THE EFFECTS OF PRODUCT AND PROCESS INNOVATIONS ON EMPLOYMENT GROWTH: EVIDENCE FROM TURKEY

by

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Abstract

This study aims to provide an empirical evidence on the relationship between innovation and employment growth at the firm level. I separately analyze the effects of the process and product innovations for Turkish manufacturing and service sector. Depending on data availability, I cover three consecutive periods: 2006-2008, 2008-2010 and 2010-2012. I use the structural framework developed by Harrison et al. (2014). The Community Innovation Survey (CIS) which is collected by Turkish Statistical Office (Turkstat) provides me the data needed to disentangle the effects of product and process innovations on employment growth. I find that product innovations increase employment growth, whereas process innovations do not account for job destruction in the manufacturing sector, but are responsible for significant but small displacement effect during the period 2008-2010 and 2010-2012 in the service sector.

ÜRÜN VE SÜREÇ YENİLİĞİNİN İSTİHDAM ÜZERİNDEKİ ETKİSİ: TÜRKİYE'DEN KANIT

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Özet

Bu çalışma istihdam büyümesi ile yenilik faaliyetleri arasındaki ilişkiyi firma düzeyinde ampirik kanıtlarla göstermeyi amaçlamaktadır. Ürün ve süreç yeniliklerinin istihdam büyümesine olan etkilerini ayrı ayrı, hem Türkiye sanayi sektörü hem de Türkiye hizmet sektörü için inceledim. Veri bulunurluluğuna bağlı olarak, çalışmam üç ardışık dönemi kapsamaktadır: 2006-2008, 2008-2010, 2010-2012. Türkiye İstatistik Kurumu (TÜİK) tarafından toplanılan Yenilik Araştırması anket verilerini kullandım. Harrison et. al 2014) makalesinde geliştirilmiş olan yapısal modeli kullandım. Bulduğum sonuçlara göre ürün yeniliği istihdam büyümesini artırırken, süreç yeniliği sanayi sektöründe iş yıkımına sebep olmamaktadır. 2008-2010 ve 2010-2012 dönemlerinde ise, süreç yeniliği hizmet sektöründe küçük fakat istatistiksel olarak önemli iş yıkımına sebep olmaktadır.

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1 Introduction

Turkey has no less than 10% unemployment rate since 2002 whereas high income OECD countries have on average six to seven percent unemployment rates (World bank, Unemployment Rates, 2002-2013).[1] In addition, youth unemployment rates are even more severe averaging 20 percent for the last decade. This persistently high unemployment rates increase payments for unemployment benefits which in turn may force the government to collect more taxes or borrow money from abroad or cut government spending. Employment opportunities increase with the growth of the economy. Technological progress and innovation foster economic growth. However, the effect of innovations on employment growth is not clear. Since no empirical investigation is made in order to determine the impact of innovations on employment growth for Turkey, I believe that it is more important than ever to answer the following question: ”Do product and process innovations increase employment growth?”

According to Statistical Office of the European Communities (2005), ”A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics (p. 48)”. On the other hand, ”process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software (p. 49)”. Process and product innovations effect employment growth through different channels. In terms of product innovation, the new demand created by the new or significantly improved products allows the innovating firm to expand in its current market or enter a new one which in turn increases the labor demand. This effect of the product innovation is called the ”compensation effect”. Its overall effect depends on the level of market concentration, the level of substitutability between the new and old products and the level of production synergies.

Process innovations, especially the ones related to production processes, increase productivity so that the innovating firm is able to produce with less input which in turn decrease its marginal costs. As an immediate effect, depending on the substitutability of production inputs, the labor demand of the process innovating firm may decrease. This impact of the process innovations is called the ”displacement effect”. In addition, firms may decrease the final prices of their goods or services due to the decreased marginal costs. As the final prices decrease, their market shares may increase which in turn creates

[1] http://data.worldbank.org/indicator/SL.UEM.TOTL.ZS., last accessed

an expansionary effect.[2] The expansionary effect due to the increased market share may outweigh the ”displacement effect” of the process innovation, since as the firm expand it demands more labor to match the increased demand for its products or services.

Various studies (Freeman, Clark and Soete, 1982; Vivarelli and Pianta, 2000) show that product innovations create new jobs since they open up new sectors or work areas via the introduction of entirely new goods or via the significant improvements of the current goods. Yet, the impact of process innovation is not clear in the sense that it may depend on firms’ pricing strategies, country-specific factors, its type and the market concentration. Given the fact that there is a strong link between innovation and employment, this paper focuses on the impact of the process and product innovations on the employment growth assuming that innovations are vital in employment creation and are considered as the engines that drive economic growth.

Main findings of this paper can be summarized as follows. Product innovations increase the employment growth in both manufacturing and service sector. In addition, new products are produced more efficiently compared to the old ones in service sector except for the period 2008-2010.[3] Net effect of the process innovation is not the ”displacement effect” in manufacturing sector. However, there is evidence for the displacement effect of the process innovations in service sector for the periods 2008-2010 and 2010-2012. I also cannot find any evidence to support that productivity gains of the non-innovating firms are responsible for job destruction.[4]

I use the Community Innovation Survey (CIS) collected by Turkish Statistical Office (Turkstat) for the periods 2006-2008, 2008-2010 and 2010-2012 in order to obtain innovation related variables. For nominal sales growth and employment growth, I use Annual Manufacturing and Service Statistics collected by Turkstat on a yearly basis. The structural model introduced by Jaumandreu (2003) and later developed by Harrison et al. (2014) fits the data and allow me to differentiate the effect of product and process innovations on employment growth for manufacturing and service sector.

The rest of the paper is organized as follows. Section 2 provides a brief literature review. Section 3 comments on the data set and related descriptive statistics. Section 4 presents the structural model that is used to determine the impacts of product and process innovations on employment growth and discuss the estimation procedure. Section 5 comments on the econometric results and problems associated with the estimation procedure. Section 6 concludes. Appendix A includes details on the definitions and calculations of the variables, descriptive statistics, and the results of OLS and IV regressions for all the

[2]This expansionary effect depends on the price elasticity of demand and the market concentration.

[3]The efficiency is defined as the Hicks-neutral efficiency with a technological parameter θ.

[4]The productivity gains of the non-innovating firms may be caused by the spill-over effects, exogeneous productivity shocks and changes in the organizational structures.

periods covered in this paper. Appendix B gives the details on the derivation of the cost functions. Appendix C gives the details on the derivation of labor demand functions.

