FIRM LEVEL ALLOCATIVE INEFFICIENCY OF LABOUR: EVIDENCE FROM TURKISH MANUFACTURING FIRMS

by

ÖZGE ELİF CESUR

Submitted to the Institute of Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

Sabancı University

July 2018

FIRM LEVEL ALLOCATIVE INEFFICIENCY OF LABOUR:
EVIDENCE FROM TURKISH MANUFACTURING FIRMS

APPROVED BY:

Dr. Öğr. Üyesi Esra Durceylan Kaygusuz (Thesis Supervisor) ....

Doç. Dr. İzak Atiyas ....

Doç. Dr. Ozan Bakış ....

DATE OF APPROVAL: JULY 19, 2018

ABSTRACT

FIRM LEVEL ALLOCATIVE INEFFICIENCY OF LABOUR: EVIDENCE FROM TURKISH MANUFACTURING FIRMS

ÖZGE ELİF CESUR

Economics, M.A. Thesis, July 2018

Thesis Supervisor: Asst. Prof. Esra Durceylan Kaygusuz

This paper quantifies misallocation of labor among firms within Turkish manufacturing sector over the period of 2006-2015. The degree of misallocation is estimated by using Petrin and Sivadasan's (2013) gap methodology. The labor gap is defined as the difference between the value of the marginal product of labor and the marginal cost of labor. Over the period 2006-2015, the average absolute labor gap is estimated to be 3.5 thousand TL. Considering that average yearly wage is 14.9 thousand TL in our data, the labor gap is equal to 2.8 times the average monthly wage. By running a firm fixed effects regression on absolute labor gap, this paper concludes that the gaps have a significant decreasing trend over 2006-2015 period. Controlling for firm characteristics, this paper also shows that the misallocation of labor is decreasing by firm size.

Keywords: allocative ineffciency, labor productivity, manufacturing sector, misallocation

ÖZET

İŞGÜCÜ TAHSİSAT ETKİNLİĞİ ÖLÇÜMÜ: TÜRKİYE İMALAT SANAYİ ÖRNEĞİ

ÖZGE ELİF CESUR

Ekonomi, Yüksek Lisans Tezi, Temmuz 2018

Tez Danışmanı: Dr. Öğr.Üyesi Esra Durceylan Kaygusuz

Bu çalışma, 2006-2015 döneminde Türkiye imalat sektöründeki firmalar için işgücünün yanlış tahsisatını ölçmektedir. Bu çalışmada Petrin ve Sivadasan'ın (2013) fark metodolojisini kullanılarak emeğin marjinal ürününün değeri ile emeğin marjinal maliyeti arasındaki farkı yani emeğin yanlış tahsisatının değeri tahmin edilmektedir. 2006-2015 döneminde, ortalama mutlak işgücü açığı 3,5 bin TL olarak tahmin edilmiştir. Verilerimizde imalat sanayiinde yıllık ortalama ücretin 14,9 bin TL olduğu göz önüne alındığında, tahmin edilen işgücü açığı aylık ortalama ücretin 2,8 katına eşit bulunmuştur. Bu çalışma, mutlak işgücü açığı üzerinde firma seviyesinde sabit etki regresyonu uygulayarak, farkların 2006-2015 döneminde belirgin bir düşüş eğilimine sahip olduğu sonucuna varmıştır. Firma özellikleri açısından kontrol edildiğinde işgücünün yanlış tahsisatının firma büyüklüğüne göre azaldığı da tespit edilmiştir.

Anahtar Kelimeler: tahsisat etkinliği, işgücü verimliliği, imalat sanayi, yanlış tahsisat

ACKNOWLEDGEMENTS

I would like to thank my thesis adviser, Asst. Prof. Esra Durceylan Kaygusuz for her support and supervision throughout this process. I believe, without her guidance and valuable suggestions this thesis would not possibly exist. I would like to thank Assoc. Prof. İzak Atiyas for his kindness in answering my questions, guidance in understanding the data and useful comments as my thesis jury member. I am grateful to Assoc. Prof. Ozan Bakış for his help, insightful questions and comments as my thesis jury member. I also thank TUIK for providing the data and working environment.

I want to thank my cohort in Sabancı Economics and my roommate İpek for all their support through my M.A. education.

Special thanks to Ahmet for making me laugh and believe myself even in most desperate situations.

Last but most importantly, I am very grateful to my parents and my brother for their love and trust in me all the time.

Contents

List of Tables

List of Figures

1 INTRODUCTION

There is a vast amount of evidence that real world firms are away from the neoclassical theory which says a profit maximizing firm operates where the value of the marginal product (VMP or marginal revenue) of an input is equal to the marginal cost of the same input. One can find different forces such as regulations, markups, firing costs, contracting problems etc. that move firms and economies further away from this optimum point. In search for reasons behind this divergence from optimal point, looking at the amount of divergence, its distribution across firms and sectors as well as its evolution bring up numerous interesting questions and findings. To get a macro level perspective about this difference between VMP and marginal cost that is recorded in the micro level, I provide figures for OECD and Turkey that shows the trends in GDP per hour worked and the labor compensation per hour worked.[1] Here, in a broad sense GDP per hour could be seen a macro level indicator for VMP while labor compensation per hour is an indicator for marginal cost.

Unit labor cost (ULC) is defined as the average cost of labor per unit of output produced which is the ratio of total labor compensation per hour worked to the output per hour worked. Hence it can be perceived as a measure of rate of divergence between marginal product and marginal cost for macro level. Here, since these are indexes with base year 2010, we can not have level comparisons but we can compare the trends in labor compensation and GDP per hour worked. Figure 1 shows that for Turkey between 2005-2015, GDP per hour worked

[1] Indexes are taken from OECD Productivity database

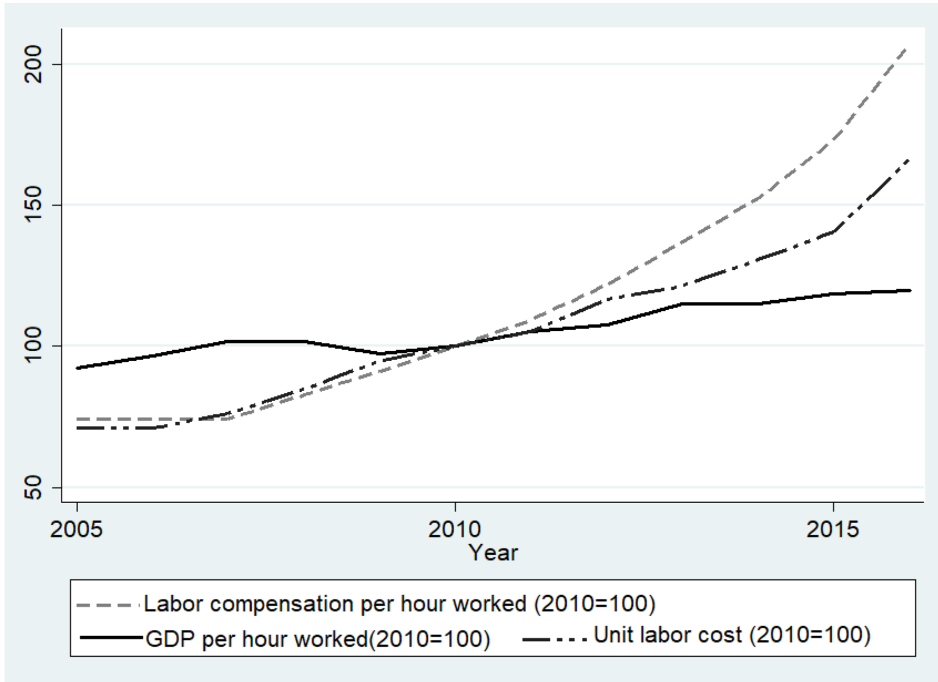

Figure 1: GDP and Labor Compensation per hour worked index: Turkey 2005-2015

has a very slight increasing trend whereas labor compensation per hour worked increased much more rapidly. Hence, an increase in the divergence measure ULC is recorded. Figure 2 provides a general comparison with Turkey. We see that for OECD average, both labor compensation and GDP per hour worked have increasing trend over the years. The trends are similar for Turkey and OECD average while the wedge between labor compensation and GDP per hour grows more rapidly in Turkey.

Starting from these macro level observations, one needs to keep in mind that these figures only provide trends and to measure and understand the wedge, we need to start the analysis at the micro level. Petrin and Sivadasan (2013) develop a straightforward yet powerful measure that uses firm level production data and defines the ”gap” of an input as the difference between an input’s value of the marginal product and marginal cost. Hence, employing this estimation with firm level data, one can estimate how distant a firm from the optimal point in allocating an input. Moreover, using firm level data, one can also estimate distance from optimal or inefficiency in allocation for industry and whole economy level.

The gap between marginal product and marginal cost of an input is a topic of interest

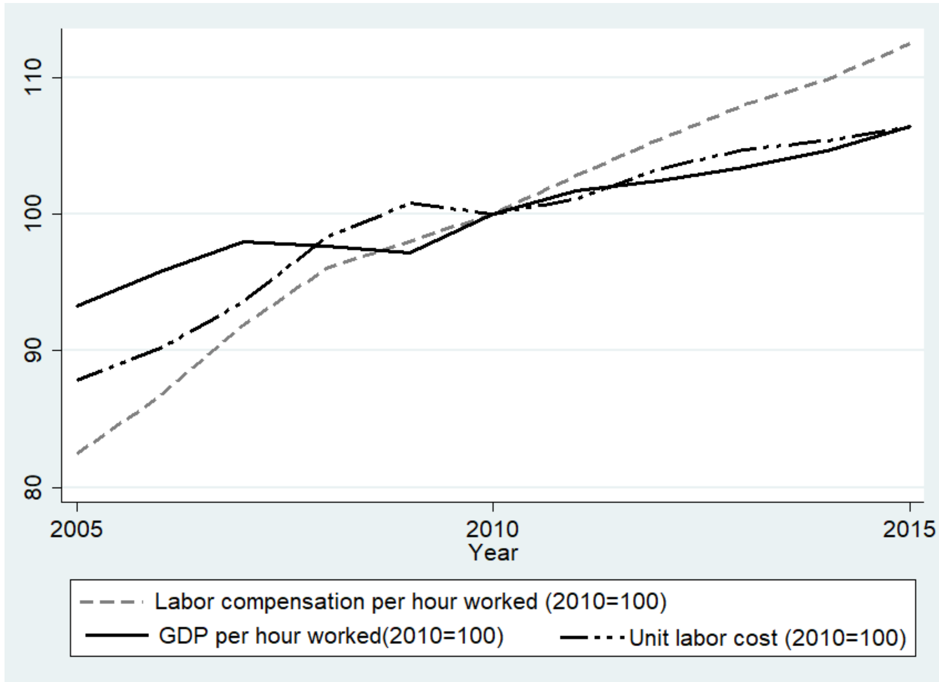

Figure 2: GDP per hour worked and Labor Compensation index: OECD average 2005-2015

because it stands for a measure of how much firms and industries away from their optimal point in allocation and hence gives us the level of misallocation of an input. It also provides that how much an industry would gain if reallocation of inputs between firms were made to reach the optimal point. The gap also indicates that whether an average worker is overpaid or underpaid within a firm and industry level.

This study aims to measure the allocation inefficiency of labor in Turkish manufacturing sector and tries to understand possible factors explaining the calculated inefficiency. I first estimate the production function coefficients and then employed the gap methodology proposed by Petrin and Sivadasan (2013) using firm level data for Turkish manufacturing industry provided by TURKSTAT for the period between 2005 and 2015. I found that the positive gaps constitute 73% percent of the total observations which means that an average worker is paid less than her marginal product in 73 % of the time. To understand the evolution of the gaps and the possible factors behind, I used a firm fixed effects regression with dependent variable being absolute gaps and independent variables being time and firm characteristics such as firm size, export and import status, ownership structure, firm age and the share of female workers.I find that the gap in labor ,i.e. allocation inefficiency, is decreasing and moving towards optimal point over the period of 2005-2015 with a remarkable decrease after 2010. I also find that firm size and the absolute gap is negatively correlated which can be interpreted as larger firms operate more closer to optimal allocation point.

