oriented and import-competing sectors with log of wage (thus, I use a discrete measure of the

[24]It should be noted, that I view unconditional labor demand equation only as an additional evidence on the effect of evaluation on labor demand elasticities, that makes this paper comparable to the previous research.

foreign competition). Export oriented sectors, tend to have lower elasticity of labor demand: all coefficient estimates are positive, but are only significant for oil, gas and metallurgy sector. The elasticity tends to be higher for import competing firms in oil, gas and production sector, but estimates are not statistically significant. The last two results are in-line with theoretical prediction. The only estimate that contradicts theory comes from the estimates for machinery sector, where the coefficient of interaction term between log-wage and import competition dummy comes positive and significant.

Overall, for oil, gas, and metallurgy sector the estimates support the theoretical prediction, that export-oriented firms have significantly less elastic labor demand, while that for import-competing ones it is somewhat more elastic. For machinery sector data does not support theory - coefficients are either insignificant or have a wrong sign. At the same time, the main prediction about effect of devaluation on labor demand elasticity holds in all specifications independently of estimation method!

7.2 Endogeneity

There are two potentially endogenous variables in specification of the labor demand. The first one is wage. The second potentially endogenous variable is sales.

7.2.1 Wage Endogeneity

The main identification assumption made in this paper is that each firm faces perfectly elastic labor supply, or in other words, that every firm is a price taker. This is a typical assumption, made by almost each and every author whose papers were reviewed in the literature survey above. This assumption might be violated, if say, there is a deficit of labor of particular type within the region where firm locates. If this is the case the supply does not need to be perfectly elastic, and wage is not an exogenous variable anymore. The error term (or at least a part of it) is also likely to be region specific, as workers are relatively immobile[25] in Russia.

[25] This immobility is due both to preferences (staying close to friends and family is highly valued) and to high transactions costs in the real estate market and overall bureaucracy which make moving costly.

If wages are not exogenous the estimates given above could be biased.[26] I use the IV approach to correct for such bias. A good instrument here would be correlated with the wage but uncorrelated with the error term. Following Nevo (2001) I use wages in the same sector, but in other regions as instruments.[27] Wages in a sector in all other regions are likely to be correlated with wages in the given region, but uncorrelated with the error term as it is likely to be region specific.

To construct this instrument, I take a narrowly defined ($5-$digit Okonh, 390 sectors) sector and for each region I calculate the average wage for the same sector and the same labor type in all other regions. In the first stage of estimation, I regress each firm's wage on this proxy, as well as on the region's GRP (Gross Regional Product) per capita relative to the Russian mean, on average wage in the region (across all sectors), on the growth rate of the regional economy for the given year, and on the regional unemployment level. I also include the share of population with higher education for each region to have at least a rough proxy for the quality of the labor force. In some specification firm sales are used as an explanatory variable at the first step. Besides these variables, I use a full set of region, industry and time specific effects.

Table 5 summarizes the IV estimates for the data set on relatively smaller firms. My constructed instruments have good predictive power for both wage of production and non-production workers. The RHS variables in the first stage equations manage to explain from 37% to 58% of variation in the firm-level data (Table 5, Columns $1-4$). Constructed proxies for the firm wage for production and non-production labor are highly correlated with those variables in the raw data, with correlations of about $0.6-0.7$. Columns $5-8$ of the Table 5 reports the fixed effects estimation results of the conditional labor demand elasticities when instruments for wages are used. For production labor, they are close to those based on the raw data numbers (-0.28, Table 1.1. Column 3), and are in range from -0.21 to -0.25 (Table 5, Columns 5-6). For non-production labor elasticity estimates are substantially lower, than the uncorrected numbers (-0.27, Table 1.1. Column 3) and are estimated to be from -0.08

[26]Of course, the bias in the estimate of labor demand elasticity might be the same before and after the devaluation so that it would not affect the main conclusions of the paper.

[27]Nevo (2001) instrumented potentially endogenous prices of ready-to-eat cereals by prices of the same cereals, but in other geographical areas.

to -0.12 (Table 5, Columns $7-8$). This might reflect the fact that non-production labor is more heterogeneous across firms and regions, and wages for non-production labor are harder to predict.

The key variable of interest - interaction term between log of wage and post-1998 dummy - is significant and positive in all specifications, as expected. These estimates suggest a roughly $33-58\%$ drop in elasticities after the devaluation - a bit more than predicted without two-steps procedure and instruments being used. Interaction terms between constructed wage proxies and tariff variable remain positive and significant in all specifications, supporting earlier findings as well.

7.2.2 Output (Sales) Endogeneity

What sort of endogeneity might we worry about? Suppose firms are unable to hire or fire workers. Then we could be in the situation that rather than labor demand being high because sales are high, causation runs the other way. Sales are high precisely because the firm has a lot of labor it cannot fire. In this case, sales and error term will be negatively correlated and endogeneity bias will occur. To correct for such issues, I use as an instrument the overall level of sales in this sector excluding sales in my region. This should be correlated with the firm's own sales to the extent that common forces operate on all firms in this sector, but will be uncorrelated with the firm's own labor demand or error term.

I thus, use variation in sales of a narrowly defined industry as a proxy for firm sales: for each firm I calculate average sales of all the other firms in the same narrowly defined sector ($5-$digit OKONH) but in other regions. Then I regress sales of each firm on the relevant industry average as well as on dummy variables for import-competing and export-oriented firms, their interactions with post-1998 dummy, tariffs, and on the regional specific characteristics. The latter include region GRP per capita relative to those of Russia and regional economy growth rates. Region, industry ($3-$digit) and time specific effects are included as well.[28] Once I have predicted sales for each firm, I include them into the estimation of the

[28] I tried a number of additional instruments that are not reported in this paper. For instance, I tracked sectors that demonstrated higher increase in their output prices relative to the economy. This helps to identify the sectors that faced favorable market conditions. For instance, rapid growth of the world metal price would increase the price index for metal producers by more than for the whole economy and can explain

labor demand.

The elasticity estimates fall compared to those when instrumenting for wages only. For production labor, the estimates of elasticity are in the range from -0.13 to -0.19, while for non-production labor from -0.10 to -0.13.[29] This is not surprising as I use industry and regional variation to explain firm specific sales and lose some firm-specific demand shifters, which noises out relationship between employment and wage. The measured change in labor demand elasticity after 1998 is even more pronounced - from 50 to 100%. The coefficient on the tariff measure interacted with wage remains positive and significant in all specifications implying that firms that pay higher tariffs on inputs tend to have lower labor demand elasticities.