2 Literature Review

A large number of empirical studies are focused on the relationship between innovation and employment growth for European and Latin American countries. They differ in terms of data sets and econometric methodologies ranging from the assessment of correlations between innovation and employment to the assessment of reduced form relationships. As more data becomes available at he firm level, many studies turned their focus on the structural modelling approach in analysing the relationship between innovation and employment. However, there is no empirical study to show the relationship between innovation and employment for Turkish manufacturing and service sector. Thus, this study contributes to the literature by providing empirical evidence about the effects of product and process innovations on employment growth for Turkish manufacturing and service sector.

Before the launch of CIS survey, many studies related to innovation and employment used input-oriented indicators such as intramural R&D expenditure, innovation expenditure and Information and Communication (ICT) investment by using reduced form relationships (e.g., Grilliches, 1995). R&D expenditure is found positively correlated with employment growth(e.g., Regev, 1998). The problem associated with using input-oriented indicators is that it is impossible to disentangle the impact of product and process innovations om employment growth, since innovation inputs like R&D expenditure contribute to the both types of innovation.

As more data becomes available at the firm level with the development of CIS survey, the focus of the many studies changed to output-oriented indicators for innovation activities. With the release of CIS survey, researchers can now determine whether the firms have introduced process and/or product innovations. Majority of the studies that have used CIS survey, have also used the structural model developed by Jaumandreu, (2003) as a basis. (Jaumandreu, 2003 for Spain, Peters, 2004, 2008, for Germany; Benavente and Lauterbach, 2008 for Chile; Crespi anc Tacsin, 2011 for Latin America; Harrison et al., 2014 for Spain, UK, Germany and France). According to those studies, it is evident that product innovations are key forces behind employment growth (except for Chile). On the other hand, the impact of process innovations differ between countries and regions.

To situate the structural modelling approach used in this paper, I compare it with one of the existing studies which used a closer approach (Van Reenen, 1997). It uses firm-level data on headcounts of innovation for 598 UK manufacturing firms. The econometric model used in Van Reenen (1997) develops first-order conditions for labor and capital which leads to a labor demand function including input prices and unobserved technology variable. The technology variable defined by the ratio of labor augmenting technological change to Solow-neutral technological change is proxied by headcounts of innovation. Hence, it only shows the relationship between innovation and employment growth at the firm level without differentiating the effects of product and process innovations on employment growth. The contribution of the structural model and the data set used in this paper contributes to the literature by showing a simple way to disentangle the effects of product and process innovations on employment growth.

3 Data Set and Descriptive Statistics

I use the Community Innovation Survey (CIS) collected by Turkish Statistical Office (Turkstat). I separately use three waves of CIS covering the periods 2006-2008, 2008-2010 and 2010-2012 both for manufacturing and service firms. [5] Employment and nominal sales levels are taken from Annual Industry and Service Statistics collected by Turkstat. The CIS survey is collected via using random sampling method. Annual Industry and Service Statistics is collected via using full sampling method. Hence, I can merge two data sets via matching the firms' identification numbers.

The CIS survey is collected by methods of web-based survey with two years frequency. It is also compulsory which is important in the sense that I do not have any selectivity bias in my estimations. It provides information about product and process innovations, sources of information, R&D and Innovation expenditures, effects of innovations on goods and services and share of new products' sales.

I exclude the firms which experience a merger or acquisition during the reference period and the firms which are established at the beginning of the reference period. The reason is that I cannot identify the source of the employment growth if the firm experience a merger or acquisition. I also exclude the firms with the missing data. For the first two periods (2006-2008 and 2008-2010), the CIS survey allows the non-innovating firms to pass the innovation-related questions from which I generate my instrumental variables. For 2010-2012, there is not a clear guidance stating that non-innovating firms may pass the innovation-related questions. However, given the fact that 94% of the non-innovating firms in the last period did not answer the questions related to the process and product

[5] Before 2006, CIS survey and Annual Industry and Service Statistics cannot be merged due to the firm identification mismatch.

innovations (i.e sources of information, R&D and Innovation expenditures), I assume that they do not complete the survey since most of the survey questions are redundant for them. Hence, while generating my variables, I treated innovation-related questions for the non-innovating firms as either no or irrelevant depending on the type of the question.

Table 1 and 2 report the descriptive statistics of the manufacturing and service sectors. I compiled the data into three sub-groups: non-innovators, process innovation only and product innovators (may also perform process innovations as well). According to the descriptive statistics, more than half of the manufacturing and services firms are non-innovators, whereas in the last period, the share of non-innovators increases to 65% and 74% in the manufacturing and service sector respectively. As suggested in Harrison et al. (2014), the lagged R&D Intensity is the main indicator for the current period's innovation performance. Looking at the R&D Intensity of the overall manufacturing and service firms, I observe that during the period 2008-2010, the R&D Intensity dropped to 0.52% from 0.87% and to 0.19% from 0.64% respectively so that increasing share of non-innovators during the period 2010-2012 is due to decreased R&D intensity in the period 2008-2010.

Looking at the employment growth of the manufacturing and service firms, product innovators experience higher employment growths compared to non-innovators and process innovator only firms. The employment growth rates of process innovator only firms are higher than those of the non-innovators although they experience productivity gains. This suggests that, on average, displacement effect of the process innovations are outweighed by the growth of output. Furthermore, during the period 2008-2010, low employment growths for all the firms can be associated with the effects of global subprime mortgage crisis and other related financial shocks. Turning to the sales growth of manufacturing and service firms, product innovators experience higher nominal sales growth which in turn may imply higher employment growth. Notice that the new products cannibalize the sales of the old ones to some extent given the fact that nominal sales growths due to the old products are negative across all periods in manufacturing and service sector.[6]

In order to deflate the nominal sales growth rates, I need to use inflation rates of the manufacturing and service industries. To compute the inflation rates, I use producer price indices on 2-digit NACE level for manufacturing sector.[7] For the service sector, I can only use industry level price indices for transportation, communication and financial services via consumer price indices and for the rest of the activities; I use aggregated consumer price index. Table 3 reports all the industries of the manufacturing and service sector and the distribution of the firms and their average sizes within those industries.

[6]The negative nominal sales growth due to the old products for the product innovators does not necessarily imply cannibalization of the new ones. It is also possible that traditional markets for the old products are shrinking which in turn decreases the sales of the old products.

[7]NACE is a classification system for business activities.

To sum up, according to the descriptive statistics, employment growth rates are higher in innovating firms and especially in product innovators. The sales growth due to the new products compensates the decrease in the sales of the old products both in manufacturing and service sector.

4 Model

The structural model introduced by Jaumandreu (2003) and later developed by Harrison et al. (2014) allows analyzing the effects of product and process innovations at firm-level employment growth using the firm-level micro data provided by CIS survey. The model builds upon the fact that during the period under consideration, firms can decide to launch new or significantly improved products or implement new or significantly improved production or delivery processes which in turn are considered as product and process innovation respectively.