The paper proceeds as follows: Section 2 provides a summary of the literature on allocation inefficiency and studies on Turkish manufacturing sector. Section 3 explains methodology for productivity and gap estimation in detail. Section 4 introduces the firm level data for Turkey and gives estimated coefficients for production and gap. Section 5 explains the regression used in analysis and results are provided in Section 6. Finally, Section 7 concludes.

2 LITERATURE REVIEW

Empirical studies show that resources are not easily reallocated from less to more productive firms because of several different factors such as regulation, rigidity in input markets, business cycles etc. (Fontagne and Santoni,2018). This rigidity in reallocation implies that firms are not performing at optimal allocation point of an input across firms in a given sector. Hence, this deviation from optimal allocation is defined to be resource (input) misallocation. In a pioneer study of Hsieh and Klenow (2009), they showed that input misallocation have negative effects on total factor productivity (TFP). Base on the idea that in an environment with no distortions, revenue-based productivity should be same across firms within sector. They define a measure of resource misallocation by the dispersion of revenue-based productivity generated by the product of productivity and firm level output price. They go through a hypothetical input reallocation exercise for China and India. They conclude that China and India would have 30-50 % and 40-60 % higher TFP respectively if they were at the misallocation level calculated for the US economy.

Following the gains from reallocation argument and methodology of Hsieh and Klenow (2009), Berhou and Sandoz (2014) find very high heterogeneity in firm productivity in France, Spain and Belgium implying that the allocation inefficiency of labor could be a key determinant of differences in aggregate productivity. Using micro-data from France, Bellone and Pisano (2013) concludes that sizeable differences in input allocation that are denoted between the US and China or India, does not exist between France and the US.

Acknowledging the possible negative impact of allocation inefficiencies within industries on total productivity, one natural question would be what are the factors behind misallocation? This question bears a great importance because as denoted by Syverson (2014) both microeconomic policies such as taxes, subsidies, investment and labor market regulations and macroeconomic policies such as trade policies, agreements, rules and laws shaping allocation of resources across businesses are tied to firm-level misallocation.

Bento and Restuccia (2014) showed that allocation inefficiencies and firm size are important factors in explaining international productivity differences.They conclude that policy distortions, market frictions and institutions are prominent factors driving level of misallocation. In search of understanding the dynamics of allocative inefficiency, Ranasinghe (2014) detects one important mechanism as distortions on incentives. He showed that when distortions are related to productivity, they also lead a decrease in innovation and hence amplify the negative effects on TFP and lead allocation inefficiencies. The intuition behind this is that disruptive effect of policies are observed differently on heterogeneous firms and hence misallocation of inputs within industries.

As one of the prominent works in the literature on input misallocation, Petrin and Sivadasan (2013) proposed a new methodology, which we will explain in detail in section 3.2. They measure the lost output caused by inefficiencies in input allocation and effect of a distortion. Petrin and Sivadasan (2013) proved that "... only when the firm faces an infinite price elaticity of demand and there are no firing costs will the value of the marginal product (VMP) be equated to the wage " (p.8). Then any distortion of the input market would cause a deviation from VMP=MC point and since a distortion also tied to the misallocation of an input, the deviation from VMP=MC point is argued to be measure of input misallocation. The main proof and the measure depends on the following claim that difference of the value of the marginal product (VMP) and its marginal cost (MC) should be equal to the change in output by reallocation of that input by one unit. By directly generalizing this one unit reallocation to economy level reallocation of input from inefficient firms to efficient ones, one can see that the mean gap in absolute terms would give us the aggregate gain from correcting a misallocation. Apart from gains of reallocation, the gap between VMP and MC can be used to measure how much a plant is deviating from efficient point. Hence, Petrin and Sivadasan (2013) also showed the effect of increase in severance pay on misallocation by denoting the increase in the mean labor gaps within firm after the regulation.

Fontagne and Santoni (2018) aim to understand the effect of agglomeration economies on firm-level labor misallocation by employing Petrin and Sivadasan (2013)'s methodology. Using firm-level French data, they first asses evolution of labor gaps and importance of firm characteristics. They conclude that average gaps are increasing over time. By controlling on production size and export status of the firm, they showed that larger firms and exporting firms have significantly smaller gaps and hence they argue that more productive firms allocate more efficiently. Then controlling for firm characteristics, non-random selection of location by workers and firm-level wage or productivity shocks, they conclude that location of firms has significant effect on allocation inefficiencies so that firms in denser areas have significantly lower labor gaps.

When one aims to measure allocation inefficiencies, one can use either distribution of revenue based productivity proposed by Hsieh and Klenow (2009) or the VMP and MC gap measure of Petrin and Sivadasan (2013). Here, although these measures come from similar line of reasoning, I choose to employ the Petrin and Sivadasan (2013) method because Hsieh and Klenow (2009) method usually used in international comparisons of relation between allocation and TFP. With the firm level gap measure, I am also able to directly measure the degree of how much firms are away from optimum point of production.

Following the literature on input misallocation, this study is aimed to calculate misallocation in labor for Turkish manufacturing sector. Using firm level data, I employ Petrin and Sivadasan (2013) methodology to quantify misallocation in labor and then I aim to denote the evolution of the labor misallocation for the period 2006-2015 and asses the role of firm characteristics in allocative inefficiency.

There exist several studies on TFP and TFP growth (TFPG) in Turkey for different time periods (Altug et.al. (2008), Atiyas and Bakis (2014), Ismihan and Ozcan (2009), Saygili and Cihan (2008)). By using a growth accounting exercise Altug et al. (2008) studies TFPG at the sectoral level for the period of 1880-2005. With a broad sectoral differentiation as agricultural and non-agricultural, they conclude that for the period between 1980-2005 TFPG at non-agricultural sectors has the greatest contribution to aggregate growth. Atiyas and Bakis (2014) gives a more sophisticated analysis by examining the TFPG at the three main sectors (agriculture, industry, and services). They denote that in 2000s the average TFPG in agricultural sector was greater than industry and services. They suggest that this observation could be related to reallocation of labor from agriculture to manufacturing and services.

Filiztekin (2000) focuses on the effect of trade liberalization on productivity growth in Turkish manufacturing sector for the period between 1970-1999. By industry level data, he finds that openness to trade by increasing share of imports and exports improved the productivity growth. Another analysis on manufacturing sector by Erzan and Filiztekin (2005) concludes that size of the firms are important in growth performance of the firms such that smaller firms recorded lower productivity growth for the years between 1980-1999. They also point out that productivity growth of the smaller firms are much more sensitive to negative macroeconomic changes.

There is one study by Nguyen et al.(2016) on misallocation in Turkish manufacturing sector. Using firm level Turkish data provided by TURKSTAT and following the method proposed by Hsieh and Klenow (2009), they go through a hypothetical resource reallocation exercise. They conclude that TFP for Turkish manufacturing sector would have been 24.5% higher if Turkey were at misallocation level of the US. For the period of 2003-2013, they find a significant decreasing trend in level of misallocation, whereas an increase for 2014. They also conclude that within manufacturing sector, the misallocation is especially higher in textiles, food, leather products and transportation.

From the above provided summary of studies on productivity estimation and manufacturing sector in Turkey, we can see that more research is needed for Turkey covering recent time periods and using recent productivity estimation methodologies. Moreover, there is only one analysis elaborating on resource misallocation for Turkey which looks at total reallocation for capital and labor together. Hence, I think quantifying labor productivity and inefficiency in labor allocation is important since it would give us a comparable measure in terms of TL that can be used in understanding labor market dynamics, evolution and reasons behind inefficiencies in allocation of labor. I choose the method of Petrin and Sivadasan (2013) to measure allocation inefficiency in labor since the gap measure provides how far a firm or an industry is away from optimal point in input allocation. The gap measure used in this study also gives information on the situation of an average worker in an industry. Moreover, using the gap measure, I am able to denote the trend in inefficiency in labor allocation through 2006-2015 and give some firm level insights regarding labor allocation.

I show that average absolute labor gap is 3,508 TL for whole manufacturing sector and it is equal to 23% of the yearly average real minimum wage for the period 2006-2015. By running firm fixed effects regression on the absolute labor gap with time, firm size and different firm characteristics as explanatory variables, I conclude that the absolute labor gap, i.e. misallocation, is decreasing over years and by the firm size. Although we have different misallocation measures, my results are similar with Nguyen et al. (2016) in terms of trends of misallocation in Turkish manufacturing sector, whereas I conclude for different sectors as having highest misallocation namely: Metals, transportation and chemicals. By using the same gap measure of Petrin and Sivadasan (2013), Fontagne and Santoni (2018) concludes for French manufacturing sector that the gaps are increased in period between 1998-2007, whereas the gaps are decreasing by the firm size.

3 MEASURING INEFFICIENCIES AT THE FIRM LEVEL

3.1 Productivity Estimation

This section is aimed to explain the approach used in estimating the production function and productivity levels of firms. We used Wooldridge(2009) methodology which is built on the literature on productivity estimation by Olley and Pakes (OP) (1996), Levinsohn and Petrin (LP) (2003) and Ackerberg et al. (ACF) (2015). The production function is assumed to have the Cobb-Douglass form:

$$Q_{it} = A_{it} {L_{it}}^{\beta_l} {K_{it}}^{\beta_k}, \tag{1}$$

where Q_{it} is output of the firm *i* at time *t*, L_{it} is labor and K_{it} is capital. A_{it} stands for the productivity level of the firm. Taking the natural logarithm of the function (1), we get:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \epsilon_{it}, \tag{2}$$

where q_{it} is the log of the real output, l_{it} is the log of number of workers, k_{it} is the log of real capital stock and ϵ_{it} stands for productivity A_{it} of firm *i* at time *t*. The error term is assumed to be:

$$\epsilon_{it} = \omega_{it} + \eta_{it}, \tag{3}$$

where ω_{it} is the transmitted component of the productivity and η_{it} is the i.i.d. shock to productivity or the measurement error.

In estimation, we need to be careful about the error term since ω_{it} is assumed to be observed by the firm but not the econometrician and η_{it} is unobserved to both the firm and the econometrician. Endogeneity problem arises since firms could be deciding the input levels (especially variable input,L_{it}) after observing the trasmitted component ω_{it}. Hence there could be a positive correlation between input and transmitted component ω_{it}. OLS estimation that fails to correct for endogeneity leads a positive bias in input coefficient (Van Beveren,2012). Also in the data, we observe only a self-selected group of firms since some firms exit after observing ω_{it}. For any given level of current productivity, we can argue that firms can expect larger future productivity if it has a larger capital stock in current period and hence decide to stay for lower ω_{it} levels. Hence, self-selection of the firms results in negative bias of the coefficient of capital, i.e. selection bias (Olley and Pakes,1996).

To solve the endogenity and selection bias in OLS estimates, OP and LP propose two stage dynamic estimation methodology using firm level data. OP uses investment as a proxy to transmitted component of productivity (ω_{it}) and assumes that each firm decides exit or stay in business at each period according to its expected future productivity. The drawback of this method is that it requires non-zero investment for all observations. To loosen this requirement, LP uses intermediate materials and electricity as proxy variable which usually reported more frequently and accurate than investment (Levinsohn and Petrin,2003).