8 Summary of Results

The predictions and results for both unconditional and conditional labor demand are summarized in Table A:

Table A: Summary of the Main Findings

	Theory	Data
Conditional labor demand elasticity ε_w^L		
Exchange rate (for fixed γ) ($E \uparrow$)	$\downarrow$	$\downarrow$
Tariffs on the inputs ($T \uparrow$)	$\downarrow$	$\downarrow$
% change in ε_w^L with % change in E ($S_{m^e} \uparrow$)	$\uparrow$ if $S_{m^e} < \bar{S}_{m^e}$	$\uparrow$
Unconditional labor demand elasticity		
Higher import penetration ratio ($I_{trade,home} \uparrow$)	$\uparrow$	weak $\uparrow$

9 Conclusion

Foreign exchange shocks are common and often large. They have implications not only at the macro level, but also at the micro one. I focus on one such implication at the micro

the growth in the revenues of a sector. However, such additional instruments have marginal or no effects on the estimates.

[29]These results are not reported in the Appendix and are available upon request.

level by relating shocks in the exchange rate to changes in the labor demand elasticities for production and non-production labor.

An exchange rate shock not only affects the price of final imports, acting like a tariff on them, but also simultaneously changes the price of imported intermediates used by producers. In this way, it affects both the final demand of a firm and the unit labor requirement, as the choice of inputs is affected by tariffs on intermediates. It also affects completely differently the final demand for import-competing and export-oriented firms. In this paper, by using a simple, yet very revealing theoretical model, I develop several testable predictions about the conditional and unconditional labor demand elasticities and find support for them in the data. These predictions are richer and more nuanced than the simple à la Rodrik hypothesis, which states openness makes labor demand more elastic.

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10 Appendix

10.1 Model

The simple theoretical model below helps frame the regressions and highlights the testable predictions of the theory.

Let the cost function for the firm be multiplicatively separable in factor prices, TFP measure and output:

$$TC(w, r, m, m^e, A, Q) = c\,(w, r, m, m^e) * g(A) * f(Q), \tag{4}$$

where w is real wage per unit of labor, r is the real price of capital, m is the real price of non-traded inputs, $m^e(E, T)$ is the real price of imported inputs in Russian rubles, E is exchange rate (defined as the price of foreign exchange in Russia, i.e. rubles per dollar), Q is total output, A is the TFP measure, and $g(\cdot)$ and $f(\cdot)$ are, respectively, monotonically decreasing and increasing functions. Finally, T is defined to be $1 + t$, where t is the ad-valorem tariff on imported intermediates.

By Shephard's Lemma, the demand for labor is given by:

$$\frac{\partial TC(w, r, m, m^e(E, T))}{\partial w} = \frac{\partial c\,(w, r, m, m^e)}{\partial w} * g(A) * f(Q) = a^L(w, r, m, m^e(E, T)) * g(A) * f(Q). \tag{5}$$

Thus, the conditional labor demand is given by:

$$L^d(w, r, m, m^e(E, T), A, Q) = a^L(w, r, m, m^e(E, T)) * g(A) * f(Q). \tag{6}$$

Taking logs yields the standard conditional labor demand specification used in estimation.

10.1.1 Elasticity of Conditional Labor Demand

The conditional elasticity of demand for labor is defined to be positive and is:

$$\varepsilon_w^L(w,r,m,m^e(E,T)) = -\frac{d\ln a^L(w,r,m,m^e(E,T))}{d\ln w}. \tag{7}$$

How does this elasticity depend on tariffs and the exchange rate? To get explicit solutions, some further assumptions on the production function have to be made. In particular, I assume that the production function is CES:

$$Q = A\left[L^\rho + K^\rho + M^\rho + \gamma\left(M^e\right)^\rho\right]^{\frac{\beta}{\rho}}, \tag{8}$$

where L, K, M, and $M^e(E,T)$, A stand for, correspondingly, labor, capital, domestic intermediate inputs, imported inputs used in production and firm specific productivity; while γ is a parameter that defines the "quality" of intermediate inputs. An increase in γ means that, in effect a unit of the imported intermediate has more services packed into it so that the price per service of intermediate falls as γ rises, given its price. One might expect that if γ is high, then imported intermediates are effectively cheap relative to domestic inputs. Therefore, as long as the elasticity of substitution is more than unity as assumed throughout, this would lead to a larger share in cost of imported intermediates. Parameter β characterizes the nature of returns to scale, with $\beta = 1$ corresponding to the CRS case.

For this production function, the corresponding cost function is given by:

$$TC(\cdot,Q) = \left[r^{1-\sigma} + w^{1-\sigma} + m^{1-\sigma} + \gamma^\sigma m^e(E,T)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} A^{\frac{1}{\beta}} Q^{\frac{1}{\beta}} = c(\cdot) * A^{\frac{1}{\beta}} Q^{\frac{1}{\beta}}, \tag{9}$$

where $\sigma = \frac{1}{1-\rho}$ is the elasticity of substitution.

There are several essential assumptions made here. The first assumption is one about elasticity of substitution between factors of production, σ. I assume that $\sigma > 1$, thus *all* factors of production are treated as substitutes. This assumption could be easily relaxed by production function nesting and all the results pass through as long as imported materials and labor remain substitutes.

Second, it is assumed that there is only one type of (aggregate) labor used by firms. The second assumption can be weakened easily as well - it is enough to model firms' aggregate labor input (L) as a function of the number production and non-production workers hired:

$$L = [L_P^\tau + L_{NP}^\tau]^{\frac{1}{\tau}}, \tag{10}$$

where L_P and L_{NP} stand for, respectively, number production and non-production workers, and $\sigma_L = \frac{1}{1-\tau} > 0$ for the elasticity of substitution between labor types. Wage paid by a firm per unit of aggregate labor (L), is $w = [w_P^{1-\sigma_L} + w_{NP}^{1-\sigma_L}]^{\frac{1}{1-\sigma_L}}$, where w_P and w_{NP} are wages of production and non-production workers correspondingly. The Marshall rules of derived demand imply that elasticities of labor demand for skilled ($\varepsilon_w^{Ls}(\cdot)$) and unskilled ($\varepsilon_w^{Us}(\cdot)$) workers *follow the same pattern as the elasticity of demand for an aggregate labor* (L), $\varepsilon_w^L(\cdot)$, because:

$$\varepsilon_w^{Ls}(\cdot) = \sigma_L \frac{w_{NP}^{1-\sigma_L}}{w_P^{1-\sigma_L} + w_{NP}^{1-\sigma_L}} + \frac{w_P^{1-\sigma_L}}{w_P^{1-\sigma_L} + w_{NP}^{1-\sigma_L}} \varepsilon_w^L(\cdot) = \sigma_L [1 - S_p] + S_p * \varepsilon_w^L(\cdot) \tag{11}$$

where S_p is the cost share of production labor. If $\varepsilon_w^L(\cdot)$ decreases, demand for both types of labor becomes less elastic. In this way, all the results below, that explain behavior of demand for aggregate labor (L) hold for demand for production and non-production labor. Thus, for a sake of space concerns, I limit the discussion below to the simplest production function possible and model demand for only one type of aggregate labor (L).