The model describes a "two-period and two-goods" environment in which the beginning and the end of the reference period are denoted by $t = 1$ and $t = 2$ respectively. For the sake of the analysis, all products produced at $t = 1$ are called as old products and denoted by $j = 1$.[8] On the other hand, at $t = 2$ firm i may produce old products and new or significantly improved products if the firm at hand is a product innovator and the latter will be denoted by $j = 2$.[9] In year $t = 1$, the output produced by the firm is denoted by Y_{11}.[10] In year t = 2, if the firm is a product innovator there are two types of output: Y_{12} and Y_{22}. The former represents the output of old products and the latter represents the output of the new products.[11]

Innovation outputs depend on the lagged R&D and Innovation expenditures, so it is assumed that innovation decision is predetermined to the employment decision. This assumption is critical in the sense that it allows the analysis to overcome a possible endogeneity problem due to the simultaneous decision on employment and innovation. Hence, the innovation decision is not the result of the employment growth. It is further assumed that in order to produce old and new products, the production technologies have the standard input factors; capital K and labor L. The production technologies also have the property of constant returns to scale (CRTS) in both input factors. It is also assumed that

[8] At the beginning of the reference period, firms may be producing and selling a variety of products which we group as "old products".

[9] Definition of new or significantly improved products and related examples can be found from the Community Innovation Survey conducted by TURKSTAT in 2013.

[10] Note that the first subindex represents the type of the product and the second one represents the time.

[11] Note that Y_{22} is zero if the firm is not a product innovator.

technological advancements increase the marginal productivity of capital and labor by Hicks-neutral efficiency parameters: θ_{jt} for $j = 1, 2$. The following equation represents the production function of the firm i at $t = 1$ and at $t = 2$ respectively:

$$\begin{aligned} Y_{11i} &= \theta_{11} F(K_{11i}, L_{11i}), \\ Y_{12i} &= \theta_{12} F(K_{12i}, L_{12i}), \end{aligned}$$

and if the firm is a product innovatior,

$$Y_{22i} = \theta_{22} F(K_{22i}, L_{22i}).$$

It is also assumed that the decisions about the amount of input factors used in the production function are made while taking into account the cost minimization principle. Given the production technology, the cost functions for the old products at the beginning and at the end of the reference period, and the cost function of the new product can be formulated as respectively:

$$c(w_{11i}, r_{11i}) \frac{Y_{11i}}{\theta_{11}},$$
$$c(w_{12i}, r_{12i}) \frac{Y_{12i}}{\theta_{12}},$$
$$c(w_{22i}, r_{22i}) \frac{Y_{22i}}{\theta_{22}},$$

where $c(.)/\theta_{jt}$, r and w represent the unit costs, interest rate and wage respectively (see Appendix B for detailed derivation).[12]

Using Shephard's Lemma, labor demand functions for the old and new products can be derived as follows (see Appendix C for the detailed derivation of labor demand function):

$$\begin{aligned} L_{11i} &= c_w(w_{11i}, r_{11i}) \frac{Y_{11i}}{\theta_{11}}, \\ L_{12i} &= c_w(w_{12i}, r_{12i}) \frac{Y_{12i}}{\theta_{12}}, \\ L_{22i} &= c_w(w_{22i}, r_{22i}) \frac{Y_{22i}}{\theta_{22}}, \text{ if } Y_{22i} > 0 \text{ and } L_{22i} = 0 \text{ otherwise.} \end{aligned}$$

$c_w(.)$ represents the derivative of the $c(.)$ with respect to wage. Since there is no data available on input prices, it is assumed that $c_w(.)$ does not change across time. Since $c(.)$ is homogeneous of degree one in input prices which in turn guarantees that $c_w(.)$ is homogeneous of degree zero. Given the fact that input prices for the new and old products at the end of the period are the same, and the relative input prices for the old products are

[12] Note that unit cost multiplied by total output gives the total cost.

roughly constant, even if the input prices vary, $c_w(.)$ does not vary.

In order to obtain the "estimating equation", the employment growth expression is separated into two parts in terms of employment growth due to old and new products. Hence, the employment growth can be summarized as:[13]

$$\frac{\Delta L}{L} = \frac{L_{12} + L_{22} - L_{11}}{L_{11}} = \frac{L_{12} - L_{11}}{L_{11}} + \frac{L_{22}}{L_{11}} \approx \ln \frac{L_{12}}{L_{11}} + \frac{L_{22}}{L_{11}},$$

where $\ln \frac{L_{12}}{L_{11}}$ denotes the logarithmic employment growth rate due to the demand for old products and $\ln \frac{L_{22}}{L_{11}}$ denotes the employment growth rate due to the introduction of new products.

Given the labor demand functions derived above, the employment growth rate due to the new products, old products and possible efficiency gains can be represented by the following equation:

$$\frac{\Delta L}{L} = -(\ln \theta_{12} - \ln \theta_{11}) + (\ln Y_{12} - \ln Y_{11}) + \frac{\theta_{11}}{\theta_{22}} \frac{Y_{22}}{Y_{11}}. \tag{4.1}$$

According to the equation (4.1), there are three factors which affect the employment growth. The first term is the efficiency increase in the production of the old product. It is important to note that efficiency change which is denoted by $(\ln \theta_{12} - \ln \theta_{11})$ exists for non-innovators as well due to possible spill-over effects, changes in the organizational structures and exogenous productivity shocks. Nevertheless, it is expected to be larger for firms who engage into some kind of a process innovation. The second term is the change in the production of the old product. The third term is the introduction of a new or significantly improved product. Furthermore, given the fact that the impact of product innovations depends on the relative efficiency of old and new products production technologies denoted by $\frac{\theta_{11}}{\theta_{22}}$; if new products are produced more efficiently, this ratio will be less than 1 which in turn implies that there is not a one-to-one relationship between employment and output growth due to new products.[14]

The following equation represents the econometric model associated with the equation (4.1) while taking into account efficiency increases which possibly gained by process innovations:[15]

$$l - y_1 = \alpha_0 + \alpha_1 d + \beta y_2 + u, \tag{4.2}$$

where;

[13] For the sake of simplicity, subindex i is dropped.

[14] I expect this ratio to be smaller than 1, given the fact that process innovations associated with the introduction of new products exhibit higher efficiency gains for new products production technology hence higher θ_{22}.

[15] In order to differentiate efficiency changes of non-process and process innovators I decompose $(\ln \theta_{12} - \ln \theta_{11})$ term into α_0 and α_1 so that the analysis is more clear on how process innovations effect the employment growth rate.

l: rate of change in employment growth

α_0: average efficiency gains for firms which do not undertake process innovations

α_1: average efficiency gains for firms which engage in process innovations

d: dummy variable being 1 if the firm introduces any type of process innovations which is not associated with the new products (process innovation only)

y_1: real output growth due to the old products denoted by $(\ln Y_{12} - \ln Y_{11})$

y_2: real output growth due to the new products denoted by $\frac{Y_{22}}{Y_{11}}$

u: disturbance term with $E[u|d, y_1, y_2] = 0$.