Following to methodologies of OP and LP , Wooldridge (2009) assumes trasmitted component ω_{it} to be a function of the state variables and a proxy variable. What differs between OP and LP methods is the choice of a proxy variable. Building up on this literature, Wooldridge (2009) defines function *g()* :

$$\omega_{it} = g(x_{it}, m_{it}), \qquad t = 1, ..., T, \tag{4}$$

where x_{it} is the set of observed state variables and m_{it} is the set of proxy variables.In our estimation we use capital(k_{it}) as state variable and intermediate inputs (m_{it}) as proxy variable. Hence, equation (4) can be written as:

$$\omega_{it} = g(k_{it}, m_{it}). \tag{5}$$

Ackerberg et al. (ACF) (2015) discusses identification problem in two-stage OP and LP mmethodologies. The problem occurs when labor is chosen together with intermediate inputs, which means labor can also be written as a function of proxy and state variables similar to unobserved productivity, ω_{it}. Then, the coeffcient of labor (in general the variable input) would be nonparametrially unidentified. ACF tries to solve identification problem by adding assumptions on timing of input choice decisions. Wooldridge (2009) solves the identification problem of two-stage estimation by estimating a generalized method of moments (GMM) framework.

One key assumption in all methods is that the state variable, k_{it}, is not correlated with the innovation, a_{it}:

$$a_{it} = \omega_{it} - E(\omega_{it}/\omega_{it-1}). \tag{6}$$

To deal with identification problem Wooldridge assumes that lagged state (k_{it}) and proxy (m_{it}) variables are also uncorrelated with the innovation:

$$E(\omega_{it}|k_{it}, l_{it-1}, m_{it-1}, ..., l_{i1}, k_{i1}, m_{i1}) = E(\omega_{it}/\omega_{it-1}). \tag{7}$$

From equation (4) we can write that:

$$\omega_{it-1} = g(x_{it-1}, m_{it-1}), \qquad t = 1, ..., T. \tag{8}$$

Hence the following equivalence holds for a function f:

$$E(\omega_{it}/\omega_{it-1}) = f\,[g(k_{it-1}, m_{it-1})]. \tag{9}$$

The variable input l_{it} allowed to be correlated with innovation whereas state variable k_{it} and lagged values of (k_{it}, l_{it}, m_{it}) are not correlated with the innovation a_{it}. Then, plugging $\omega_{it} = a_{it} + f\left[g(k_{it-1}, m_{it-1})\right]$ in (1) gives us:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + f\left[g(k_{it-1}, m_{it-1})\right] + u_{it}, \qquad t = 2, ..., T, \tag{10}$$

where $u_{it} = a_{it} + \epsilon_{it}$. By using equation (10) together with the following equation (11) :

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + g(k_{it-1}, m_{it-1}) + \epsilon_{it} \qquad t = 1, ..., T \tag{11}$$

we need to assume following moment conditions to identify β_l and β_k:

$$E(\epsilon_{it} | l_{it}, k_{it}, m_{it}, l_{it-1}, m_{it-1}, ..., l_{i1}, k_{i1}, m_{i1}) = 0 \qquad t = 1, ..., T \tag{12}$$

and

$$E(u_{it} | k_{it}, l_{it-1}, m_{it-1}, ..., l_{i1}, k_{i1}, m_{i1}) = 0 \qquad t = 2, ..., T \tag{13}$$

In the estimation procedure, following Petrin and Sivadasan (2013), we use second order polynomial to approximate $f\left[g(k_{it-1}, m_{it-1})\right]$ where instruments are first and second lags of materials, capital and second lag of labor. Detailed explanation on estimation and the table of coefficient estimates provided in following chapter on data and estimation.

3.2 Calculating the Value of the Marginal Product and the Gap

This section explains Petrin and Sivadasan's (2013) methodology on how the gaps between the value of marginal product (VMP) and marginal input costs can be estimated using firm level data. Starting with a Cobb-Douglas production function denoted by equation (1) ,the marginal product of an input, here labor, is defined as:

$$\frac{\partial Q_{it}}{\partial l_{it}} = \beta_l {L_{it}}^{\beta_l - 1} {K_{it}}^{\beta_k} e^{\epsilon_{it}} = \beta_l \frac{Q_{it}}{L_{it}} \tag{14}$$

Given the production function and observed input and output levels, VMP is defined as the marginal product of labor multiplied by firm level output price. However, in calculation, one should be careful about the error term since one can not identify whether η_{it} is unpredicted productivity or a measurement error. Conditioning whether on full error term (ϵ_{it}) or only transmitted component (ω_{it}) is a crucial choice and it depends on the question of interest. As denoted in Petrin and Sivadasan (2013), conditioning on the full error term does not posit a problem when the question is related to effects of reallocation in aggregate level productivity. However, as we are interested in firm level misallocation, conditioning on the full error term could give us biased results if η_{it} is a measurement error whereas condioning on the full error term means that we assume full error term is the actual productivity. As explained in the previous section, while estimating the production function it is usually assumed that variable inputs are chosen after observing transmitted part of productivity (ω_{it})(Levinsohn and Petrin (2003), Olley and Pakes (1996)). Hence, we can assume in calculating the VMP that firms are equalizing marginal product conditional on ω_{it} to the marginal cost of the input. To get what Q_{it} would have been if the productivity only included ω_{it}, we need to subtract η_{it} part:

$$log(\tilde{Q}_{it}) = q_{it} - \eta_{it} = log(Q_{it}) - (log(\epsilon_{it}) - log(\omega_{it})) \quad . \tag{15}$$

Removing logs will give marginal product conditional on ω_{it} :

$$\beta_l \frac{Q_{it} e^{\omega_{it}}}{L_{it} e^{\epsilon_{it}}} \quad . \tag{16}$$

Multiplying the marginal product by the firm output price gives the value of the marginal product , VMP_{it}:

$$VMP_{it} = P_{it}\left(\beta_l \frac{Q_{it}e^{\omega_{it}}}{L_{it}e^{\epsilon_{it}}}\right) \quad (17)$$

where P_{it} firm level output price.

Finally the gap measure for allocation inefficiencies at the firm level is defined as follows:

$$G_{it} = VMP_{it} - w_{it} \quad (18)$$

where w_{it} represents the wage of the marginal worker in firm *i* at time *t*. These gaps are in nominal terms. So, we deflate it by consumer price index (CPI) for comparability and define the absolute real gap:

$$Absolute\, real\, gap = \frac{|G_{it}|}{CPI_t} \quad (19)$$

The absolute value of the gap is used in Petrin and Sivadasan (2013), Fontage and Santoni (2018) since it will give directly the possible increase in value added when labor reallocates from current situation to an optimal case.Hence, it can be thought as the value of misallocation. When we think in terms of the gaps, Petrin and Sivadasan (2013) offers an intuitive conclusion that the social optimal is reached when all gaps in all inputs is zero.However, one may argue that since there are taxes,mark-ups, adjustment costs, hiring and firing costs,frictions in labor markets etc. we would not be at social optimum. Hence, one can also think as suggested by Syverson (2011) that an efficient allocation would suggest not zero but equalized gaps across firms. In light of these intuitions,in following chapters we try to answer the questions on how far Turkish manufacturing firms from socially optimum , how these gaps move with respect to time and what factors can explain differences in gaps across firms.

4 THE DATA SET and THE ESTIMATION

4.1 Description of the Data Set

I use the Annual Industry and Service Statistics provided by TURKSTAT which is a confidential data set available to use only in data center within the institute. The data set includes all firms which have 20 or more employees and use a representative sample for the firms employing less than 20 workers. The data set is available from 1981 onward. However, since the survey questions and included firms are different, the data is not comparable over the years and the observation number is highly restricted in some years. Hence, I could only employ the period between 2005-2015[2]. The data set is collected according to 3-digit industry code NACE.Rev2. The survey questions include information on gross revenue, value added, number of employees by gender, wages, intermediate inputs, investment and percentage of foreign ownership. Summary statistics by industry is provided in Table 1 and distribution of firms by years is shown in Figure 3.

To get export and import status of the firms, I use Foreign Trade Statistics available by TURKSTAT covering all traded goods entering/exiting borders of Turkey by firm id that is matching to our main data set. Ages of the firms are derived from Enterprise surveys available by TURKSTAT.

[2]Since the observation number for 2005 is less than half of the each following year, I report calculations for the period 2006-2015. Results including the data of 2005 available in the appendix.

	Means							
	value added	total wage	annual wage per worker	# workers	male	female	female ratio	#Nobs
Basic Metals	5356835	2005851	17599	138.6	129.1	9.5	6.8	5559
Chemicals	3787640	1012181	19698	72.1	54.2	17.8	24.7	4531
Computer and Elect	8204397	1757992	18697	129.4	89.3	40.0	30.9	1523
Electrical eqiup.	4022757	1420994	16286	114.2	90.4	23.7	20.8	6930
Fabricated Metal	1646190	700165	14758	72.4	64.2	8.1	11.3	17459
Food prod.	2672847	1107432	13359	108.2	77.4	30.7	28.4	19738
Furniture	1047121	526941	12015	72.1	64.0	8.1	11.2	9766
Leather prod.	990287	408388	11781	61.1	48.3	12.8	21.0	4788
Machinery and equip.	2013393	730382	16099	69.2	61.7	7.5	10.9	14444
Motor Vehichles	8683441	2514518	17293	172.8	146.6	26.1	15.1	7094
Non-metallic prod.	2717513	949426	13562	96.2	85.2	11.0	11.4	14062
Other Manuf	1943107	475137	13639	60.1	43.3	16.7	27.8	4059
Other Trasport	6910669	1703791	17379	105.2	95.5	9.6	9.1	1438
Paper prod.	2864165	949016	16443	82.9	69.0	13.9	16.7	4147
Printing	1611094	591879	14680	58.5	46.5	11.9	20.3	2705
Repair and insal.	1666325	493266	14122	56.9	53.3	3.6	6.3	3160
Rubber and Plastic	2192513	738955	15157	74.5	62.1	12.3	16.6	12353
Textiles	2670195	977243	12815	126.7	93.3	33.3	26.3	21172
Wearing apparel	1458788	594768	11486	88.2	44.2	43.9	49.8	30769
Wood prod.	2802202	621277	12218	69.3	62.7	6.5	9.4	3218
All sectors	3230568	1009099	14911	91.5	73.9	17.6	19.0	184892

Value added, total wage bill and annual wage per worker are net values deflated by CPI with base year 2003.

Table 1: Summary Statistics by Industry, real TL (2003=100), years: 2006-2015

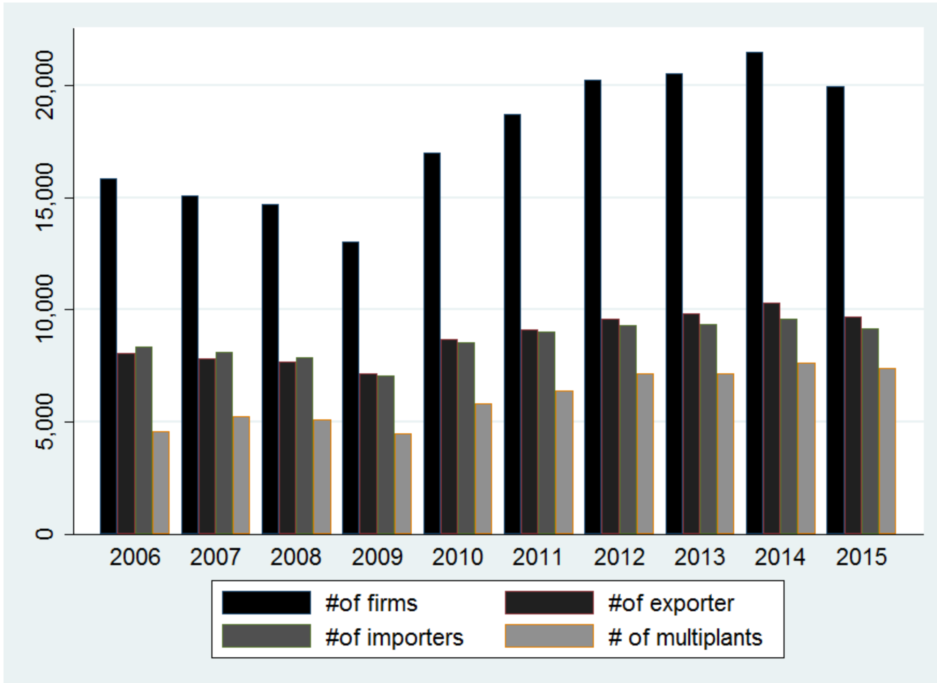

Figure 3: Distribution of firms: years 2006-2015

Firm-level real output is value added deflated by 3-digit industry level domestic producer price index provided by TURKSTAT website[3]. Labor is provided as number of total workers for a given firm at a given year. Unfortunately, there is not distinction between blue and white collar workers in the data set. Total number of employees are reported by gender allowing us to create a gender dummy that takes the value 1 if ratio of female workers to total workers is greater than 50%. Intermediate inputs in the data is calculated by total purchases of goods and services excluding expenditures on capital goods. Since variable on intermediate inputs includes expenditure on materials and energy together, it is deflated by 1-digit producer price index for intermediate goods rather than separate deflators for energy and materials [4]. Investment on tangible goods, machinery/equipment, and buildings are provided in the data whereas capital is not reported. Hence, I use the capital series generated by Atiyas and Bakis (2018) where they employ perpetual inventory method for the same time period [5].