Under the assumptions made, $a^L(w, r, m, m^e(E, T))$ is:

$$a^L(w, r, m, m^e(E, T)) = \left[\frac{w}{c(\cdot)}\right]^{-\sigma}. \tag{12}$$

and labor demand can be expressed as:

$$\ln L^d(w, r, m, m^e(E, T), Q) = \ln a^L(w, r, m, m^e(E, T)) + \frac{1}{\beta}\ln(A) + \frac{1}{\beta}\ln(Q). \tag{13}$$

The domestic price for imported intermediates, in rubles is:

$$m^e(E, t) = m^* ET, \tag{14}$$

where m^* is the world price of imported inputs, E is the exchange rate, and $T = (1+t)$. Note that an increase in the tariff on inputs and a depreciation in the exchange rate have the same effect on the price of imported materials. Also, it is implicitly assumed that country facing exchange rate shock is a small economy and does not affect the world price of intermediate goods, m^*. This is not a bad assumption, as Russian economy was small compared to the world in late 1990s.

The responsiveness of the conditional labor demand to changes in the wage is:

$$\varepsilon_w^L(w, r, m, m^e(E,T)) = -\frac{d \ln a^L}{d \ln w} = \sigma \left[1 - S_L\right] > 0, \tag{15}$$

where S_L is the cost share of labor:

$$S_L = \frac{wa^L(\cdot)}{c(\cdot)} = \frac{w^{1-\sigma}}{\left[r^{1-\sigma} + w^{1-\sigma} + m^{1-\sigma} + \gamma^\sigma m^e(E,T)^{1-\sigma}\right]}. \tag{16}$$

It can be easily verified that this elasticity is decreasing in both E and T :

$$\frac{d \ln \left[\varepsilon_w^L(\cdot)\right]}{d \ln E} = -(\sigma - 1)\gamma^\sigma \frac{S_L^2}{1 - S_L}\left[\frac{w}{m^e(E,T)}\right]^{\sigma-1} < 0. \tag{17}$$

Expression (17) implies that if national currency devaluates, (i.e., E increases), or if government imposes taxes on imported inputs (T increases), then the conditional labor demand elasticity falls! This prediction might be easily tested on data that covers a period of substantial devaluation. But is the percentage change in elasticity defined by formula (17) the same for all sectors? If different sectors of the economy depend on the imported inputs to a different extent, i.e., parameter γ varies across industries, then the answer is "no"!

A high value for γ will result in a higher share of imported materials if the elasticity of substitution, σ, is more than unity. As imported intermediates are of higher quality, a higher γ means one needs less of the imported intermediate in physical terms per unit of output and this reduces its cost share. However, as imported intermediates have become cheaper, one substitutes towards them in production and this raises their expenditure share. As the elasticity of substitution exceeds zero, the latter dominates the former and expenditure shares rise with increases in γ :

$$\begin{aligned} s_{m^e} &= \frac{m_e(E,T)M^e(\cdot)}{c(\cdot)} \\ &= \frac{\gamma^\sigma m^e\left(E,T\right)^{1-\sigma}}{\left[r^{1-\sigma}+w^{1-\sigma}+m^{1-\sigma}+\gamma^\sigma m^e(E,T)^{1-\sigma}\right]} \\ &= \frac{1}{1+\left(\frac{1}{\gamma^\sigma}\right)\left[\left(\frac{w}{m^e(E,T)}\right)^{1-\sigma}+\left(\frac{r}{m^e(E,T)}\right)^{1-\sigma}+\left(\frac{m}{m^e(E,T)}\right)^{1-\sigma}\right]}. \end{aligned} \tag{18}$$

Thus, when γ is high, so is the share of intermediate imports in costs. This is the reason for the next result, which shows the responsiveness of the labor demand elasticity to change in the exchange rates is hump shaped in γ. If γ is very low, then the share of imported intermediates is very low, and thus, the impact of any change in exchange rates on labor demand is limited. Therefore, the responsiveness of labor demand elasticity to changes in the exchange rate is close to zero. As γ rises, so does the responsiveness of labor demand elasticity to changes in the exchange rate. However, if γ is very high, then imported intermediates are used extensively and labor is only used where essential. In this extreme case, again, the responsiveness of labor demand elasticity to changes in the exchange rate is limited. This causes the hump shaped pattern.

More formally, it could be shown that:

$$\begin{cases} \dfrac{\partial\left[\frac{d\ln\left[\varepsilon_w^L(\cdot)\right]}{d\ln E}\right]}{\partial\gamma} \leq 0, \text{ if } \gamma \leq \bar{\gamma}; \\ \dfrac{\partial\left[\frac{d\ln\left[\varepsilon_w^L(\cdot)\right]}{d\ln E}\right]}{\partial\gamma} > 0, \text{ if } \gamma > \bar{\gamma}. \end{cases} \tag{19}$$

This seems reversed but it is not as $\left[\frac{d\ln\left[\varepsilon_w^L(\cdot)\right]}{d\ln E}\right] < 0$.

Expressions (18) and (19) provide another useful testable application. Sectors that have a high cost share of imported materials are likely to have high γ. On the other hand, formula (19) says that when a devaluation occurs, sectors with high γ, but not too high γ (or equivalently s_{m^e}), should have very high percentage changes in elasticity due to devaluation!

10.1.2 Full Elasticity of Labor Demand

The conditional elasticity of labor demand derived above explains changes in firms labor requirements keeping output constant, however, the full elasticity should also account for a change in demand faced by a firm. This means that some further assumptions regarding the final demand for a product and nature of returns to scale have to be made.

First, I further assume that production function is CRS, i.e. that $\beta = 1$. Second, I model each firm to face the following residual demand for its final good:

$$Q\left(p, I, I^*, E, T^f\right) = D(p, I) - X\left(\frac{p}{ET^f}, I^*\right), \tag{20}$$

where $D(p, I)$ reflects the home market size at price p and income I. $X(p/ET^f, I^*)$ stands for excess supply of the good from abroad at price p in rubles, so that p divided by the exchange rate E times $T^f = 1 + t^f$, where t^f is the ad valorem tariff on final goods, gives the dollar price obtained after accounting for tariffs. Income abroad is denoted by I^*. When $X(p/ET^f, I^*) > 0$, firm faces competition from abroad at the home market (imports are positive), and when $X(p/ET^f, I^*) < 0$, it sells abroad (exports are positive). I assume that $X_1'(p/ET^f, I^*) > 0$. As the ruble devaluates, i.e., p/ET^f decreases, $X(p/ET^f, I^*)$ decreases and the residual demand faced by a firm, $D(p, I) - X(p/ET^f, I^*)$, increases.

There might be different assumptions about the pricing behavior of the firm. Assume that the firm is charging a fixed mark-up over its costs. Then $p = \mu c(w, r, m, m^e)$, where $\mu > 1$, or in extreme case $p = c(w, r, m, m^e)$ and $\mu = 1$.