In order to estimate the net employment effect of the product innovation, I use $l - y_1$ instead of l since the introduction of new products may provoke demand for the old products up to some point.

Equation (4.2) allows me to determine the effects of product innovation and process innovation on employment growth separately. By estimating the coefficient β, I can identify the effect of product innovation on employment growth rate. Similarly, observing the efficiency gains due to the process innovations allows me to determine the net effect of the process innovations.

In the following section, I will discuss possible problems in estimating the parameters of equation (4.2)

4.1 Endogeneity Problem

Equation (4.2) requires real output levels. However, in most data sets, economists observe nominal sales and deflate them with firm level price indices or with an aggregate price index and proxy real output. Firm level price indices are not available, so that for the manufacturing firms I use industry level price indices according to 2-digit NACE classification. For the service firms, I can only find industry level price indices for transportation, communication and financial services and for the rest of the activities, I use headline consumer price index.[16] Using firm-level price indices, nominal sales growth due to the old

[16]See Table 3 for detailed information on manufacturing and service industries.

and new products can be written as respectively:[17]

$$
\begin{aligned}
g_1 &= \frac{P_{12}Y_{12} - P_{11}Y_{11}}{P_{11}Y_{11}} \text{ with } \pi_1 = \frac{P_{12} - P_{11}}{P_{11}} \text{ implying that } (1 + y_1) = \frac{(1 + g_1)}{(1 + \pi_1)} \text{ then,} \\
y_1 &\approx g_1 - \pi_1, \\
g_2 &= \frac{P_{22}Y_{22}}{P_{11}Y_{11}} \text{ with } \pi_2 = \frac{P_{22} - P_{11}}{P_{11}} \text{ implying that } y_2 = \frac{g_2}{(1 + \pi_2)}.
\end{aligned}
$$

I substitute y_1 with g_1 and y_2 with g_2 so that equation (4.2) takes the following form:

$$l - g_1 = \alpha_0 + \alpha_1 d + \beta g_2 + v \text{ where } v = -\pi_1 - \beta\pi_2 y_2 + u \quad (4.3)$$

Equation (4.3) has an endogeneity problem in the sense that variable g_2 is correlated with the error term v. Correlation is caused by the fact that the ratio of nominal sales of new to old products (g_2) is dependent on the price growth of new products with respect to the old products (π_2) which is included in v. Furthermore, the nominal sales growth may also be affected by the unanticipated shocks (i.e. economic recessions) which are included in u. In order to avoid a possible endogeneity problem, I need to determine instrumental variables that are sufficiently correlated with g_2 and are uncorrelated with unanticipated shocks and π_2. Other than that it can be the case that variable d is correlated to the unanticipated shocks. However, given the fact that innovations are the results of the R&D engagement of a firm and other technological investments which are decided in advanced, they are not affected by the unanticipated shocks at the time of innovation. Hence, it is quiet unlikely that there is a correlation between d and v. In section 4.3, I discuss about possible instrumental variables for g_2 and their validity to avoid a possible endogeneity problem.

4.2 Identification Problem

Other than the endogeneity problem induced by g_2, there is an identification problem induced by the fact that the data about the price changes for the old products are not available at the firm level (π_1) and as a result π_1 is included in the error term. Given the fact that price changes of old products depend on the marginal cost change, c_δ, I can define $\pi_1 = \pi_0 + \lambda c_\delta$, where λ represents the rate at which marginal cost change is reflected to price changes with $0 < \lambda < 1$. Assuming that marginal cost changes are directly related to the introduction of process innovations, I can define $c_\delta = \alpha_1 d$ which implies that

[17] For small x, the following approximation is valid: $ln(1+x) \approx x$. Assuming that y_1 and π_1 are not too large to disturb the approximation, $\ln(1+y_1) = \ln(1+g_1) - \ln(1+\pi_1)$ can be approximated to $y_1 \approx g_1 - \pi_1$.

$\pi_1 = \pi_0 + \lambda\alpha_1 d$.[18] As a result, in equation (4.3) estimating variable d will give a downward biased effect of process innovation $(1-\lambda)\alpha_1$. As a_1 gets closer to 1, the effect of process innovation will have no effect on employment growth rate. In order to avoid such an identification problem, I use $l-(g_1-\pi)$ as the dependent variable which leads to error term to include $-(\pi_1-\pi)$ where π is the average price change for the related industry. However, if firm-level price changes deviate from the average price change for the related industry, the coefficient a_1 is still attenuated but with this modification the downward bias is partly corrected.[19]

4.3 Estimation Procedure

As it is discussed in subsection 4.1, due to an endogeneity problem induced by g_2, using OLS to estimate equation (4.3) would yield inconsistent and downward biased coefficients. In order to validate the endogeneity problem, I run Hausman tests for all the periods and I find that g_2 is in fact an endogenous variable. Thus, I use instrumental variable procedure to correct for the endogeneity problem.

I use *Improved Range* as an instrument for the period 2006-2008 and *Client* for the periods 2008-2010, 2010-2012 respectively in estimating the endogeneous variable. *Improved Range* variable takes value of 0, if the innovation activities have no impact on improving the range of products, and takes value of $1/2/3$ if they have a low/medium/high impact. It is significantly and positively correlated with g_2 at 1% level. It is also quiet unlikely that *Improved Range* variable is correlated with the price changes and unanticipated shocks since it only indicates how effective are the innovations on increasing the product range. *Client* variable takes value of 0, if either clients from the private sector or the clients from the public sector are not sources of information for innovation activities, and takes value of $1/2/3$ if they have been a low/medium/high sized information source for the innovation activities. Same as *Improved Range*, it is significantly and positively correlated with g_2 at 1% level. I do not expect any correlation between *Client* and the price changes and unanticipated shocks, since it only indicates how important are the clients as sources of information for innovation activities. In subsection 5.1, I check the validity of my preferred instruments with the help of two suspicious IVs, and test the implicit assumption on the exogeneity of process innovation only dummy (d) with the help of two valid IVs.

[18] Note that a constant returns to scale production function exhibits a constant returns to scale cost function. Since the marginal cost change is associated with the change in the necessary amount of input factors (in this case labor), the displacement effect created by process innovation has a one-to-one relationship with the marginal cost change given the CRTS condition.

[19] To fully correct the downward bias problem associated with the process innovation, better information about the prices changes at the firm level needed.