[3] Turkish Statistical Institute. (2018). Domestic Producer Price Index (D-PPI) (2003=100). Retrieved from `https://biruni.tuik.gov.tr/medas/?kn=64&locale=en`

[4] Turkish Statistical Institute. (2018). Domestic Producer Price Index- Main Industrial Groupings (2003=100). Retrieved from `http://www.tuik.gov.tr/PreTablo.do?alt_id=1076`

[5] for more detailed information on estimation please check Atiyas and Bakis (2014)

In generating capital variable, observations reporting less than zero value added, sales or investment or reporting missing depreciation are excluded. We also need to exclude firms that are observed only once in the data since we need lagged variables of inputs to be able to use Wooldridge (2009) method. After trimming firms that constitute at the bottom 1% of the wage distribution (yearly wage per worker recorded less than 4.000 TL), we have unbalanced panel of 184.892 observations and 37.108 firms. I use both multi-plant and single plant firms since data available for both. [6] For single plant firms, firm characteristics are comparable and estimated labor gaps are not significantly different from the general data set.

4.2 Estimation

This section explains the problems faced is estimation and the possible solutions to them. The first important point is the selection of the method of production function estimation. As I discussed in chapter on productivity estimation (3.1), I use the method proposed by Wooldridge (2009) firstly because the lumpiness of the investment data in Turkey and secondly since Wooldridge (2009) methodology is immune to identification problem posit by Ackerberg et al. (2015). I estimate the production function coefficients by using intermediate inputs as proxy variable, labor as freely adjustable input, and capital as fixed input. Estimation is done for each industry at 2-digit level.

The second problem in the estimation is that as in many firm level data sets, the output variable is not observed rather we observe firm level revenues. I also do not have information on firm level prices; therefore, I choose the predominant approach in the literature (Petrin and Sivadasan 2013, Fontagne and Santoni 2018) and deflate the firm-level value added by the industry price deflator. Through the literature, it is denoted that for the production function estimates to be consistent we need the correlation between inputs and deviation of the firm level price from industry price to be zero. Since we can not control for this correlation, we need to accept possible weakness in using industry level price index.

[6] Statistics covering only single plant firms are available in appendix.

	Input Coefficients			
Industry	β_l	β_k	RTS	Nobs
Basic Metals	0.65	0.12	0.77	5559
Chemicals	0.46	0.10	0.56	4531
Computer and Elect	0.57	0.22	0.79	1523
Electrical Equip	0.67	0.08	0.75	6930
Fabricated Metal	0.62	0.11	0.73	17459
Food products	0.59	0.12	0.71	19738
Furniture	0.59	0.06	0.65	9766
Leather products	0.64	0.06	0.70	4788
Machinery and Equip	0.60	0.10	0.70	14444
Motor Vehicles	0.73	0.09	0.82	7094
Non-metallic pro	0.65	0.15	0.80	14062
Other Manuf	0.73	0.10	0.83	4059
Other Trasport	0.58	0.17	0.75	1438
Paper Products	0.64	0.05	0.69	4147
Printing and rec	0.74	0.09	0.83	2705
Repair install	0.51	0.08	0.59	3160
Rubber and Plastic	0.61	0.12	0.73	12353
Textiles	0.63	0.09	0.72	21172
Wearing apparel	0.75	0.05	0.80	30769
Wood products	0.67	0.08	0.75	3218

Table 2: Input Coefficients - years 2006-2015

In the estimation, I excluded Petroleum, Tobacco, Beverages and Pharmaceuticals because each industry has number of observations below 1000 and hence they do not provide reliable estimates. The coefficient estimates are given by Table 2. Estimated labor coefficient is around 0.60-0.70 and capital is bounded away from zero around 0.10. Estimated coefficients are in line with literature. Using Wooldridge (2009) methodology, Fontagne and Santoni (2018) estimate labor coefficient around 0.65 and capital around 0.20 for French manufacturing sector. Although Petrin and Sivadasan (2013) calculated labor coefficient for blue and white collar separately, their capital coefficients are comparable and around 0.6 for Chilean manufacturing firms. Here one can question our capital coefficients being low around

0.10; however, in their analysis for cross country comparisons with micro-level data, Seker and Saliola (2018) also estimates capital coefficient for Turkey as 0.11 using enterprise surveys of the World Bank. Estimated returns to scale is around 0.73 with all point estimates below one. Hence, we have decreasing returns to scale in production function which is sufficient condition for optimization.

The third problem in estimation is about the calculation of value of marginal product variable. The problem is about whether the full error term in production function estimates is the true productivity or it contains a measurement error. Because of the reasons that I denote in previous chapter (3.2), I condition my estimates on predictable part of the error term (ω_{it}) but I also report the labor gaps conditioning on the full error term [7].

The last problem is related to the calculation of the gap measure. Input prices are not available in Turkish data and rather we have total expenditures on inputs and total input used in production for a given year, *t*. Hence, in calculation of the gap measure, I use average wage, given by yearly total wages divided by total number of workers in the firm, as marginal cost of labor. Here, one major drawback is that as we do not have skill dimension in labor variable, we also don't have wages for different skill groups. Therefore, our gap measure denotes an overall inefficiency level where gaps by skill groups could potentially give more meaningful analysis.

Summary statistics by industries for the absolute labor gaps are provided by table 3. For whole manufacturing sector mean absolute gap is 3,508 TL [8] where average yearly wage per worker in manufacturing industry is 14,911 TL. Dispersion between and within firms are not very high with coefficient of variation for total is 0.97 and mean absolute gap is between 1,716 TL to 7,130 TL with furniture and basic metals, respectively.

While mean absolute gaps are important in providing a measure of misallocation or divergence from optimal, the sign of the gaps is also meaningful. Recalling the gap definition, one can deduce that positive gaps mean that the value of marginal product of an average worker

[7] results are available in appendix
[8] Real TL deflated by CPI provided by TURKSTAT with base year 2003

Industry	Mean $\|Gap\|$	Std.dev	Median	Min	Max	CV	#Obs
Basic Metals	7130	5988	5716	2.564	54348	.83	5521
Chemicals	5529	5190	4033	2.001	43602	.93	4265
Computer and Elect	4493	3729	3641	1.629	30376	.82	1600
Electrical Equip	4503	3432	3818	2.846	30658	.762	6658
Fabricated Metal	3725	3077	2998	.491	30493	.82	17322
Food products	3281	3034	2449	.258	26925	.92	19384
Furniture	1459	1716	958	.060	25440	1.17	9725
Leather products	2003	1776	1544	.040	16116	.88	4739
Machinery and Equip	4046	2937	3520	.053	22942	.72	14325
Motor Vehicles	5037	3839	4298	.596	35761	.76	6689
Non-metallic pro	3871	3766	2801	.031	42462	.97	13735
Other Manuf	4102	3389	3308	.156	26269	.82	4001
Other Trasport	5572	6481	3454	4.644	47552	1.16	1427
Paper Products	5440	4556	4384	2.824	40618	.83	3949
Printing and rec	4911	3417	4292	.137	24124	.69	2648
Repair install	3172	3477	2009	1.204	25824	1.09	3063
Rubber and Plastic	3976	3717	2953	1.028	36125	.93	11998
Textiles	3048	2308	2595	.504	25450	.75	20254
Wearing apparel	2128	1866	1692	.108	26446	.87	30381
Wood products	2862	2987	2084	.152	26683	1.04	3208
All sectors	3508	3408	2585	.031	54348	.97	184892

Table 3: Absolute Gap ($|Gap|$) Statistics by Industry, Real TL

in the firm is higher than what is paid to her, hence the average workers is underpaid. By the same line of reasoning, negative gaps mean the average worker is paid more than her value of the marginal product to firm, i.e. the worker is overpaid. When we look at general tendency for given time period 2006-2015, positive gaps constitute 76% of the gaps with an average positive gap recorded 33% higher than average negative gap. Although the sign of the gaps change by industry, 76% average positive gap could at least conclude us that underpayment is a more widely observed case for Turkish manufacturing sector. One other interpretation of positive gaps is as follows: the comparably more efficient firms inclined to be smaller than optimal size and because of frictions in input markets these firms are not able to equalize marginal revenue to marginal cost hence positive gaps are seen (Fontagne and Santoni,2018). For industry level analysis summary statistics of real gaps is provided in Table 5. One can see that there are only two industries that have negative average gap (Furniture and Repair&

installation) which are very small compared to average positive gaps. While interpreting the positive and negative gaps, we should denote the possible bias coming from informality. In Turkey, one can argue that firms tend to report the number of workers and the wages to avoid social security payments. Then, by having lower marginal cost for labor, positive gaps can be estimated higher than the actual case. Hence, the our estimation on average positive gap being higher than average negative gap could be related to informality.

	$\|Gap\|$	$Gap > 0$	$Gap < 0$
#Obs	184892	141737	43155
% Share	100	76	24
Mean	3508	3808	-2523
Std.dev	3408	3450	3064
10%	430	606	-6355
50%	2585	2952	-1411
90%	7634	7924	-203

Table 4: Summary Statistics for Positive and Negative Gaps, Real TL

	Real Gaps					
	Mean	Std.dev	Median	Min	Max	#obs
Basic Metals	6368	6793	5466	-26408	54348	5521
Chemicals	2938	6992	2632	-30306	43602	4265
Computer and Elect	1266	5701	1674	-24752	30376	1600
Electrical Equip	3260	4630	3278	-19484	30658	6658
Fabricated Metal	2445	4168	2395	-30493	30389	17322
Food products	2183	3899	1898	-26925	26304	19384
Furniture	-54	2252	120	-25440	8198	9725
Leather products	1327	2325	1256	-16116	12651	4739
Machinery and Equip	2426	4371	2852	-22742	22942	14325
Motor Vehicles	4039	4878	3913	-20794	35761	6689
Non-metallic pro	2697	4679	2159	-25480	42462	13735
Other Manuf	3160	4281	2856	-26269	25331	4001
Other Trasport	2674	8119	1614	-27031	47552	1427
Paper Products	4360	5599	3996	-22421	40618	3949
Printing and rec	3852	4578	3853	-19639	24124	2648
Repair install	-467	4684	-130	-25824	21819	3063
Rubber and Plastic	2888	4614	2463	-21726	36125	11998
Textiles	2230	3106	2253	-25450	24482	20254
Wearing apparel	1351	2488	1333	-26446	11848	30381
Wood products	2124	3550	1703	-17946	26683	3208
Total	2330	4300	2010	-30493	54348	184892

Table 5: Real Gap Statistics by Industry, Real TL

5 EVALUATION OF ALLOCATIVE INEFFICIENCY OF LABOR

After estimating production function coefficients and calculating labor gaps, this section is devoted to understanding dynamics and factors behind the labor gap. First, I will try to understand time evolution of the gaps and whether there is a trend towards higher or lower levels of misallocation. Then controlling for size of the firms, we can evaluate on whether firms with different sizes have different efficiencies in optimizing input level. Third, by including dummies for export and import status, foreign ownership, the ratio of the female workers, I try to capture some of the firm characteristics that could give us explanations in understanding the sources of misallocation.