Then the firm's labor demand can be expressed as:

$$\begin{aligned} \ln l &= \ln A + \ln a^L(w, r, m, m^e(E, T)) + \\ &\quad + \ln\left[D(\mu c(w, r, m, m^e), I) - X\left(\frac{\mu c(w, r, m, m^e)}{ET^f}, I^*\right)\right], \end{aligned} \tag{21}$$

where the first term reflects an optimal choice of labor needed to produce one unit of a final good given all factor prices, while the second part describes a state of demand that the firm faces given its pricing behavior, exchange rate, and tariffs. This representation is very helpful in understanding which variables have to be included in estimation of the unconditional equation and in which manner. By totally differentiating $\ln l$ and by rearranging terms, it can be shown that:

$$\frac{d\ln l}{d\ln w} = \left[-\varepsilon_w^L(w,r,m,m^e(E,T)) + \left[\frac{-\varepsilon_p^{HD}}{1-X(\cdot)/D(\cdot)}s_L + \frac{\varepsilon_p^X}{1-D(\cdot)/X(\cdot)}s_L\right]\right] \tag{22}$$

where

$$\varepsilon_p^X = \begin{cases} \frac{X_1'(\cdot)c(w,r,m,m^e(E,t))/\left(ET^f\right)}{X(\cdot)} > 0, \; if \; X(\cdot) > 0; \\ \frac{X_1'(\cdot)c(w,r,m,m^e(E,t))/\left(ET^f\right)}{X(\cdot)} < 0, \; if \; X(\cdot) < 0, \end{cases} \tag{23}$$

is elasticity of excess supply with respect to price, $\varepsilon_w^L(w,r,m,m^e(E,T))$ is a constant output elasticity of labor demand with respect to wage; ε_m^M, ε_r^K, and ε^{M^e} are, correspondingly, constant output elasticities of capital demand, intermediate non-traded inputs demand, and traded inputs demand with respect to their prices; ε_p^{HD} is elasticity of the total home market size with respect to price of the final good; and s_L is the cost share of labor.

Define the ratio of excess supply from abroad to the home market size as:

$$\begin{aligned} I_{trade,home} &= \frac{excess\ supply}{production\ at\ home + excess\ supply} = \\ &= \frac{X(\cdot)}{[D(\cdot)-X(\cdot)]+X(\cdot)} = X(\cdot)/D(\cdot). \end{aligned} \tag{24}$$

Note that when $X(\cdot) > 0$, the country is an importer of the good, and $X(\cdot)/D(\cdot)$ is the import share in consumption (production + import) at home. For goods that are mostly imported and are not produced at home this ratio is close to 1. If $X(\cdot) < 0$, then the country is an exporter of the product and $-X(\cdot)/D(\cdot)$ is the relative size of exports to the home market. For a purely export oriented firm that ratio can go up to $+\infty$.

Thus, the labor demand elasticity can be rewritten in terms of the $I_{trade,home}$ ratio as:

$$\begin{aligned} &\left[\varepsilon_w^L(w,r,m,m^e(E,t)) + \left[\frac{\varepsilon_p^{HD}}{1-I_{trade,home}}s_L + \frac{I_{trade,home}}{1-I_{trade,home}}\left(\varepsilon_p^X\right)s_L\right]\right] \\ = &\left[\varepsilon_w^L(w,r,m,m^e(E,t)) + s_L\left[\varepsilon_p^{HD}\lambda + (1-\lambda)\left(\varepsilon_p^X\right)\right]\right] \\ = &\left[\varepsilon_w^L(w,r,m,m^e(E,t)) + s_L\left[\left(\varepsilon_p^{HD} - \varepsilon_p^X\right)\lambda + \varepsilon_p^X\right]\right], \end{aligned} \tag{25}$$

where $\frac{1}{1-I_{trade,home}} = \lambda$. Note that, if the good is imported, $I_{trade,home}$ is between zero and unity. Thus, $\lambda > 1$. As $I_{trade,home}$ rises, so does λ. It means that in the cross section greater λ should be associated with a greater labor demand elasticity for imported goods. This suggests running regression of log l on log w and log w interacted with imports relative to production plus imports or in the absence of intra industry trade, the import penetration ratio. It is also worth noting that if λ goes to unity, or imports are close to non-existent, then labor demand elasticity is just the conditional one plus $s_L \varepsilon_p^{HD}$ a la Marshall.

How does labor demand elasticity change with E? Unfortunately, there are no clear predictions for the unconditional demand here. At the same time, a higher tariff on the final good (T^f) unambiguously decreases the unconditional labor demand elasticity (via a fall in $X(\cdot)$), without affecting the conditional labor demand at all.

10.2 Data Details

Firm specific electricity prices

Regional level data on prices is available for approximately 50 regions out of 89 for 1995-2002 with some gaps. At the first step, for each region I calculate average yearly connection and consumption charges. Then, I first use the price of electricity in the consequent years (if available) and fill gaps by OLS predictions. It is trickier to obtain price approximations for regions with data missing for many or all years. To do so, I predict regional prices based on climate characteristics (mean temperatures in January or July), yearly electricity production data, on the power characteristics of nuclear and hydro power stations located within the region bounds, and year dummies. The predicted values are used as proxies for regional electricity prices. Once I have price data and a schedule for all regions and for all years, I use firm specific data on connected power in 1993 (latest data available) to outline which tariff schedule is most likely to be applicable to a firm. Here, I implicitly assume that over the later period firms do not *significantly* change connected power, which is a costly investment, and as result, remain at the same tariff schedule. Using schedule information and information on electricity consumption in 1993, I recover price of KWH for each firm. For small firms price predictions are particularly precise. For larger firms price per KWH depends on current consumption, and, thus, if firms have decreased energy consumption, my price estimates are potentially upward biased. Once electricity prices are obtained for a firm in nominal terms, I used an industry / year specific deflator to obtain real prices. Gaps in the data that arise for the younger firms and those with missing information for 1993 are filled with the predicted values, that are calculated based on the firm location, industry, year, and sales.

Region specific construction prices

Russian statistical committee reports prices for a newly constructed properties (per square meter) and for a secondary market since 1996. Data is not reported for 1995. Also, the coverage of regions is not complete, as there are some missing observations for different regions. To minimize data loss, I fill gaps in data using auto-regression and regional characteristics. If gaps still remain, I use an average price of construction in neighboring regions in the same year as a proxy. Once all missing observations are filled for 1996 and later years, I use information on non-food products inflation by regions to approximate construction prices for 1995. After that, the regional level data on nominal construction prices is linked to the firm level data. The nominal prices are deflated by industry specific deflators (PPIs).

Table 1.1. Estimation results for whole manufacturing sector on the data set on small, medium firms and large firms for **production** workers.