5 Econometric Results

Table 4 presents the estimation results of the model for the manufacturing firms using OLS for the period 2006-2012 in which the industry dummies are also included. The value of the constant in OLS regression represents the average real productivity growth for non-innovating firms. As it is discussed, non-innovating firms may also increase their productivity due to spill-over effects, changes in the organizational structures and exogenous productivity shocks. The negative sign shows the negative correlation between productivity growth and employment growth hence indicating the net displacement effect. At the period 2010-2012, the constant is statistically significant and negative, whereas in other periods the constant is not statistically significant. Hence I cannot find any evidence to support that net displacement effect due to the productivity gains occur for the non-innovating manufacturing firms except for the last period. Although, the coefficient of the process innovation is expected to be negative and statistically significant, it turns out to be very close to zero and statistically insignificant for all the periods. There may be two explanations for it. The first one is related to the lack of firm level price indices, especially if they deviate from industry level price indices substantially. As it is discussed in subsection 4.2, the identification problem becomes more severe as the deviations of firm level price indices increase. The second one can be related to the fact that marginal cost changes are highly reflected on final prices which in turn create expansionary effect. In other words, firms may be using aggressive pricing strategies so that the displacement effect of the process innovations is balanced. Finally, the coefficient of sales growth due to new products, β, is less than unity for all periods suggesting that new products are produced more efficiently than old products. Nevertheless, due to the endogeneity problem the coefficient presents a downward biased result.

In order to tackle with the endogeneity problem, I use instrumental variable for g_2. For the period 2006-2008, my preferred instrumental variable is *Improved Range* so that I can make comparisons with the results of Harrison et al. (2014). However, due to the lack of information for periods 2008-2010 and 2010-2012, instead of *Improved Range*, I use a different IV: *Client*. As it is discussed in subsection 4.3, the preferred instruments are not correlated with the price changes and unanticipated shocks. According to the results of my first stage reduced form regressions, both *Client* and *Improved Range* are significantly and positively correlated with g_2 at 1% level. There are other candidates that are significantly and positively correlated with g_2 such as *R&D Intensity, Innovation Intensity, Improved Quality* and *Increased Market Share*. Nevertheless, they are correlated with either price changes or unanticipated productivity shocks, so that they cannot be valid IVs.[20]

[20] *R&D Intensity* and *Innovation Intensity* variables are correlated with unanticipated productivity shocks,

The first columns of Table 5, 6 and 7 present the IV estimates for the periods 2006-2008, 2008-2010 and 2010-2012 for manufacturing firms respectively. Instrumenting *Improved Range* and *Client* for the endogenous variable, g_2, the IV estimates of the relevant coefficients are different than those of the OLS ones. The most important change is in the coefficient of the sales growth due to new products. Note that the IV coefficient is higher than the OLS one which supports the claim on downward biased scenario due to endogeneity problem. Based on IV estimation, I cannot find any evidence to support that new products are produced more efficiently than the old ones since the coefficient of the sales growth due to new products is not less than unity except for the period 2008-2010. Looking at the coefficients of g_2, I show that 1% increase in the sales growth due to the new products, on average, causes 1% increase in the employment growth in the manufacturing firms for the period 2006-2008. In the second period, 1% increase in g_2 causes 0.92% increase in the employment growth whereas this effect turns out to be 1.18% in the last period.

For the service firms, the results of the OLS regressions reported at Table 8 resemble those of the manufacturing firms. I cannot find any evidence to support that productivity gains of the non-innovating firms and process innovation of the innovative firms create net displacement effect. However, due to the lack of information on price indices, I use aggregated price deflators for all of service activities except for communication, transportation and financial services. Hence, the identification problem caused by the lack of information on price indices may be more severe in the service sector.

The first columns of Table 9, 10 and 11 present the IV estimates for the period 2006-2008, 2008-2010 and 2010-2012 respectively. 1% increase in the sales growth due to the new products causes 0.85%, 1.21% and 0.94% increase in the employment growth for the periods 2006-2008, 2008-2010 and 2010-2012 respectively. Based on the coefficients of g_2, I show that the new products are produced more efficiently than the old ones given the fact that the coefficients of the sales growth due to the new products are less than unity except the period 2008-2010. The coefficient of the process innovation only dummy (d), is insignificant for the period 2006-2008 and is close to zero. However, it is significant at 10% and 5% level for periods 2008-2010 and 2010-2012 respectively. I show that process innovations create significant but small net displacement effect in service sector for the periods 2008-2010 and 2010-2012.

Comparing my results with the findings of Harrison et al. (2014), the effect of product innovations on employment growth is similar in Spanish, French, German and British manufacturing and service sectors. The effect of process innovations on employ-

since R&D and Innovation expenditures may be changed rapidly in response to productivity shocks. *Increased Market Share* is correlated with the price changes, since lower prices allow the firm to expand in the market. *Improved Quality* is also correlated with price changes, since improvement in product quality is positively correlated with high prices.

ment growth differ in each country. In French manufacturing and service sectors, the coefficient of process innovation only dummy (d), is negative but insignificant as in the Turkish case.[21] Another comparison can be made with the findings of Benavente and Lauterbach (2008) on Chile and Crespi and Tacsin (2011) on Latin American countries. The employment effect of product innovations expect for Chile is again consistent with Turkish case, but the displacement effect of the process innovations vary depending on the region. For Argentina, Costa Rica and Uruguay, process innovations are not responsible for job destruction, whereas they create significant but small displacement effect for Chilean manufacturing and service firms.

5.1 Testing the Exogeneity of d and Validity of Preferred IVs

Up to this point, it is assumed that the process innovation only dummy is exogenous. With the help of some additional instrumental variables and "Difference-in-Sargan" test, I confirm that the exogeneity of the process innovation only dummy. In addition to *Improved Range* and *Client* variables, I look for other candidates. Similar to *Client* variable, the *Science* variable which is defined as use of universities or public institutions as information sources for innovations is a strong indicator for the sales growth due to the new products. *Science* variable is another potential IV along with the *Continuous R&D* variable which indicates whether the firms engage in continuous intramural R&D activities or not. They are both positively and significantly correlated with the endogenous variable and statistically significant at 1% level. The second columns of Table 5, 6, 7 and Table 9, 10, 11 reports the IV estimates of manufacturing and services sector using three above mentioned instruments respectively. For the period 2006-2008, in addition to *Improved Range*, I add *Client* and *Continuous R&D*, whereas for the periods 2008-2010 and 2010-2012, in addition to *Client*, I add *Science* and *Continuous R&D* variables.[22] I fail to reject the null hypothesis of Sargan test with high probabilities for the service and manufacturing sector across all periods. Hence, I conclude that the additional IVs are valid.