The estimated base equation is as follows:

$$Y_{it} = \alpha_0 + \delta_1 + \delta_2 + \delta_3 + \delta_4 + \beta\Gamma_{it} + \xi_i + \epsilon_{it} \tag{20}$$

Here Y_{it} denotes real labor gap, δ_1 is time dummy for 2008, δ_2 for 2009, δ_3 for 2010-2012 and δ_4 for 2013-2015 with the constant α_0 giving value of the average gap at the base period (2006-2007). Γ_{it} stands for the firm characteristics that we add in second regression onward. Firm characteristics include the log age and squared age of the firm, four size dummies generated by number of workers, dummy for export and import at the given year, dummy for foreign ownership and dummy for share of the female workers. ξ_i is control for the firm fixed effects and ϵ_{it} idiosyncratic shocks.

Size classification is constructed as in Atiyas and Bakis (2018). Firms with number of workers between 1-19 classified as size 1, between 20-49 as size 2, between 50-249 as size 3 and 250+ as size 4. After controlling time evolution and effect of size of the firms, export dummy included to infer whether firms facing international competition have significantly different labor allocation. Foreign ownership dummy takes the value 1 if the firm *i* at time *t* has a foreign investor share greater than zero. I also include female ratio dummy which takes the value one if share of female workers greater than 50% to control the possible effect of the widely discussed argument that women are paid less than men on average.

With above explained specification, I use firm fixed effects for all regressions and for robustness check, I also estimated the last specification with industry fixed effects. Here, one possible concern is the fact that we do not observe firm-level prices. As we denote earlier if input choice and the diversion of firm-price from industry price is correlated, there will be potential negative bias in production function estimates (Fontagne and Santoni,2018). By using firm fixed effects, we can say that we toned down the possibility of bias because our estimation would only face omitted firm-level price bias if the firm to industry relative prices change systematically over time. Although we do not have an exact control variable on this, we can argue that export and import variables together with size dummies also control for firm-level prices since in the literature markups expected to be positively correlated with exports and productivity (Bellone et al., 2016).

Results from above specified regression and discussion can be found in the following chapter.

6 RESULTS

This section elaborates on the main results of the regression specified in previous section. In all specifications, standard errors are clustered at the firm level to control for serial correlation. The first regression shows the evolution of gaps through five time periods with base period taken to be years 2006-2007 conditional only on firm age. It shows that the absolute labor gap, which measures how far we are from the optimal point (MP=MC) in allocation of labor, is decreasing significantly over time. In line with this finding, evolution of the average gaps is demonstrated by Figure 4 and 5. We can see that until 2010, there is not much of difference through years but maybe a slightly increasing trend for both negative and positive gaps, which means negative gaps are moving towards the optimal whereas positive gaps are moving away. Whereas after 2010, we see a convergence of average gaps to (-)2.000 TL levels. In line with the evolution of the positive and negative gaps, average real and average absolute real gaps record a decreasing trend. When we have a closer look to time dummies in our regression, we also see that in the period 2010-2012 the wedge is on average 428 TL lower than the base period 2006-2007, whereas this average wedge is only 99 TL lower in 2009 than the base period.

Second column shows the results where we control for firm size together with age and firm fixed effects. When we include size dummies, we confirm that the decrease in the gap by time is significant. Moreover, we also see that the gap is decreasing by firm size and the

Table 6: Evolution of Absolute Gaps, TL, base period: 2006-2007

	(1) $\|Gap\|$	(2) $\|Gap\|$	(3) $\|Gap\|$	(4) $\|Gap\|$	(5) $\|Gap\|$	(6) $\|Gap\|$
2008	-64.17*	-72.45**	-72.23**	-72.29**	-72.32**	-73.81**
	(-2.44)	(-2.75)	(-2.74)	(-2.75)	(-2.75)	(-2.82)
2009	-99.50***	-136.7***	-136.3***	-136.2***	-136.2***	-132.6***
	(-3.66)	(-5.00)	(-4.99)	(-4.99)	(-4.99)	(-4.87)
2010-2012	-428.7***	-447.7***	-447.5***	-447.5***	-447.5***	-441.7***
	(-16.64)	(-17.34)	(-17.33)	(-17.33)	(-17.33)	(-17.17)
2013-2015	-657.1***	-663.0***	-662.8***	-662.9***	-662.9***	-658.1***
	(-23.43)	(-23.45)	(-23.45)	(-23.45)	(-23.45)	(-23.37)
$ln(age)_{it}$	79.17*	70.25*	70.19*	70.16*	70.15*	70.28*
	(2.38)	(2.11)	(2.11)	(2.11)	(2.11)	(2.12)
$ln(age)^2{}_{it}$	0.0877	3.300	3.306	3.320	3.320	3.433
	(0.01)	(0.37)	(0.37)	(0.37)	(0.37)	(0.39)
size 2		-461.9***	-462.7***	-462.8***	-462.8***	-469.5***
		(-17.84)	(-17.88)	(-17.89)	(-17.89)	(-18.18)
size 3		-620.8***	-622.5***	-622.7***	-622.8***	-631.6***
		(-18.55)	(-18.62)	(-18.63)	(-18.63)	(-18.94)
size 4		-853.8***	-856.1***	-856.8***	-857.1***	-873.2***
		(-11.57)	(-11.61)	(-11.62)	(-11.63)	(-11.88)
export			4.252	4.217	4.215	4.880
			(0.22)	(0.22)	(0.22)	(0.26)
import			12.04	12.00	11.97	12.45
			(0.64)	(0.64)	(0.63)	(0.66)
foreign ownership				57.41	57.37	51.88
				(0.46)	(0.46)	(0.42)
female intense					5.828	5.730
					(0.25)	(0.25)
constant	3704.6***	4222.3***	4215.8***	4214.2***	4213.6***	3501.6***
	(106.12)	(93.84)	(91.29)	(90.89)	(90.65)	(10.55)
Fixed effects	firm	firm	firm	firm	firm	firm and ind
$Nobs$	163242	163242	163242	163242	163242	163242

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Dependent variable absolute labor gap deflated by CPI (base year=2003).

Std.err clustered at the firm level.

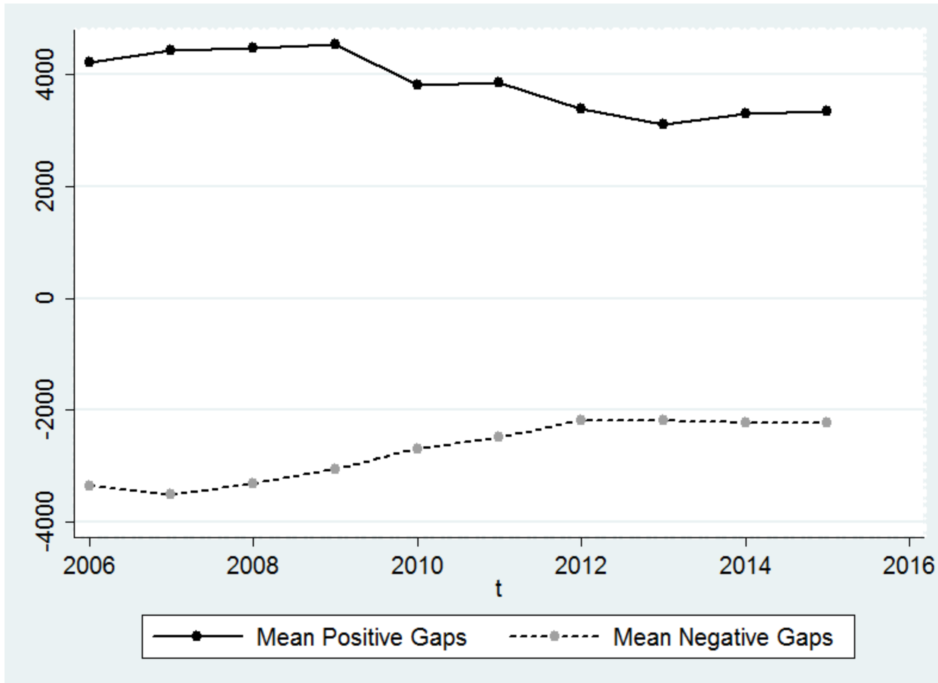

Figure 4: Evolution of Positive and Negative Average Gaps: years 2006-2015

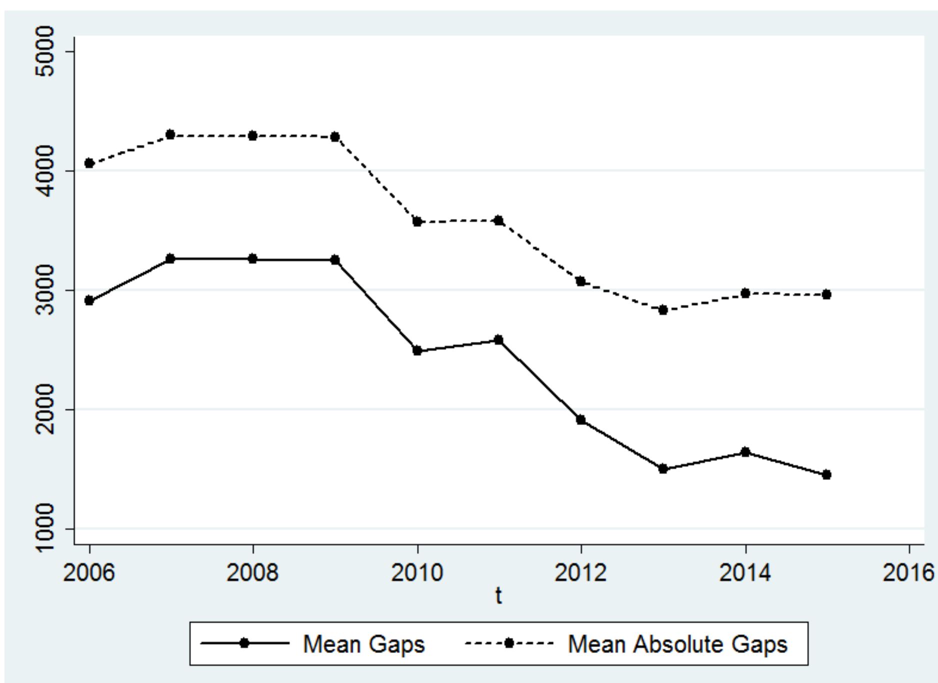

Figure 5: Evolution of Mean Gaps: years 2006-2015

largest firm records 854 TL lower gaps on average compared to average smallest firm at the period 2006-2007. All size dummies are negative and significant at 1% level.

From third column onward, I include export, import, foreign ownership and female worker dummies to control for the factors that can be effective in firms' pricing strategies for labor. Here, export status or having a share of foreign ownership is expected to decrease the gap since we can argue that international competition or international ownership require more regulated and efficient business. If we accept that women are paid less than men on average at the same job, then at similar marginal product levels, marginal cost of a women to a firm would be lower and the gap would be greater. Hence, the female worker dummy expected to have a positive coefficient. Although the intuition behind is clear, I fail to conclude any significant effect of these controls over the absolute gap. For the last specification, I also check industry fixed effects together with firm fixed effects and conclude no significant difference in coefficients.