Estimation method	OLS regression	Robust regression	Fixed effects	Random Effects‡	OLS regression	Fixed Effects	Arellano-Bond	1 Year Diff. OLS†
	1	2	3	4	5	6	7	8
Dependent variable	ln of production workers employment							Diff. ln emp.
Specification includes l_{t-1}	No	No	No	No	Yes	Yes	Yes	No
	Variables measuring elasticity, its link to openness and to the devaluation							
ln of wage	-0.525***	-0.728***	-0.318***	-0.352***	-0.064***	-0.215***	-0.202***	-0.234***
	(0.041)	(0.012)	(0.008)	(0.009)	(0.010)	(0.008)	(0.011)	(0.011)
ln of wage*post shock dummy	0.079***	0.078***	0.079***	0.047***	-0.009**	0.036***	0.025***	0.026***
	(0.012)	(0.007)	(0.004)	(0.004)	(0.004)	(0.003)	(0.005)	(0.003)
ln wage * ln(1+sector tariff)	-0.225*	0.144**	0.453***	0.325***	-0.052	0.294***	0.209***	0.354***
	(0.130)	(0.059)	(0.039)	(0.042)	(0.034)	(0.035)	(0.051)	(0.051)
ln wage * ln non-prod. wage	-0.025*	0.028***	0.025***	0.017***	-0.003	0.017***	0.012***	0.018***
	(0.013)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
	Demand shifters							
ln of sales	0.720***	0.740***	0.287***	0.434***	0.121***	0.226***	0.189***	0.209***
	(0.003)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)
Export-oriented sector	0.099***	0.084***	—	0.251***	0.001	—	—	—
	(0.020)	(0.008)	—	(0.020)	(0.005)	—	—	—
Import-competing sector	-0.151***	-0.140***	—	-0.025**	-0.035***	—	—	—
	(0.010)	(0.005)	—	(0.012)	(0.003)	—	—	—
ln(1+sector tariff)	1.890***	1.497***	0.102	0.532***	0.239***	0.038	0.086	0.074
	(0.239)	(0.107)	(0.079)	(0.084)	(0.062)	(0.072)	(0.099)	(0.094)
	Lagged employment							
1 year lagged employment l_{t-1}	—	—	—	—	0.859***	0.359***	0.301***	—
	—	—	—	—	(0.003)	(0.003)	(0.034)	—
	Other controls included into specifications§							
Time specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects*post shock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed firm effects	No	No	Yes	Yes	No	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effects*post shock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Additional regression information							
R-squared ("(w)"=within)	0.84	—	0.43 (w)	0.41 (w)	0.97	0.56 (w)	—	0.20
Number of observations	68,158	68,158	68,158	68,158	63,255	63,255	36,754	50,374
Number of distinct firms	16,860	16,860	16,860	16,860	16,242	16,242	11,750	—
	Labor demand elasticities implied by estimation (Evaluated at the mean electric price and mean log tariff value)							
Elasticity prior to shock	-0.72	-0.99	-0.28	-0.37	-0.02	-0.15	-0.11	-0.15
% change due to devaluation	-11.0	-7.9	-28.6	-12.8	≈0.0	-23.4	-23.2	-17.2%

†– One year differences for all regressors are used. Fixed effects for industries/firms/ regions are eliminated by differencing over time.

‡– Hausman test strongly rejects random effects specification in favor of fixed effects specification.

§– Other variables included into specification and estimation, but not reported here are: ln of construction price, ln of construction price*post shock dummy, ln of electricity price, ln of electricity price*post shock dummy, ln wage * ln electricity price.

Interaction term between construction price and log of wage is not included in any of specifications as it is very highly correlated to ln of wage and causes collinearity.

***, **, * - statistically significant at correspondingly 1%, 5% and 10% level.

Table 1.2. Estimation results for whole manufacturing sector on the data set on small, medium firms and large firms for **non-production** workers.

Estimation method	OLS regression	Robust regression	**Fixed effects**	**Random Effects**‡	OLS regression	Fixed Effects	**Arellano-Bond**	**1 Year Diff. OLS**†
	1	2	**3**	**4**	5	6	**7**	**8**
Dependent variable	ln of non-production workers employment							**Diff. ln emp.**
Specification includes l_{t-1}	No	No	**No**	**No**	Yes	Yes	**Yes**	**No**
	Variables measuring elasticity, its link to openness and to the devaluation							
ln of wage	-0.364***	-0.466***	**-0.295*** **	**-0.320*** **	-0.119***	-0.271***	**-0.293*** **	**-0.306*** **
	(0.024)	(0.011)	**(0.008)**	**(0.008)**	(0.008)	(0.008)	**(0.013)**	**(0.012)**
ln of wage*post shock dummy	0.029***	0.048***	**0.055*** **	**0.017*** **	-0.006	0.048***	**0.045*** **	**0.040*** **
	(0.010)	(0.007)	**(0.004)**	**(0.004)**	(0.005)	(0.004)	**(0.006)**	**(0.005)**
ln wage * ln(1+sector tariff)	0.034	0.206***	**0.291*** **	**0.272*** **	-0.099***	0.216***	**0.149** **	**0.333*** **
	(0.100)	(0.057)	**(0.042)**	**(0.044)**	(0.038)	(0.041)	**(0.065)**	**(0.063)**
ln wage * ln of prod. wage	-0.029***	0.008***	**-0.013*** **	**-0.011*** **	-0.012***	-0.020***	**-0.028*** **	**-0.024*** **
	(0.010)	(0.003)	**(0.003)**	**(0.002)**	(0.002)	(0.003)	**(0.004)**	**(0.004)**
	Demand shifters							
ln of sales	0.684***	0.702***	**0.224*** **	**0.435*** **	0.155***	0.196***	**0.162*** **	**0.173*** **
	(0.003)	(0.001)	**(0.003)**	**(0.002)**	(0.003)	(0.003)	**(0.004)**	**(0.004)**
Export-oriented sector	0.195***	0.131***	—	**0.332*** **	0.030***	—	**0.000**	—
	(0.020)	(0.009)	—	**(0.020)**	(0.006)	—	**(0.000)**	—
Import-competing sector	0.032***	0.021***	—	**0.136*** **	-0.001	—	**0.000**	—
	(0.010)	(0.005)	—	**(0.011)**	(0.003)	—	**(0.000)**	—
ln(1+sector tariff)	1.934***	1.645***	**0.252** **	**0.697*** **	0.513***	0.265**	**0.039**	**-0.023**
	(0.241)	(0.133)	**(0.105)**	**(0.109)**	(0.088)	(0.106)	**(0.164)**	**(0.149)**
	Lagged employment							
1 year lagged employment l_{t-1}	—	—	—	—	0.796***	0.186***	**0.239*** **	—
	—	—	—	—	(0.004)	(0.004)	**(0.026)**	—
	Other controls included into specifications§							
Time specific effects	Yes	Yes	**Yes**	**Yes**	Yes	Yes	**Yes**	**Yes**
Fixed industry effects	Yes	Yes	**Yes**	**Yes**	Yes	Yes	**Yes**	**Yes**
Fixed industry effects*post shock	Yes	Yes	**Yes**	**Yes**	Yes	Yes	**Yes**	**Yes**
Fixed firm effects	**No**	**No**	**Yes**	**Yes**	**No**	Yes	**Yes**	**Yes**
Region fixed effects	Yes	Yes	**Yes**	**Yes**	Yes	Yes	**Yes**	**Yes**
Region fixed effects*post shock	Yes	Yes	**Yes**	**Yes**	Yes	Yes	**Yes**	**Yes**
	Additional regression information							
R-squared ("(w)"=within)	0.84	0.86	**0.24(w)**	**0.22 (w)**	0.96	0.29(w)	—	**0.17**
Number of observations	68,158	68,158	**68,158**	**68,158**	62,846	62,846	**36,627**	**50,374**
Number of distinct firms	16,860	16,860	**16,860**	**16,860**	16,211	16,211	**11,664**	—
	Labor demand elasticities implied by estimation (Evaluated at the mean electric price and mean log tariff value)							
Elasticity prior to shock	-0.40	-0.42	**-0.27**	**-0.30**	-0.14	-0.27	**-0.31**	**-0.29**
% change due to devaluation	-7.3	-11.4	**-20.5**	**-5.7**	≈0.0	-17.8	**-14.6**	**-13.9**

†– One year differences for all regressors are used. Fixed effects for industries/firms/regions are eliminated by differencing over time.