After confirming the validity of the additional IVs, I can test the exogeneity assumption of process innovation dummy (d), using "Difference in Sargan" test.[23] If I maintain the exogeneity of process innovation dummy (d), I have two-overidentifying restrictions since I have one endogenous variable (g_2). If I do not maintain the exogeneity of d, I have

[21] Note that Harrison et al. (2014) covers the period 1998-2000. Although I do not cover the same period with Harrison et al. (2014), I still believe that making cross-country comparisons are still interesting.

[22] In order to check their validity, I use Sargan test with two degrees of freedom. The null hypothesis of Sargan test states that the over-identifying restrictions are valid.

[23] The null hypothesis of "Difference in Sargan" test states that specified orthogonality condition is valid. In this case I check the orthogonality between d and the error term.

one over-identifying restriction since I have two endogenous variables (g_2 and d). I fail to reject the null hypothesis of ”Difference in Sargan” test for both manufacturing and service sector across all periods. Hence, I conclude that process innovation dummy (d), is orthogonal to the error term which means that it is an exogeneous variable. The relevant probabilities of the “Difference-in-Sargan” test are reported in the second column of Table 5, 6, 7 and Table 9, 10, 11 for the manufacturing and services sector respectively.

It can also be argued that validating our instruments and the exogeneity assumption of process innovation only dummy with the results of Sargan tests is unrealistic. In order to confirm the validation methodology, I use more suspicious instruments and apply the Sargan test just to see if we obtain different probability values. The third column of Table 5, 6, 7 and Table 9, 10, 11 reports the IV estimates of manufacturing and service sectors across all periods using some dubious instruments respectively. For the period 2006-2008, in addition to *Improved Range* variable, I add two more instruments: *Improved Quality* and *Increased Market Share*. As it is discussed in section 5, both of the variables are correlated with the price changes and correlated with the error term. Intuitively, I can argue that those variables are not valid IVs. In fact, the Sargan test rejects the validity of those additional IVs given the fact that probability values are quiet low. For the other periods, in addition to *Client* variable, I add *R&D Intensity* and *Innovation Intensity* variables. As it is discussed in section 5, both of the variables are correlated with the unanticipated productivity shocks and correlated with the error term. Not surprisingly, the Sargan test results suggest that the validity of those additional variables are rejected both for manufacturing and services sector. As a result, I conclude that the Sargan test is reliable in determining the validity of additional IVs.

6 Conclusion

Using the model developed by Harrison et al. (2014), I show the effects of product and process innovations on employment growth in Turkey. The effect of product innovation is due to the sales growth caused by the new products. I also show that new products are produced more efficiently than the old ones for the period 2008-2010 in manufacturing sector and for the period 2006-2008 and 2010-2012 in service sector. On the other hand, I cannot find any evidence to support neither positive nor negative effect of process innovation on employment growth in manufacturing sector. I argue that this may be due to the lack of information on the firm-level price indices. I can only partly address this problem by replacing the firm-level price indices with the industry-level price indices based on 2-digit NACE specification.

Based on the IV estimates, I can conclude that for Turkish manufacturing and service firms, on average, the product innovations increase the employment growth rate. The estimates further suggest that the relationship between employment growth rate and sales growth due to the new products is not one-to-one for both manufacturing and service sector. Furthermore, displacement effects of process innovations are dominated by the growth of output in manufacturing sector hence, I cannot conclude that process innovations are responsible for job destruction in manufacturing firms. I can however, conclude that process innovations are responsible for significant but small net displacement effect in services sector during the periods 2008-2010 and 2010-2012. However, having firm-level price indices may change the accuracy of the employment effects of process innovation.

The impacts of product innovations for Turkish manufacturing and service firms are quiet similar to those found for other countries such as Argentina, Costa Rica, Spain, Uruguay and UK which in turn provides evidence to an international pattern between employment and product innovation.

Appendix A

Variables in alphabetical order

Client: Variable being 0, if either clients from the private sector or the clients from the public sector have not been a source of information for innovation activities, being 1/2/3 if they have been a low/medium/high sized information source for the innovation activities.

Continuous R&D: Dummy variable being 1, if the firm has conducted R&D activities continuously and being 0 otherwise.

Employment Growth (l): Firm's employment growth rate for the whole period.

Industry Dummies: 11 dummies for manufacturing sector and 7 dummies for services sector according to the list given in Table.

Improved Range: Variable being 0, if the innovation activities have had no impact on improving the range of products, being 1/2/3 if they have had a low/medium/high impact.

Improved Quality: Variable being 0, if the innovation activities have had no impact on improving the quality of products, being 1/2/3 if they have had a low/medium/high impact.

Increased Market Share: Variable being 0, if the innovation activities have had no impact on increasing market share, being 1/2/3 if they have had a low/medium/high impact.

Nominal Sales Growth (g): Firm's nominal sales growth for the whole period. Computed as: $[\frac{\text{Current Sales of Old Products + Current Sales of New Products - Past Sales of Old Products}}{\text{Past Sales of Old Products}}]$

Nominal Sales Growth due to New Products (g_2): Firm's nominal sales growth due to new products for the whole period. Computed as:$[\frac{\text{Current Sales of New Products}}{\text{Past Sales of Old Products}}]$ Current sales of new products are calculated according to the proportion of sales of new products and this proportion is taken from the survey.

Nominal Sales Growth due to old products (g_1): Firm's nominal sales growth due to old products for the whole period. Computed as:$[g - g_2]$.

Price Growth (π): Price growth rate for the whole period which is detailed at industry levels.

Process and Product Innovation: Dummy variable being 1, if the firm has introduced product and process innovation and being 0 otherwise.

Process Innovation: Dummy variable being 1, if the firm has introduced a new production technology and/or new delivery methods and/or new production supporting procedures during the reference period and being 0 otherwise.

Process Innovation Only (d): Dummy variable being 1, if the firm has introduced a process innovation but not a product innovation and being 0 otherwise.

Product Innovation: Dummy variable being 1, if the firm has introduced at least one new or significantly improved product and being 0 otherwise.

Science: Variable being 0, if either universities or public research institutes have not been a source of information for innovation activities, being $1/2/3$ if they have been a low/medium/high sized information source for the innovation activities.