One might also argue that in a country like Turkey, where informality is a significant issue, one can argue that the gap measure may not be giving the real measure of misallocation. If the wage and number of workers reported by firms is less than the real values, then our gap estimates could bear a positive bias. In line with this possibility, our analysis on time evolution of the gaps and the relationship to the firm size could also be affected by informality. Studies on informality in Turkey shows that informality tend to decrease over years and it tend to have negative correlation with the firm size (Acar and Tansel (2014), Elgin and Sezgin (2017)). Figure 6 illustrates informality rates provided by Social Security Institution of Turkey which is derived from household labor force surveys [9].

Until 2009, we do not have rates at the manufacturing sector level but we have it for the general industry level. At the industry level, from 2005 to 2007 the informality rates were around 35% level. Then between 2008-2011 informality rates are recorded around 32% in a decreasing trend with only exception of 2009 which is possibly a reflection of economic

[9] reached at 12.07.2018 from `http://www.sgk.gov.tr/wps/portal/sgk/tr/calisan/kayitdisi_istihdam/kayitdisi_istihdam_oranlari/kayitdisi_istihdam_orani`

crisis seen in 2008. After 2011, we observe informality rates to be around 20-25% with a decreasing trend. Keeping informality rates in mind, our results denote decreasing trend in both 2008 and 2009 dummies whereas informality is increasing. Hence for these years, we can argue that our estimates do not capture informality. For 2010 and onward, where the informality rates are smaller, we also estimate smaller gaps on average. Hence, we should admit that we may be capturing the effect of informality in our gap estimates.

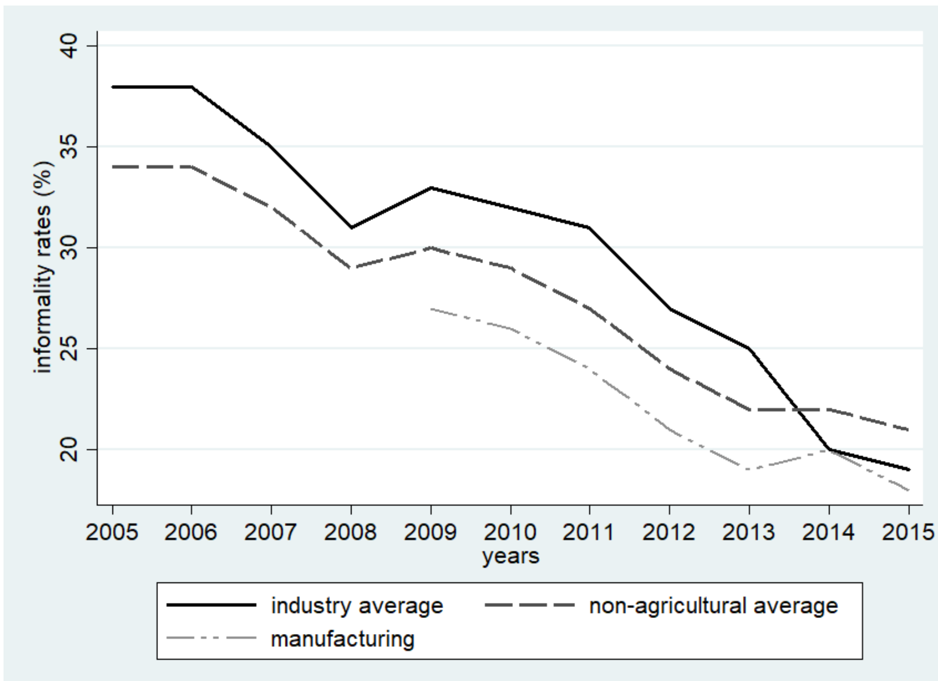

Figure 6: Informality rates (%): years 2005-2015

To control for possible effect of informality, I employed a robustness check as follows: First, I regress absolute gaps on informality rates by year provided at industry level. I conclude a positive significant relation of informality on gaps which is in line with the hypothesis that firms tend to report lower wages and hence generate greater gaps. Second, to understand whether our conclusion on time evolution of the gaps are biased by informality rates, I include time dummies and informality rates together. As shown in Table 7, the recorded decrease in gaps by time remain significant after controlling for informality over years. Hence, we can argue that conclusion on time effects are not driven by evolution of informality. From column 3 and 4 in Table 7, we can see that our results on size effect do not affected by informality.

Table 7: Informality Robust Results, Absolute Gaps, TL, base period: 2006-2007

	(1)	(2)	(3)	(4)
	$\|Gap\|$	$\|Gap\|$	$\|Gap\|$	$\|Gap\|$
informality	78.64***	1.82	-2.08	-2.06
	(61.61)	(0.82)	(-0.93)	(-0.93)
2008		-59.00*	-78.23**	-78.29**
		(-2.20)	(-2.91)	(-2.90)
2009		-96.7***	-139.9***	-139.4***
		(-3.54)	(-5.09)	(-5.09)
2010-2012		-421.7***	-455.1***	-454.9***
		(-15.90)	(-17.11)	(-17.10)
2013-2015		-665.4***	-687.8***	-687.9***
		(-17.75)	(-19.17)	(-19.16)
$ln(age)_{it}$		79.25*	69.89*	69.88*
		(2.39)	(2.10)	(2.11)
$ln(age)^2{}_{it}$		.687	2.58	2.61
		(0.08)	(0.29)	(0.29)
size 2			-463.0***	-463.8***
			(-17.86)	(-17.89)
size 3			-623.5***	-625.4***
			(-18.52)	(-18.60)
size 4			-858.1***	-861.8***
			(-11.58)	(-11.63)
export				4.08
				(0.21)
import				12.00
				(0.64)
foreign ownership				57.41
				(0.46)
female intense				5.828
				(0.25)
constant	1238.6***	3938.2***	4215.8***	4291.2***
	(33.77)	(40.76)	(91.29)	(90.89)
Fixed effects	firm	firm	firm	firm
$Nobs$	163242	163242	163242	163242

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Dependent variable absolute labor gap deflated by CPI (base year=2003).

Std.err clustered at the firm level.

7 CONCLUSION

Through this paper, I aim to quantify and give an explanation to misallocation in labor input in Turkish manufacturing sector over the period between 2006-2015. Quantifying the misallocation in labor is important since it could give us a measure of how much the firms or industries are away from their optimal allocation point and hence how much they could gain by reallocation. Moreover, denoting changes in misallocation levels by time or by firm characteristics is important in providing possible explanations for the misallocation in labor.

To asses misallocation in labor, I choose to employ the gap methodology proposed by Petrin and Sivadasan (2013). The gap is defined as the difference between the value of the marginal product of each input and its cost to the firm. To calculate the labor gap, I first estimate two digit industry level labor productivity using the method proposed by Wooldridge (2009). Then multiplying the marginal product of labor with industry level input prices, I calculate the value of the marginal product. Taking difference between the value of the marginal product and the wage per worker in a firm and deflating it with CPI, I estimated the labor gap for each firm i at time t. I conclude that the average absolute gap in Turkish manufacturing sector between 2006-2015 is equal 3.580 TL. Considering the average yearly wage per worker in manufacturing sector is recorded as 14,911 TL , the labor gap is 2.8 times of the average monthly wage in manufacturing sector. The sign of the labor gap is also important since it provides us whether an average worker is overpaid or underpaid. By looking at the distribution of the gaps, I conclude that 76 % of the gaps are positive which means that an average worker in manufacturing sector is under paid with probability 76 %.

After estimating the labor gap, I run a firm fixed effects regression with dependent variable being absolute labor gap and independent variables being time dummies and firm characteristics. With this regression, I aim to denote the time trends in misallocation as well as the factors effecting the misallocation at the firm level. I conclude that the labor gap, i.e. misallocation in labor, decreases significantly over time between 2005-2015 with an even a sharper decrease after 2010. I also find that the labor gap is decreasing by firm size i.e. larger firms allocate more efficiently. Although I try to control for other firm characteristics by including different controls on export and import status, foreign ownership and female worker ratio, I fail to estimate any significant effect of included variables.

To conclude, I want to point out that informality, as a prominent problem of Turkey, might also affect out results. If we accept that the firms' tendency is towards reporting lower wages to avoid high social security payments in employer side, then our gap estimates could be higher than the real values. Although I control for possible decrease in informality and conclude no effect on evolution of the gaps, as a further research idea, I would suggest looking for different control variables or IV regression to avoid possible bias coming from informality. Lastly, one other further research topic could be related to effects of agglomeration or regional policies on labor misallocation.

References

[1] Acar, E.O., Tansel, A. (2014). Defining and Measuring Informality in the Turkish Labor Market (IZA Discussion Papers, No. 8377). Institute for the Study of Labor (IZA), Bonn.

[2] Ackerberg, D. A., Caves, K., Frazer, G. (2015). Identification properties of recent production function estimators. *Econometrica*. 83, 2411–2451.

[3] Altug, S., Filiztekin, A., Pamuk, S. (2008). Sources of Long-Term Economic Growth for Turkey, 1880–2005. *European Review of Economic History*. 12(3), 393–430. doi:10.1017/S1361491608002293.

[4] Atiyas, I., Bakis, O. (2014). Aggregate and sectoral TFP growth in Turkey: a growth accounting exercise (Türkiye'de toplam ve sektörel toplam faktör verimliliği büyüme hızları: bir büyüme muhasebesi çalışması). *İktisat, İşletme ve Finans*. 29(341), 9-36.

[5] Atiyas, I., Bakis,O. (2018). Sıçrama yapan şirketler (Leapfrogging firms). Project Report. TUSİAD.
Retrieved from https://tusiad.org/tr/yayinlar/raporlar/item/9969-sicrama-yapan-sirketler-raporu

[6] Bartelsman, E., Haltiwanger, J., Scarpetta, S. (2013). Cross-Country Differences in Productivity: The Role of Allocation and Selection. *American Economic Review*. 103 (1), 305-34. doi: 10.1257/aer.103.1.305

[7] Bellone, F., Pisano, -M.J. (2013). Is Misallocation Higher in France than in the United States? (GREDEG Working Paper Series No.2013-38). University Nice Sophia Antipolis, CNRS, GREDEG. Revrieved from: http://www.gredeg.cnrs.fr/working-papers/GREDEG-WP-2013-38.pdf

[8] Bellone, F., Musso, P., Nesta, L., Warzynski, F. (2016). International trade and firm-level markups when location and quality matter. *Journal of Economic Geography*. 16, 67–91.

[9] Bento, P., Restuccia, D., (2014). Misallocation, Establishment Size, and Productivity (Working Papers tecipa-517). University of Toronto, Department of Economics. Retrieved from: https://ideas.repec.org/p/tor/tecipa/tecipa-517.html

[10] Berthou, A., and Sandoz, C. (2014). Labour productivity in europe: allocative efficiency of labour or performance of firms?. *Quarterly selection of articles - Bulletin de la Banque de France*. 34, 47-67.

[11] Combes, P.-P., Duranton, G., Gobillon, L., Puga, D., Roux, S. (2012a). The productivity advantages of large cities: distinguishing agglomeration from firm selection. *Econometrica*. 80, 2543–2594.

[12] Elgin, C., Sezgin, M.B. (2017). Sectoral Estimates of Informality: New Method and Application for Turkish Economy. *The Developing Economies*. 55(4), 261–289.