‡– Hausman test strongly rejects random effects specification in favor of fixed effects specification.

§– Other variables included into specification and estimation, but not reported here are: ln of construction price, ln of construction price*post shock dummy, ln of electricity price, ln of electricity price*post shock dummy, ln wage * ln electricity price.

Interaction term between construction price and log of wage is not included in any of specifications as it is very highly correlated to ln of wage and causes collinearity.

***, **, * - statistically significant at correspondingly 1%, 5% and 10% level.

Table 2.1. Sector by sector estimation results for the data set on small, medium and large firms for **production** workers. Fixed effects estimates.

Sector	Power & Oil & Gas	Ferrous/ Non Ferrous metallurgy	Petro-chemical	Machinery and metal working	Timber including processing	Construction materials	Light industry	Food & food processing	Other manufacturing sectors
	1	2	3	4	5	6	7	8	9
Share of imported materials‡	6%	15%	13%	16%	7%	6%	34%	11%	10%
	Variables measuring elasticity and its link to the devaluation								
ln of wage	-0.048	-0.119***	-0.371***	-0.288***	-0.249***	-0.336***	-0.290***	-0.188***	-0.275***
	(0.052)	(0.038)	(0.045)	(0.015)	(0.017)	(0.017)	(0.017)	(0.010)	(0.017)
ln of wage*post shock dummy	0.011	0.055***	0.080***	0.098***	0.064***	0.068***	0.077***	0.074***	0.074***
	(0.017)	(0.019)	(0.020)	(0.008)	(0.009)	(0.009)	(0.010)	(0.006)	(0.008)
	Demand shifters								
ln of sales	0.222***	0.204***	0.277***	0.304***	0.362***	0.337***	0.285***	0.278***	0.217***
	(0.012)	(0.014)	(0.013)	(0.006)	(0.006)	(0.006)	(0.007)	(0.004)	(0.006)
ln(1+sector tariff)	-7.645***	0.001	-0.837	1.501***	-2.131***	0.241	2.582***	0.300***	2.976***
	(1.797)	(0.793)	(1.275)	(0.479)	(0.458)	(1.517)	(0.367)	(0.083)	(0.237)
	Other controls included into specifications§								
Time specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed firm effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Additional regression information								
R-squared (within)	0.234	0.302	0.406	0.447	0.499	0.533	0.517	0.357	0.334
Observations	1,980	1,225	1,785	12,656	8,604	8,102	7,843	18,033	8,218
Number of unique firms	469	295	393	3,014	2,469	2,042	1,981	4,545	1,751
	Implied change in elasticity due to devaluation								
Elasticity (at mean point)	-0.06	-0.10	-0.24	-0.23	-0.27	-0.21	-0.27	-0.17	-0.20
Change in elasticity, %	**-17.9**	**-55.3**	**-32.9**	**-41.8**	**-24.8**	**-32.3**	**-28.7**	**-44.4**	**-37.0**
	Alternative estimates of labor demand elasticity and its change due to devaluation								
Elasticity (Random Effects)†	-0.131***	-0.176***	-0.305***	-0.358***	-0.306***	-0.248***	-0.328***	-0.194***	-0.279***
Change in elasticity (Coeff.)	-0.003	0.048**	0.029	0.083***	0.031***	0.028***	0.035***	0.046***	0.041***
Elasticity (AB), short run	-0.001	-0.154***	-0.260***	-0.176***	-0.190***	-0.143***	-0.142***	-0.127***	-0.145***
Change in elasticity (Coeff.)	-0.001	0.036	0.063***	0.024**	0.018	0.026**	0.014	0.019***	0.036***
Lag of employment (AB)	0.050	0.013	0.013	0.463***	0.247***	0.126***	0.353***	0.151***	0.251***

Industries description and aggregation into categories (Russian industry classification "Okonh" system):
1– power industry, fuel industry, coal, peat, and shale industry; 2– extraction and processing of ferrous and nonferrous metals;
3– chemical and petrochemical industry; 4– machinery and metal-working industry (e.g., aircraft construction, automotive construction and engineering, shipbuilding industry, etc.); 5– timber, woodworking, pulp, and paper industry; 6– construction materials industry; 7– light industry (inc. textiles, sewing, leather, footwear, furriery sectors); 8– food industry (e.g., sugar, baking, confectionery, etc.); 9– other sectors (microbiological, flour-and-cereals industry, printing industry, toys production, jewelry, state certification services).

‡ – data from input-output tables, †– Hausman test strongly rejects random effects specification in favor of fixed effects specification.

§– Other variables included into specification and estimation, but not reported here are: ln of construction price, ln of construction price*post shock dummy, ln of electricity price, ln of electricity price*post shock dummy. Interaction terms between construction price and log of wage, ln wage * ln electricity price, ln wage * ln(1+tariff) are *not* included in any of equations as it is very highly correlated to ln of wage.

***, **, * - statistically significant at correspondingly 1%, 5% and 10% level.

Table 2.2. Sector by sector estimation results for the data set on small, medium and large firms for **non-production** workers. Fixed effects estimates.