Table 1: Employment and Sales Growth Rates for Innovative and Non-Innovative Manufacturing Firms

Period	2006-2008	2008-2010	2010-2012
Number of Firms	**1533**	**1618**	**2202**
Non-innovators (%)	58.4	51.9	65.1
Process Innovators Only (%)	8.3	10.9	8.4
Product Innovators (%)	33.3	37.2	26.5
Product & Process Innovators (%)	28.4	31.1	21.2
Employment Growth (%)			
All Firms	0.9	-3.0	10.6
Non-Innovators	-1.7	-6.4	9.5
Process Innovators Only	2.3	-3.6	9.3
Product Innovators	5.1	1.8	13.6
Sales Growth (%)			
All Firms	25.1	4.2	39.3
Non-Innovators	24.9	1.4	41.2
Process Innovators Only	32.1	-4.3	32.3
Product Innovators	23.8	10.5	37.0
of which:			
Old Products	-27.3	-25.9	-5.2
New Products	51.1	36.4	42.1
Price Growth (%)			
All Firms	25.4	18.3	19.8
Non-Innovators	25.1	20.5	20.0
Process Innovators Only	26.7	18.2	21.0
Product Innovators	25.5	17.6	19.0

Table 2: Employment and Sales Growth Rates for Innovative and Non-Innovative Service Firms

Period	2006-2008	2008-2010	2010-2012
Number of Firms	**920**	**795**	**1445**
Non-innovators (%)	72.8	58.6	73.5
Process Innovators Only (%)	5.1	15.3	11.7
Product Innovators (%)	22.1	26.1	14.8
Product & Process Innovators (%)	15.7	21.9	12.5
Employment Growth (%)			
All Firms	1.4	-0.8	10.9
Non-Innovators	0.4	-2.3	10.7
Process Innovators Only	0.8	0.6	10.8
Product Innovators	3.2	2.1	12.1
Sales Growth (%)			
All Firms	27.1	8.6	31.1
Non-Innovators	26.3	4.5	30.0
Process Innovators Only	32.5	9.6	30.9
Product Innovators	28.7	20.6	36.9
of which:			
Old Products	-11.2	-9.5	-10.2
New Products	39.9	30.1	47.1
Price Growth (%)			
All Firms	12.4	17.6	19.9
Non-Innovators	12.5	17.3	19.8
Process Innovators Only	12.2	17.8	19.7
Product Innovators	12.1	17.9	20.0

Table 3: Number of firms and average firm size, by sector

	Number of Firms			Average Firm Size[a]		
	2006-2008	2008-2010	2010-2012	2006-2008	2008-2010	2010-2012
Manufacturing						
Food / Beverages	51	173	284	459	627	433
Textile	223	429	589	306	458	362
Wood / Print	379	51	124	394	247	182
Chemicals	40	72	213	317	541	209
Plastic Rubber	95	90	129	115	285	242
Non Metals	6	158	160	26	351	315
Metals	242	248	261	210	376	360
Electrical	212	89	154	306	707	433
Machinery	117	104	92	128	275	348
Vehicles	112	117	85	303	714	846
Furniture	51	87	111	550	283	333
Services						
Wholesale	-	285	544	-	276	206
Transport	353	231	372	209	811	464
Communication	323	208	294	417	352	242
Technical Serv.	93	57	126	124	144	121
R&D	96	14	10	193	40	67
Financial Int.	55	-	-	1329	-	-
Visual Serv.	-	-	99	-	-	240

[a]Average number number of employees at the end of the reference period

Table 4: OLS specification for Manufacturing Firms

Testing the specification: Manufacturing Firms[a] Dependent Variable: $l-(g_1-\pi)$			
	2006-2008	2008-2010	2010-2012
Regression	OLS	OLS	OLS
Constant	0.050 (0.055)	-0.030 (0.040)	-0.162** (0.050)
Process Innovation Only (d)	-0.062 (0.041)	0.034 (0.042)	-0.057 (0.049)
Sales Growth due to New Products (g_2)	0.869*** (0.025)	0.825*** (0.034)	0.969*** (0.035)
No. Of Firms	1533	1618	2202

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity
Significance Levels:*10% , **5%, ***1%

Table 5: IV specification for Manufacturing Firms, 2006-2008

Testing the specification: Manufacturing Firms for 2006-2008[a] Dependent Variable: $l-(g_1-\pi)$			
Regression	IV[b]	IV[c]	IV[d]
Constant	0.081 (0.064)	0.083 (0.064)	0.098 (0.064)
Process Innovation Only (d)	-0.030 (0.041)	-0.030 (0.041)	-0.038 (0.041)
Sales Growth due to New Products (g_2)	1.004*** (0.047)	1.000*** (0.046)	0.971*** (0.044)
No. Of Firms	1533	1533	1533
Sargan (m)	-	0.67 (2)	5.38 (2)
Prob Value	-	(0.71)	(0.07)
Diff. Sargan (m)	-	0.51 (1)	-
Prob Value	-	(0.43)	-

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
[b] The instrument used is *Improved Range*
[c] The instruments used are *Improved Range, Client* and *Continuous R&D*
[d] The instruments used are *Improved Range, Improved Quality* and *Increased Market Share*
Significance Levels:*10% , **5%, ***1%

Table 6: IV specification for Manufacturing Firms, 2008-2010

Testing the specification: Manufacturing Firms for 2008-2010[a] Dependent Variable: $l-(g_1-\pi)$			
Regression	IV[b]	IV[c]	IV[d]
Constant	-0,006 (0,055)	-0,007 (-0,055)	0.001 (0,055)
Process Innovation Only (d)	0.052 (0,039)	0.053 (0,039)	0.048 (0.039)
Sales Growth due to New Products (g_2)	0.916*** (0,068)	0.919*** (0,066)	0.894*** (0.066)
No. Of Firms	1618	1618	1618
Sargan (m)	-	0,49(2)	5.94(2)
Prob Value	-	(0,78)	(0.05)
Diff. Sargan (m)	-	1.06 (1)	-
Prob. Value	-	(0.30)	-

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
[b] The instrument used is *Client*
[c] The instruments used are *Client, Science and Continuous R&D*
[d] The instruments used are *Client, R&D Intensity and Innovation Intensity*
Significance Levels:*10% , **5%, ***1%

Table 7: IV specification for Manufacturing Firms, 2010-2012

Testing the specification: Manufacturing Firms for 2010-2012[a] Dependent Variable: $l-(g_1-\pi)$			
Regression	IV[b]	IV[c]	IV[d]
Constant	-0.138 (0.056)	-0.140 (0.056)	-0.137 (0.056)
Process Innovation Only (d)	-0.021 (0.044)	-0.020 (0.044)	-0.022 (0.044)
Sales Growth due to New Products (g_2)	1.178*** (0.077)	1.185*** (0.073)	1.174*** (0.076)
No. Of Firms	2202	2202	2202
Sargan (m)	-	0.91 (2)	6.55 (2)
Prob Value	-	(0.63)	(0.04)
Diff. Sargan (m)	-	0.95 (1)	-
Prob. Value	-	(0.33)	-

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
[b] The instrument used is *Client*
[c] The instruments used are *Client, Science and Continuous R&D*
[d] The instruments used are *Client, R&D Intensity and Innovation Intensity*
Significance Levels:*10% , **5%, ***1%