[13] Erzan, R., Filiztekin, A. (2005). Does size matter in growth, productivity, employment and vulnerability/flexibility in Turkish manufacturing?. *Turkish Studies*. 6(1), 113-126. doi:10.1080/1468384042000339357

[14] Filiztekin, A. (2000). Openness and Productivity Growth in Turkish Manufacturing (Sabanci University Discussion Paper Series No. 0104), Sabanci University. Retrieved from: http://myweb.sabanciuniv.edu/alpayf/files/2010/04/ae_open.pdf

[15] Fontagne, L., Santoni, G. (2018). Agglomeration economies and firm-level labor misallocation. *Journal of Economic Geography*. 1-22. doi:10.1093/jeg/lby007

[16] Garicano, L., LeLarge, C., Reenen, J. V. (2016). Firm Size Distortions and the Productivity Distribution: Evidence from France. *American Economic Review*. 106 (11), 3439-79. doi: 10.1257/aer.20130232

[17] Hsieh, C.-T., Klenow, P. J. (2009). Misallocation and manufacturing TFP in China and India. *The Quarterly Journal of Economics*. 124, 1403–1448.

[18] Ismihan, M., Ozcan,K.M. (2009). Productivity and Growth in an Unstable Emerging Market Economy: The Case of Turkey, 1960-2004. *Emerging Markets Finance and Trade*. 45(5), 4-18.

[19] Levinsohn, J., Petrin, A., (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*. 70, 317–341.

[20] Loecker, J. D., Goldberg, P. K., Khandelwal, A. K., Pavcnik, N. (2012). Prices, Markups and Trade Reform (NBER Working Papers 17925). National Bureau of Economic Research.

[21] Mollisi, V., Rovigatti, G. (2017). Theory and Practice of TFP Estimation: The Control Function Approach Using Stata (CEIS Working Paper No. 399). Retrieved from: http://dx.doi.org/10.2139/ssrn.2916753

[22] Nguyen, H.M., Taskin, T., Yilmaz, A. (2016). Resource misallocation in Turkey (Policy Research working paper no. WPS 7780). World Bank Group. Washington, D.C. Retrieved form http://documents.worldbank.org/curated/en/258441470314238325/Resource-misallocation-in-Turkey

[23] Olley, G. S., Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*. 64, 1263–1297.

[24] Petrin, A., Sivadasan, J. (2013). Estimating lost output from allocative inefficiency, with an application to Chile and firing costs. *Review of Economics and Statistics*. 95, 286–301.

[25] Ranasinghe, A. (2014). Impact of policy distortions on firm-level innovation, productivity dynamics and TFP. *Journal of Economic Dynamics and Control*. Elsevier. 46(C), 114-129.

[26] Saygili, S., Cihan, C. (2008). Türkiye Ekonomisinin Buyume Dinamikleri, 1987-2007 Döneminde Büyümenin Kaynakları, Temel Sorunlar ve Potansiyel Büyüme Oranı Yayın No. TUSIAD-T/2008- 06/462.

[27] Seker, M., Saliola, F. (2018). A cross-country analysis of total factor productivity using micro-level data. *Central Bank Review*. 18(1),13-27. Retriwved from: https://doi.org/10.1016/j.cbrev.2018.01.001.

[28] Syverson, C. (2011). What determines productivity? *Journal of Economic Literature*. 49, 326–365.

[29] Syverson, C. (2014). The importance of measuring dispersion in firm-level outcomes. IZA World of Labor, 53. doi: 10.15185/izawol.53

[30] Van Beveren, I.(2012). Total factor productivity estimation: A practical review.*Journal of Economic Surveys*.26(1), 98-128. Retrieved from https://doi.org/10.1111/j.1467-6419.2010.00631.x

[31] Van Biesebroeck, J. (2007). Robustness of productivity estimates. *The Journal of Industrial Economics*. 55, 529–569.

[32] Wooldridge, J. M. (2009). On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters*. 104, 112–114.

8 Appendix A

8.1 Statistics for 2005-2015

Below tables and figures denote the robustness check for the time period 2005-2015.

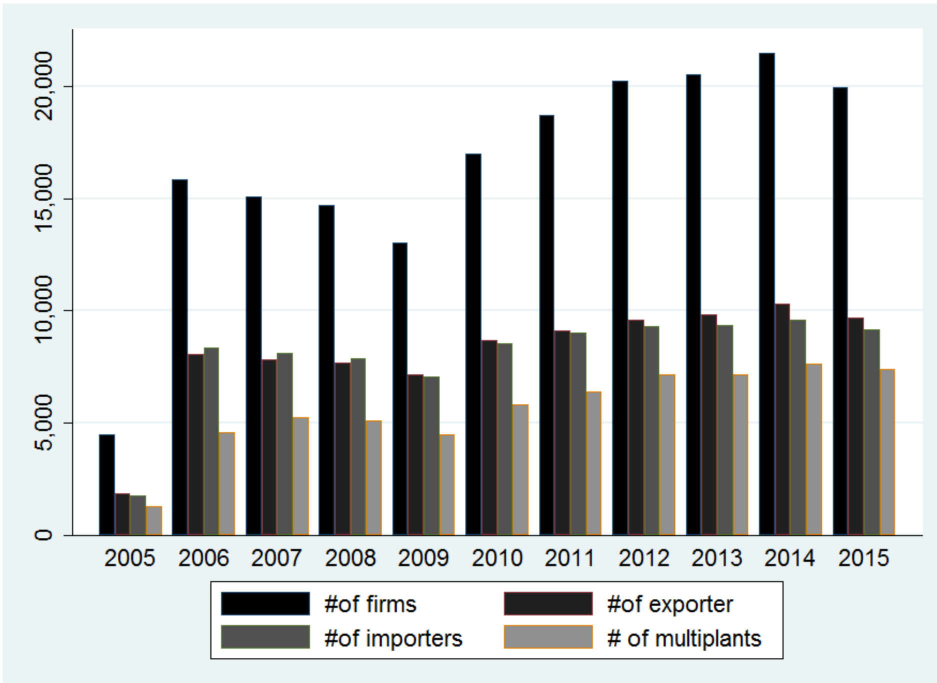

Figure 7: Distribution of firms: years 2005-2015

	value added	total wage	annual wage per worker	# workers	male	female	female ratio
Basic Metals	5194785	1956367	17333.96	136.0042	126.6905	9.313628	6.848045
Chemicals	3701447	989113.6	19330.8	70.96848	53.41768	17.5508	24.73042
Computer	8085264	1735802	18421.88	128.5409	88.69584	39.84506	30.99796
Electrical	3963731	1401854	16106.81	113.0165	89.50148	23.51504	20.80673
Fabricated metal	1626096	696342.4	14541.22	71.95555	63.84888	8.106663	11.26621
Food prod	2636389	1090810	13215.74	106.9171	76.55506	30.36209	28.39779
Furniture	1031720	518924	11880.38	71.30554	63.26519	8.040456	11.27606
Leather prod.	979608.9	404835.8	11650.95	60.81711	48.01219	12.80492	21.0548
Machinery equip.	1976478	718007	15851.92	68.50948	61.00798	7.501703	10.94987
Motor Vehichle	8561343	2466147	16937.56	169.9231	144.2406	25.68265	15.11428
Non-metall	2671610	934181.1	13400.8	95.15719	84.2716	10.88559	11.43959
Other Manuf	1915255	469100.1	13474.85	59.65958	43.02369	16.63614	27.88511
Other Trasport	6727691	1668732	17054.51	103.6753	94.23085	9.444473	9.109666
Paper Prod.	2809035	929625.7	16230.59	81.91577	68.13748	13.77829	16.82007
Printing	1596073	592934.4	14495.76	58.11618	46.25393	11.86224	20.41125
Repair install.	1637896	486180.4	13944.64	56.56887	52.95745	3.61142	6.384112
Rubber and c	2151088	725403.1	14944.34	73.4677	61.26795	12.19975	16.6056
Textiles	2639972	968695.1	12652.93	125.6619	92.44692	33.21501	26.43204
Wearing app	1435709	586363.1	11336.04	87.23756	43.75222	43.48537	49.84708
Wood prod.	2745543	612587.3	12068.07	68.69475	62.17396	6.520784	9.492405
All sectors	3172688	992863.5	14701.04	90.49817	73.07427	17.42395	19.00926

Value added, total wage bill and annual wage per worker are net values deflated by CPI with base year 2003.

Table 8: Summary Statistics by Industry: years 2005-2015

Industry	Mean $\|Gap\|$	Std.dev	Median	Min	Max	CV	#Obs
Basic Metals	7054.463	5960.625	5616.175	2.564775	54348.04	.8449438	5656
Chemicals	5510.492	5165.538	4024.594	2.001915	43602.87	.9374006	4389
Computer and Elect	4510.288	3714.134	3665.203	1.629805	30376.32	.8234805	1629
Electrical Equip	4504.644	3425.837	3823.012	2.846624	30658.65	.7605123	6805
Fabricated Metal	3724.366	3076.534	3001.545	.453046	32347.16	.8260557	17798
Food products	3277.933	3037.609	2446.967	.2581224	26925.63	.9266841	19816
Furniture	1450.28	1707.754	951.5176	.0609071	25440.5	1.177533	9944
Leather products	2014.034	1772.171	1556.36	.0401737	16116.5	.8799113	4850
Machinery and Equip	4060.939	2935.912	3547.159	.0535734	22942.34	.7229639	14714
Motor Vehicles	5090.102	3862.191	4373.375	.5965307	43982.53	.7587649	6920
Non-metallic pro	3869.044	3770.151	2795.951	.0312668	42462.79	.9744399	14010
Other Manuf	4162.67	3431.253	3394.165	.1565623	27517.25	.8242915	4093
Other Trasport	5589.359	6442.729	3504.072	4.644275	47552.16	1.152678	1478
Paper Products	5419.102	4533.551	4374.143	2.824094	40618.89	.8365871	4023
Printing and rec	4958.453	3435.939	4364.496	.1379328	24124.29	.6929458	2716
Repair install	3184.827	3472.989	2038.247	1.204488	25824.75	1.09048	3143
Rubber and Plastic	3961.451	3695.261	2946.597	1.028579	36125.76	.9328051	12311
Textiles	3054.357	2309.345	2601.136	.5048022	25450.13	.7560822	20797
Wearing apparel	2158.616	1870.241	1730.079	.1086644	26446.72	.8664075	31217
Wood products	2872.568	2970.832	2104.546	.1522385	26683.63	1.034208	3295
All sector	3514.791	3401.537	2602.156	.0312668	54348.04	.9677779	189604

Table 9: Absolute Gap ($|Gap|$) Statistics by Industry: years 2005-2015

	Real Gaps					
	Mean	Std.dev	Median	Min	Max	#obs
Basic Metals	6283.194	6768.885	5383.24	-26408.79	54348.04	5656
Chemicals	2932.187	6961.001	2660.449	-30306.03	43602.87	4389
Computer and Elect	1370.523	5680.713	1756.341	-24752.38	30376.32	1629
Electrical Equip	3265.505	4622.344	3284.061	-22899.29	30658.65	6805
Fabricated Metal	2456.138	4159.782	2415.377	-30493.01	32347.16	17798
Food products	2172.036	3905.698	1893.194	-26925.63	26304.18	19816
Furniture	-56.9596	2239.8	114.1522	-25440.5	8198.875	9944
Leather products	1348.995	2318.965	1276.407	-16116.5	12651.48	4850
Machinery and Equip	2469.545	4360.373	2896.645	-22742.02	22942.34	14714
Motor Vehicles	4116.693	4886.696	4015.687	-27553.47	43982.53	6920
Non-metallic pro	2704.326	4676.612	2159.576	-25480.32	42462.79	14010
Other Manuf	3241.343	4312.387	2929.525	-26269.86	27517.25	4093
Other Trasport	2747.993	8075.535	1675.852	-27031.11	47552.16	1478
Paper Products	4356.554	5562.623	3996.625	-21080.2	40618.89	4023
Printing and rec	3904.345	4599.072	3929.433	-19639.46	24124.29	2716
Repair install	-416.3693	4694.101	-85.79908	-25824.75	21819.83	3143
Rubber and Plastic	2884.329	4585.771	2464.216	-21726.52	36125.76	12311
Textiles	2239.578	3105.909	2264.302	-25450.13	24482.68	20797
Wearing apparel	1399.601	2489.705	1384.785	-26446.72	11848.87	31217
Wood products	2137.623	3536.831	1730.029	-17946.4	26683.63	3295
All sectors	2348.451	4290.573	2037.631	-30493.01	54348.04	189604