Sector	Power & Oil & Gas	Ferrous Non Ferrous metallurgy	Petro-chemical	Machinery and metal working	Timber including processing	Construction materials	Light industry	Food & food processing	Other manufacturing sectors
	1	2	3	4	5	6	7	8	9
Share of imported materials‡	6%	15%	13%	16%	7%	6%	34%	11%	10%
	Variables measuring elasticity and its link to the devaluation								
ln of wage	-0.093**	-0.239***	-0.219***	-0.286***	-0.248***	-0.177***	-0.266***	-0.249***	-0.200***
	(0.037)	(0.039)	(0.036)	(0.012)	(0.016)	(0.015)	(0.014)	(0.010)	(0.015)
ln of wage*post shock dummy	0.009	0.087***	0.101***	0.071***	0.065***	0.007	0.063***	0.050***	-0.002
	(0.019)	(0.024)	(0.020)	(0.009)	(0.011)	(0.010)	(0.011)	(0.007)	(0.009)
	Demand shifters								
ln of sales	0.183***	0.178***	0.228***	0.238***	0.259***	0.257***	0.204***	0.225***	0.199***
	(0.014)	(0.020)	(0.013)	(0.006)	(0.008)	(0.007)	(0.008)	(0.006)	(0.008)
ln(1+sector tariff)	-7.200***	0.238	-0.179	0.451	-0.385	-1.606	0.806*	0.653***	2.221***
	(2.114)	(1.144)	(1.357)	(0.539)	(0.559)	(1.906)	(0.422)	(0.114)	(0.314)
	Other controls included into specifications§								
Time specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed firm effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Additional regression information								
R-squared (within)	0.219	0.292	0.284	0.281	0.299	0.274	0.288	0.191	0.148
Observations	1,980	1,225	1,785	12,656	8,604	8,102	7,843	18,033	8,218
Number of unique firms	469	295	393	3,014	2,469	2,042	1,981	4,545	1,751
	Implied change in elasticity due to devaluation								
Elasticity (at mean point)	-0.26	-0.32	-0.28	-0.30	-0.28	-0.22	-0.27	-0.27	-0.24
Change in elasticity	-3.5	-27.6	-35.9	-24.0	-22.9	-3.2	-23.1	-18.5	0.8
	Alternative estimates of labor demand elasticity and its change due to devaluation								
Elasticity (Random Effects)†	-0.290***	-0.309***	-0.320***	-0.380***	-0.268***	-0.225***	-0.269***	-0.268***	-0.316***
Change in elasticity (Coeff.)	-0.020	0.079***	0.047**	0.051***	0.016	-0.028***	0.017	0.028***	-0.021**
Elasticity (AB), short run	-0.334***	-0.392***	-0.320***	-0.289***	-0.328***	-0.245***	-0.313***	-0.311***	-0.277***
Change in elasticity (Coeff.)	0.021	0.099***	0.036	0.032**	0.089***	-0.022	0.022	0.044***	0.024
Lag of employment (AB)	0.050	0.013	0.013	0.463***	0.247***	0.126***	0.353***	0.151***	0.251***

Industries description and aggregation into categories (Russian "Okonh" system)
1− power industry, fuel industry, coal, peat, and shale industry; 2− extraction and processing of ferrous and nonferrous metals; 3− chemical and petrochemical industry; 4− machinery and metal-working industry (e.g., aircraft construction, automotive construction and engineering, shipbuilding industry, etc.); 5− timber, woodworking, pulp, and paper industry; 6− construction materials industry; 7− light industry (inc. textiles, sewing, leather, footwear, furriery sectors); 8− food industry (e.g., sugar, baking, confectionery, etc.); 9− other sectors (microbiological, flour-and-cereals industry, printing industry, toys production, jewelry, state certification services).

‡ − data from input-output tables, †− Hausman test strongly rejects random effects specification in favor of fixed effects specification.

§− Other variables included into specification and estimation, but not reported here are: ln of construction price, ln of construction price*post shock dummy, ln of electricity price, ln of electricity price*post shock dummy. Interaction terms between construction price and log of wage, ln wage * ln electricity price, ln wage * ln(1+tariff) are not included in any of equations as it is very highly correlated to ln of wage.

***, **, * - statistically significant at correspondingly 1%, 5% and 10% level.

Table 3. Estimation of equation on the sample of the largest firms (Interfax Spark data) based on **total** employment.

Estimation method	Fixed effects	Random effects	A-B estimator	Fixed effects	Random effects	A-B estimator	Fixed effects	Random effects	A-B estimator
Sample	Full sample	Full sample	Full sample	Oil, gas & metals[1]	Oil, gas & metals	Oil, gas & metals	Machinery[2]	Machinery	Full sample
	1	2	3	4	5	7	6	8	9
	Elasticity and the variables measuring link between elasticity and trade openness								
ln of wage	-0.314***	-0.350***	-0.186***	-0.357***	-0.465***	-0.341***	-0.323***	-0.270**	-0.201
	(0.034)	(0.039)	(0.041)	(0.060)	(0.074)	(0.060)	(0.099)	(0.109)	(0.157)
ln of wage * post shock dummy	0.075***	0.038*	0.023	0.090***	0.051	0.040	0.088***	0.077***	0.069***
	(0.018)	(0.022)	(0.016)	(0.028)	(0.037)	(0.026)	(0.024)	(0.027)	(0.024)
ln wage * ln(1+sector tariff)	0.698**	0.237	-0.847**	1.719**	2.303***	1.918***	0.101	-0.974	-1.567
	(0.290)	(0.337)	(0.358)	(0.720)	(0.881)	(0.702)	(0.660)	(0.726)	(1.018)
	Demand shifters								
ln of sales	0.133***	0.278***	0.149***	0.078***	0.234***	0.086***	0.237***	0.352***	0.206***
	(0.009)	(0.010)	(0.014)	(0.013)	(0.015)	(0.022)	(0.013)	(0.014)	(0.017)
Export oriented sector	—	0.511***	—	—	0.631***	—	—	0.544***	—
	—	(0.098)	—	—	(0.148)	—	—	(0.139)	—
Import competing sector	—	-0.289***	—	—	1.415**	—	—	-0.248***	—
	—	(0.097)	—	—	(0.579)	—	—	(0.084)	—
	Lagged employment								
Log of lagged employment	—	—	0.643***	—	—	0.602***	—	—	0.548***
	—	—	(0.069)	—	—	(0.106)	—	—	(0.073)
	Other controls included into specifications†								
Time specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Fixed industry effects*post shock	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed territory effects	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Fixed territory effects*post shock	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
	Additional regression information								
R-squared (within)	0.24	0.21	—	0.21	0.16	—	0.38	0.36	—
Number of observations	2489	2489	1612	1091	1091	688	1398	1398	924
Number of distinct firms	640	640	557	283	283	239	357	357	318
	Labor demand elasticities implied by estimation (Evaluated at the mean log tariff value)								
Elasticities prior to shock	**-0.23**	**-0.32**	**-0.29 (SR)**	**-0.22**	**-0.28**	**-0.19 (SR)**	**-0.31**	**-0.42**	**-0.44 (SR)**
% change due to devaluation	**-23.9**	**-10.9**	**-12.4**	**-25.2**	**-11.0**	**-11.7**	**-27.2**	**-28.5**	**-34.3**

1– Extraction and processing of ferrous and nonferrous metals; Petroleum, gas, oil industry.

2– Aircraft construction and engineering industry; Automotive construction and engineering industry; Tractor and farm machinery; Metal structures and products construction; Heavy engineering industry, energy/power machinery engineering, transport engineering; Chemical and petrochemical machinery engineering; Electronic engineering; Manufacturing of computer equipment and software; Shipbuilding industry; Defense Industry; Machinery engineering for light and food industries; Radio industry; Road-building equipment Instrument making and engineering industry; Machinery and equipment repair industry; Tool engineering and production.