Table 8: OLS specification for Service Firms

Testing the specification: Services Firms[a]
Dependent Variable: $l-(g_1-\pi)$

	2006-2008	2008-2010	2010-2012
Regression	OLS	OLS	OLS
Constant	0.220 (0.099)	0.108 (0.105)	0.003 (0.087)
Process Innovation Only (d)	-0.099* (0.053)	0.070 (0.100)	0.390 (0.416)
Sales Growth due to New Products (g_2)	0.767*** (0.052)	0.909*** (0.067)	0.901*** (0.057)
No. Of Firms	920	795	1445

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
Significance Levels:*10% , **5%, ***1%

Table 9: IV specification for Service Firms, 2006-2008

Testing the specification: Service Firms for 2006-2008[a]
Dependent Variable: $l-(g_1-\pi)$

Regression	IV[b]	IV[c]	IV[d]
Constant	0.027 (0.078)	0.028 (0.078)	0.033 (0.078)
Process Innovation Only (d)	-0.087 (0.112)	-0.087 (0.112)	-0.093 (0.112)
Sales Growth due to New Products (g_2)	0.852*** (0.106)	0.848*** (0.104)	0.806*** (0.098)
No. Of Firms	920	920	920
Sargan (m)	-	0.29 (2)	10.34
Prob. Value	-	(0.87)	(0.00)
Diff. Sargan (m)	-	0.05 (1)	-
Prob. Value	-	(0.83)	-

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
[b] The instrument used is *Improved Range*
[c] The instruments used are *Improved Range, Client* and *Continuous R&D*
[d] The instruments used are *Improved Range, Improved Quality* and *Increased Market Share*
Significance Levels:*10% , **5%, ***1%

Table 10: IV specification for Service Firms, 2008-2010

Testing the specification: Service Firms for 2008-2010[a] Dependent Variable: $l - (g_1 - \pi)$			
Regression	IV[b]	IV[c]	IV[d]
Constant	-0.094 (0.203)	-0.019 (0.198)	0.036 (0.202)
Process Innovation Only (d)	-0.126* (0.070)	-0.106 (0.069)	-0.342** (0.168)
Sales Growth due to New Products (g_2)	1.209*** (0.143)	1.098*** (0.132)	0.972*** (0.053)
No. Of Firms	795	795	795
Sargan (m)	-	0.32 (2)	4.94 (2)
Prob. Value	-	(0.75)	(0.08)
Diff. Sargan (m)	-	0.03 (1)	-
Prob. Value	-	(0.86)	-

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
[b] The instrument used is *Client*
[c] The instruments used are *Client, Science and Continuous R&D*
[d] The instruments used are *Client, R&D Intensity and Innovation Intensity*
Significance Levels:*10% , **5%, ***1%

Table 11: IV specification for Service Firms, 2010-2012

Testing the specification: Service Firms for 2010-2012[a] Dependent Variable: $l - (g_1 - \pi)$			
Regression	IV[b]	IV[c]	IV[d]
Constant	0.037 (0.203)	0.044 (0.202)	0.036 (0.202)
Process Innovation Only (d)	-0.341** (0.168)	-0.331** (0.167)	-0.341** (0.168)
Sales Growth due to New Products (g_2)	0.942*** (0.046)	0.933*** (0.052)	0.972*** (0.053)
No. Of Firms	1445	1445	1445
Sargan (m)	-	0.41 (2)	8.42 (2)
Prob Value	-	(0.82)	(0.02)
Diff. Sargan (m)	-	0.06 (1)	-
Prob. Value	-	(0.80)	-

[a] Industry dummies are included in all regressions. Coefficients and standard errors are robust to heteroskedasticity.
[b] The instrument used is *Client*
[c] The instruments used are *Client, Science and Continuous R&D*
[d] The instruments used are *Client, R&D Intensity and Innovation Intensity*
Significance Levels:*10% , **5%, ***1%

Appendix B

Derivation of the Cost Functions

Proposition: If $Y = F(K, L)$ exhibits constant returns to scale, then $C(w, r, Y) = Yc(w, r)$ where $c(w, r)$ represents the minimum unit cost. Proof: Let $H(w, r, 1)$ be the cost minimizing input vector to produce one unit of output. Then we clearly have $F(tH(w, r, 1)) = tF(H(w, r, 1) = t$ by constant returns to scale property. $tH(w, r, 1)$ is able to produce t units of output. We need to show that no other input combination is able to produce t units at a lower cost. By the property of the cost function we can write down;

$$c(w, r, t) \leq tc(w, r, 1)$$

If we can show that $c(w, r, t) \geq tc(w, r, 1)$ holds as well then we can state that

$$c(w, r, t) = tc(w, r, 1)$$

By constant returns to scale property, we can that $F(\frac{1}{t}H(w, r, t)) = \frac{1}{t}F(H(w, r, t)) = 1$ This implies that; $c(w, r, 1) \leq \frac{1}{t}c(w, r, t)$ which is equivalent to $tc(w, r, 1) \leq c(w, r, t)$ We can conclude that $c(w, r, t) = tc(w, r, 1)$. Using this proposition we can now derive our cost functions as follows: If $c(w, r)$ is minimum cost of producing one unit of output given that $Y = F(K, L)$ then $\frac{c(w,r)}{\theta}$ is cost of producing one unit of output given that $Y = \Theta F(K, L)$. Using the proposition cost of producing Y unit of output would be $c(w, r)\frac{Y}{\theta}$.

Appendix C

Derivation of Labor Demand Functions

Shephard's Lemma states that if firm acts according to the cost minimization principle and if $c(y, w, r)$ is the cost function of producing y amount of output then $L(y, w, r) = \frac{dc(y,w,r)}{dw}$, where $L(y, w, r)$ denotes the labor demand function.

Proof: Let x^* be the cost minimizing input mixture in order to produce y amount of output given input price vector w^*. Then it must be the case that $w^{*\prime}x^* = c(y, w^*)$. Let $g(w) = c(y, w) - w'x^*$ be a function of input price vector w. Similarly, $g(w)$ is the cost function associated with input price vector w minus the total cost to buy x^* with w. By definition of the cost function $c(y, w)$ is the cheapest way to produce y amount of output given input price vector w. Also recall that x^* can also produce y amount of output. Hence we expect $g(w) \leq 0$ and reaches its maximum point at 0. $\frac{dg(w)}{dw} = \frac{d(c(y,w)-w'x^*)}{dw_i}$, then this derivative will be equal to 0 when $w = w^*$ given that $w^{*\prime}x^* = c(y, w^*)$. Then at $w = w^*$, $\frac{d(c(y,w^*))}{dw_i} = x_i^*$ where * is redundant.

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