Table 10: Real Gap Statistics: years 2005-2015

9 Appendix B

9.1 Statistics for Single Plant Firms

Industry	Mean $|Gap|$	Std.dev	Median	Min	Max	CV	#Obs
Basic Metals	6125.026	5023.423	4986.871	4.769186	54348.04	.8201472	3896
Chemicals	4967.185	4693.854	3631.659	3.596736	43602.87	.9449728	2651
Computer and Elect	4383.438	3695.296	3441.293	1.629805	30376.32	.8430132	1209
Electrical Equip	4362.852	3351.369	3682.06	7.647109	30658.65	.7681601	4842
Fabricated Metal	3579.651	2983.053	2895.811	.453046	32347.16	.8333362	13123
Food products	3113.401	2823.528	2379.257	.293453	26925.63	.9068953	9877
Furniture	1396.803	1667.12	906.0662	.0609071	21878.27	1.193526	6446
Leather products	1848.957	1688.357	1413.201	.0401737	16116.5	.9131401	3138
Machinery and Equip	3950.562	2867.44	3456.853	.8917353	21730.83	.7258309	10988
Motor Vehicles	4774.847	3401.187	4199.293	.5965307	35479.98	.7123132	5543
Non-metallic pro	3265.814	3331.145	2272.589	.0312668	35302.68	1.020005	8410
Other Manuf	3907.39	3353.677	3099.974	2.846349	27517.25	.8582906	2339
Other Trasport	5322.96	5937.258	3337.186	4.644275	47552.16	1.115405	1202
Paper Products	4940.745	3706.329	4256.653	3.226973	36073.65	.7501559	3107
Printing and rec	4957.111	3404.933	4345.138	3.306696	19639.46	.6868785	2116
Repair install	3047.844	3292.869	1954.628	1.204488	25824.75	1.080393	2564
Rubber and Plastic	3732.004	3452.618	2814.694	1.028579	33115.59	.9251378	8312
Textiles	2901.276	2257.83	2436.567	.6249436	25450.13	.7782198	14326
Wearing apparel	2028.9	1844.352	1589.443	.1086644	26446.72	.9090408	21146
Wood products	2376.591	2112.156	1870.334	3.910269	17946.4	.8887333	2117
All sectors	3321.819	3155.411	2478.276	.0312668	54348.04	.9499045	127352

Table 11: Absolute Gap ($|Gap|$) Statistics by Industry:Single Plant Firms, years 2006-2015

	value added	total wage	annual wage per worker	# workers	male	female	female ratio
Basic Metals	2854353	1178152	16221.69	88.40952	82.16853	6.240985	7.059177
Chemicals	1957933	582251	17900.45	49.70715	36.41426	13.29289	26.74241
Computer	6803997	1333782	17512.3	109.6982	74.34948	35.34871	32.2236
Electrical	2435752	893337	15534.08	85.91624	67.49269	18.42356	21.44363
Fabricated metal	1207362	511210.7	14327.38	58.62858	52.1247	6.503878	11.09336
Food prod.	1339784	522882.3	12840.32	62.92559	42.95383	19.97176	31.73869
Furniture	757901.7	375751.1	11710.22	55.29822	49.29197	6.006406	10.86184
Leather prod.	660916.4	273781.8	11624.33	43.94518	35.33943	8.605753	19.58293
Machinery equip.	1454471	544432.4	15542.29	56.28726	50.1208	6.166732	10.95582
Motor Vehichle	4135577	1339708	16477.85	105.2641	89.03554	16.22874	15.41717
Non-metal	1534283	573417.6	12449.34	67.17792	59.415	7.762918	11.55576
Other Manuf	1810093	419399.1	13625.18	54.95283	39.34329	15.60997	28.40613
Other Trasport	6581099	1794105	16927.64	105.3379	95.70233	9.63555	9.147277
Paper Prod	1731778	587413.4	15191.68	59.18415	48.54042	10.64373	17.98409
Printing	1294561	494440.3	14144.62	50.20252	39.68463	10.51789	20.95092
Repair install	1369509	413113.9	13188.84	52.22776	49.14402	3.083734	5.904397
Rubber and plastic	1507306	536911.9	14760.39	58.82697	48.51116	10.31582	17.53587
Textiles	1746619	642722.2	12256.04	87.98815	64.70101	23.28714	26.46622
Wearing app	1088555	448480	11237.96	68.74013	34.45815	34.28203	49.87193
Wood prod	818644.4	301064.4	11293.73	45.02985	40.09174	4.938113	10.96631
All sectors	2130546	684076.7	14204.8	68.27173	54.80523	13.46656	19.49288

Value added, total wage bill and annual wage per worker are net values deflated by CPI with base year 2003.

Table 12: Summary Statistics by Industry: Single plant, years 2006-2015

	Real Gaps					
	Mean	Std.dev	Median	Min	Max	#obs
Basic Metals	5221.639	5957.168	4644.492	-26408.79	54348.04	3896
Chemicals	2404.007	6397.896	2278.928	-30306.03	43602.87	2651
Computer and Elect	1481.622	5539.732	1696.585	-20929.44	30376.32	1209
Electrical Equip	3092.092	4550.502	3109.701	-19484.73	30658.65	4842
Fabricated Metal	2239.871	4086.083	2246.208	-30493.01	32347.16	13123
Food products	1916.083	3740.964	1730.093	-26925.63	26304.18	9877
Furniture	-148.6046	2169.922	28.5486	-21878.27	8198.875	6446
Leather products	1077.685	2260.2	1064.776	-16116.5	11446.23	3138
Machinery and Equip	2382.58	4260.677	2800.681	-21730.83	21031.56	10988
Motor Vehicles	3737.66	4516.496	3782.769	-27553.47	35479.98	5543
Non-metallic pro	2065.858	4182.71	1614.844	-25191.34	35302.68	8410
Other Manuf	2907.631	4250.111	2443.424	-13962.97	27517.25	2339
Other Trasport	2423.539	7598.032	1610.633	-27031.11	47552.16	1202
Paper Products	3934.074	4761.699	3879.361	-21080.2	36073.65	3107
Printing and rec	3864.706	4608.159	3927.279	-19639.46	18237.9	2116
Repair install	-282.6029	4478.4	-11.95038	-25824.75	21193.59	2564
Rubber and Plastic	2528.141	4411.103	2234.896	-21574.36	33115.59	8312
Textiles	2083.859	3028.699	2101.085	-25450.13	24482.68	14326
Wearing apparel	1181.048	2474.535	1163.948	-26446.72	11728.85	21146
Wood products	1620.02	2736.12	1500.05	-17946.4	16823.07	2117
All sectors	2097.774	4073.144	1861.717	-30493.01	54348.04	127352

Table 13: Real Gap Statistics: Single Plant firms, years 2006-2015

10 Appendix C

10.1 Statistics for Whole Error Term ϵ

One can directly see that conditioning on the full error term provides us higher labor gaps for all industries with an overall average of 4.989 TL. Clutter between and within firms is significantly high compared to results conditioning on ω with coefficient of variation for total is 2.26 and mean absolute gap is between 2.003 TL to 11.038 TL with lowest industry furniture whereas the highest is basic metals as in the calculations with ω.

Industry	Mean $\lvert Gap \rvert$	Std.dev	Median	Min	Max	CV	#Obs
Basic Metals	11038.7	25554.06	4913.812	.4257372	981649	2.314951	5521
Chemicals	7658.957	13775.62	3110.887	.534879	234006.7	1.798629	4265
Computer and Elect	5670.486	12461.11	2366.462	.7179995	262200.1	2.197538	1600
Electrical Equip	6065.385	12828.71	2921.985	.8658506	595720.4	2.115069	6658
Fabricated Metal	4893.542	8657.954	2414.923	.0251873	280305.4	1.769261	17322
Food products	5262.335	9971.96	2040.699	.0822457	293868.1	1.894969	19384
Furniture	2003.448	5453.101	990.1743	.2906186	315652.7	2.721858	9725
Leather products	2932.614	5163.623	1368.625	.9728093	90859.7	1.760758	4739
Machinery and Equip	5077.828	7627.792	2655.269	.1357131	148791.6	1.502176	14325
Motor Vehicles	6474.022	8890.881	3766.994	.5961485	135105.9	1.373316	6689
Non-metallic pro	6264.608	16409.77	2220.529	.0731399	440561.3	2.619441	13735
Other Manuf	6094.294	14486.37	2828.558	1.156672	409617.2	2.377038	4001
Other Trasport	9286.591	26411.4	2393.025	1.417319	339630.6	2.844037	1427
Paper Products	7175.983	18810.23	4023.78	2.79419	826312	2.621275	3949
Printing and rec	7007.5	20106.96	3779.391	3.825915	769201.6	2.869349	2648
Repair install	3609.256	13150.67	1247.997	.4495032	533630.3	3.643596	3063
Rubber and Plastic	5402.441	10078.33	2474.147	.6876643	353107	1.865515	11998
Textiles	4615.182	7987.042	2467.054	.491066	529554.6	1.730602	20254
Wearing apparel	2941.009	5207.85	1437.224	.0560753	201723.7	1.77077	30381
Wood products	4335.896	9918.823	1704.198	.0360844	240011.9	2.287606	3208
All sectors	4989.109	11280.43	2140.091	.0251873	981649	2.261011	184892

Table 14: Absolute Gap ($\lvert Gap \rvert$) Statistics by Industry: conditional on full error term ϵ, years 2006-2015

	Real Gaps					
	Mean	Std.dev	Median	Min	Max	#obs
Basic Metals	10356.26	25838.21	4534.899	-22301.65	981649	5521
Chemicals	5705.411	14692.92	1569.489	-29220.03	234006.7	4265
Computer and Elect	3723.184	13175.09	728.5066	-20590.72	262200.1	1600
Electrical Equip	5445.954	13103.71	2574.767	-23608.92	595720.4	6658
Fabricated Metal	4264.892	8984.317	2061.438	-19297.37	280305.4	17322
Food products	4287.382	10428.37	1280.265	-19606.43	293868.1	19384
Furniture	787.6207	5755.877	-128.4528	-20259.28	315652.7	9725
Leather products	2318.41	5467.073	968.181	-10008.4	90859.7	4739
Machinery and Equip	4281.594	8101.606	2214.518	-21023.99	148791.6	14325
Motor Vehicles	5966.721	9239.043	3563.405	-24443.1	135105.9	6689
Non-metallic pro	5412.105	16710.35	1658.3	-31871.69	440561.3	13735
Other Manuf	5491.684	14725.43	2414.738	-14941.74	409617.2	4001
Other Trasport	7545.101	26960.99	1040.283	-20757.3	339630.6	1427
Paper Products	6526.139	19045.5	3667.615	-18882.17	826312	3949
Printing and rec	6348.57	20324.71	3346.713	-19923.64	769201.6	2648
Repair install	1760.47	13522.98	-358.8445	-18402.86	533630.3	3063
Rubber and Plastic	4702.504	10423.35	2059.859	-29135.71	353107	11998
Textiles	3832.493	8390.773	2004.272	-25871.12	529554.6	20254
Wearing apparel	2464.746	5449.435	1164.738	-19061.81	201723.7	30381
Wood products	3786.649	10141.29	1394.295	-11252.91	240011.9	3208
All sectors	4200.961	11597.04	1629.686	-31871.69	981649	184892

Table 15: Real Gap Statistics: conditional on full error term ϵ, years 2006-2015