†– Other variables included into specification and estimation, but not reported here are: ln of construction price, ln of electricity price, ln of electricity price*post shock dummy, log of (1+ tariff). Other interactions were omitted to avoid collinearity issues in small sample.

***, **, * - statistically significant at correspondingly 1%, 5% and 10% level.

Table 4. Unconditional labor demand function estimated on the sample of the largest firms (Interfax Spark data) based on the **total** employment data.

Sample	O.G.M.[1]	O.G.M	O.G.M	O.G.M	Machin.[2]	Machinery	Machinery	Machinery
Estimation method	Fixed effects	AB fixed effects	Fixed effects	AB fixed effects	Fixed effects	AB fixed effects	Fixed effects	AB fixed effects
	1	2	3	4	5	6	7	8
	Variables measuring (and affecting) elasticity							
ln of wage	-0.537***	-0.470***	-0.307***	-0.254***	-0.387***	-0.501**	-0.371***	-0.099
	(0.103)	(0.093)	(0.063)	(0.058)	(0.122)	(0.223)	(0.118)	(0.191)
ln of wage * post shock dummy	0.120***	0.056**	0.097***	0.049**	0.103***	0.064**	0.105***	0.074**
	(0.030)	(0.025)	(0.029)	(0.024)	(0.028)	(0.030)	(0.027)	(0.029)
ln wage * $1/\left(1-I^{jt}_{trade,home}\right)$	—	—	-0.024*	-0.031***	—	—	0.014**	0.005
	—	—	(0.013)	(0.012)	—	—	(0.006)	(0.008)
ln wage * export oriented	0.144**	0.136**	—	—	0.183	0.066	—	—
	(0.063)	(0.063)	—	—	(0.148)	(0.218)	—	—
ln wage *import compet.	-0.167	-0.166	—	—	0.047	0.262***	—	—
	(0.209)	(0.185)	—	—	(0.045)	(0.067)	—	—
	Other controls included into specifications†							
Time specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects*post shock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed territory effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed territory effects*post shock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Additional regression information							
R-squared ("(w)"=within)	0.18 (w)	—	0.17 (w)	—	0.18 (w)	—	0.19 (w)	—
Number of observations	1,083	685	1,083	685	1,367	894	1,367	894
Number of distinct firms	282	239	282	239	357	314	357	314
	Labor demand elasticities Implied by the estimation (Evaluated at the mean log tariff value)							
Elasticites prior to shock	-0.32	-0.27	-0.18	-0.13	-0.21	-0.46	-0.21	-0.34
Labor dem. elast., exp. ortd.	-0.18	-0.14	—	—	-0.03	-0.39	—	—
Labor dem. elast., imp. ortd.	-0.48	-0.43	—	—	-0.16	-0.20	—	—
% change due to devaluation	-37.0	-20.4	-55.2	-28.4	-49.2	-13.9	-50.9	-22.0

1– Oil, gas and metallurgy sector (O.G.M); 2– Machinery sector. See table 3 for exact definitions of the sectors.
†– Other variables included into specification and estimation, but not reported here are: ln(1+sector tariff), ln of construction price, ln of electricity price, ln of electricity price*post shock, ln wage *(1+tariff), export ortd.*post shock, import ortd*post shock dummy. Other interaction terms are not included to avoid collinearity issues.

***, **, * - statistically significant at correspondingly 1%, 5% and 10% level.

Table 5. Robustness check: IV results for the data set on small and medium firms for production and non-production workers

	First Stage Regressions				Second Stage Equations			
Sample (product. or non-product.)	product.	non-prod.	product.	non-prod.	product.	non-prod.	product.	non-prod.
Estimation method	OLS	OLS	OLS	OLS	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
Column	1	2	3	4	5	6	7	8
Regression #	1.1	2.1	3.1	4.1	1.2	2.2	3.2	4.2
Dependent variable	ln of wage[1]				ln of b-c empl[2]	ln of w-c empl[2]	ln of b-c empl[2]	ln of w-c empl[2]
ln of wage in the same sector,	0.774***	0.741***	0.515***	0.560***	—	—	—	—
but in a different region	(0.014)	(0.015)	(0.012)	(0.013)	—	—	—	—
Gross regional product per	0.029*	0.126***	0.038**	0.136***	—	—	—	—
capita relative to Russia's average	(0.016)	(0.018)	(0.015)	(0.017)	—	—	—	—
Unemployment level in the region	-0.002**	-0.003***	-0.001	-0.003**	—	—	—	—
	(0.001)	(0.001)	(0.001)	(0.001)	—	—	—	—
Average wage in the region	0.026***	0.004	0.024***	0.002	—	—	—	—
across all sectors	(0.003)	(0.003)	(0.003)	(0.003)	—	—	—	—
ln of sales	—	—	0.157***	0.152***	—	—	—	—
	—	—	(0.002)	(0.002)	—	—	—	—
ln of wage constructed	—	—	—	—	-0.393***	-0.239***	-0.459***	-0.305***
	—	—	—	—	(0.025)	(0.028)	(0.029)	(0.031)
ln of wage constructed *	—	—	—	—	0.101***	0.046***	0.123***	0.041***
Post 98 dummy	—	—	—	—	(0.010)	(0.013)	(0.006)	(0.008)
ln wage constructed *	—	—	—	—	0.763***	0.719***	1.045***	0.917***
ln(1+sector tariff)	—	—	—	—	(0.072)	(0.095)	(0.066)	(0.086)
ln wage prod. constr. *	—	—	—	—	0.041***	0.038***	0.035***	0.037***
ln wage nob-product. constr.	—	—	—	—	(0.008)	(0.010)	(0.007)	(0.008)
ln of sales	—	—	—	—	0.258***	0.178***	0.303***	0.204***
	—	—	—	—	(0.002)	(0.003)	(0.003)	(0.004)
	Other controls included into specification							
Time specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed industry effects * $P98$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region specific effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region specific effects * $P98$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed firms effects	No	No	No	No	Yes	Yes	Yes	Yes
	Labor demand elasticities implied by the estimation (Evaluated at the mean log tariff value)							
Elasticities prior to shock	—	—	—	—	-0.21	-0.079	-0.25	-0.121
% change due to devaluation	—	—	—	—	-48.1%	-58.5%	-49.4%	-33.9%
	Additional regression information							
R-squared	0.445	0.371	0.576	0.487	0.401	0.164	0.409	0.165
Number of observations	68,061	67,957	68,061	67,957	67,875	67,875	67,875	67,875
Number of distinct firms	—	—	—	—	16,819	16,819	16,819	16,819

1– Other controls included: Dummies for export-oriented, import-competing sectors, their interactions with post 1998 dummy, share of population with a higher education in the region (not significant at 10%).

2– Other variables included into specification and estimation, but not reported here are:
ln of construction price, ln of construction price*$P98$, ln of electricity price, ln of electricity price*$P98$, ln wage * ln electricity price. Interaction term between construction price and log of wage is not included in any of specifications as it is very highly correlated to ln of wage.