Iranian Economic Review, Vol.14, No.25, winter 2010

The Impact of Trade Liberalization on Iran's Manufacturing TFP: An Application of Olley -Peaks Approach

Abbas Aminifard*
Karim Azarbaijani**
Seyed Komail Tayebi***

Abstract

Productivity is often computed by approximating the weighted sum of the inputs from the estimation of the Cobb-Douglas production function. Such estimates, however, may suffer from simultaneity and selection biases. Olley and Pakes (1996) introduced a semi-parametric method which allows us to estimate the production function parameters consistently and thus obtain reliable productivity measures by controlling for such biases. This study first reviews this method and then introduces a Stata(10) command to implement it for manufacturing industry in Iran. The results show that material, skill labor and capital play important role in production function and this is increasing return to scale (IRS) by estimation of Olley and Pakes approach versus decreasing return to scale (DRS) by fixed effect. After estimation of production and calculated total factor productivity (TFP), we concluded that the effect of export and exit rate on TFP at manufacturing industry (ISIC 4digits) in Iran is not very considerable to compare to import penetration coefficient and year effect.

Keyword: Simultaneity and production functions; Firm Dynamics; Productivity; Iranian manufacturing industry.

---

* Ph.D.'s Student, Department of Economics, University of Isfahan, Iran.
** Associate Professor, Department of Economics, University of Isfahan, Iran.
*** Associate Professor, Department of Economics, University of Isfahan, Iran.

1- Introduction

There is plenty of evidence that tariff reduction increases the efficiency of manufacturing firms. Tybout. (1992) studied the impact of trade liberalization on the performance of Chilean firms in the 70s. They concluded that industries that experienced higher tariff reductions were the same as those that experienced higher efficiency gains. Similar results were found by Harrison (1994) for the Ivory Coast, by Iscan (1998) for Mexico, and by Hay (2001) for Brazil. More recently, several papers sharing similar methodology, which solves some econometric problems regarding productivity estimation, also tried to answer whether trade liberalization enhances firm productivity gains. Pavcnik (2002) found that the in-plant productivity improvements in Chile can be attributed to trade liberalization. Fernandes (2003) and Muendler (2002), using data from Colombia and Brazil, respectively, found a negative relationship between nominal tariffs and productivity, reinforcing the perception that trade liberalization has a positive impact on productivity. Tybout (2000) surveys several papers on productivity and trade based on firm-level databases.

Recent evidence on firm-level adjustments to trade liberalization have documented that firm jointly make innovation and export market participation decisions (see Aw, Roberts, and Winston (2005), Trefler (2004), Verhoogen (2007)). Another large and established research agenda using micro-level production data has confirmed time and again the strong self-selection of more productive firm into export markets. More recently, another branch of this literature has found some evidence for a "learning-by-exporting" phenomenon, whereby firm improve their productivity subsequent to export market participation (see for instance, De Loecker (2006), Girma, Greenaway, and Kneller (2004), Topalova (2004)).

This paper provides evidence for the trade liberalization hypothesis using a unique firm- level dataset covering virtually the entire manufacturing sector of Iran for the period 1994–2006. We organize the paper as follows. In Section 2 we discuss the estimation procedure for obtaining reliable estimates of productivity. We employ the Olley and Pakes (1996) technique and demonstrate how this allows us to control for the simultaneity bias when we estimate production functions. In Section 3 we discuss the dataset and perform some preliminary analysis and a brief review of Iranian trade liberalization.In Section 4, we show the effect of export and import penetration on total factor productivity of Iran's manufacturing Industry and collects concluding remarks.

2- Productivity

We use the semi-parametric estimator from Olley and Pakes (1996) to estimate total factor productivity (TFP) at the plant level for each group of plants that operate in the same sector, defined at the four digit level of disaggregation. A key issue in the estimation of production functions is the correlation between unobservable productivity shocks and input levels, which yields inconsistent estimates under OLS. The reason is that the variable input factors and thus their choice can be affected by the current value of the unobservable productivity shock. In other words, the variables of input factors are likely to be correlated positively with the error term. This results in an upward bias of the coefficients on the variable input factors, like labor and material, under OLS. One way to deal with this endogeneity problem is to use instrumental variables as in Arellano and Bond (1991). However, this estimator requires a large number of cross-section observations to obtain reliable estimators. Pooling all sectors together to estimate the production function would be one option, but this has the disadvantage of imposing the same technological coefficients across all sectors. An additional problem is that it is not straightforward to find good instruments. Lagged values of the endogenous input factors are sometimes used; however, the validity of such instruments relies on the absence of serial correlation in production.

As an alternative, Olley and Pakes developed a semi-parametric estimator that uses investment as a proxy for these unobservable productivity shocks. An advantage of this approach is that it also controls for endogenous exit from the sample, which is assumed to occur when productivity falls below a threshold. In particular, plants with more capital, such as importers, are likely to allow for greater reductions in productivity, making the exit threshold a decreasing function of capital. Following Olley and Pakes, we estimate a Cobb-Douglas production function, taking the logs of equation 1, which we denote by small letters,

$$y_{it} = \beta_0 + \beta_{ls} ls_{it} + \beta_{lus} lus_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \mu_{it} \tag{2}$$

$$e_{it} = \omega_{it} + \mu_{it}$$

The error term, e_{it}, has two components, a white noise component, μ_{it}, and a time varying productivity shock, ω_{it}, which is known to the firm, but not to the econometrician. It is a state variable that can have an impact on the choices of inputs, which leads to a simultaneity problem. Pakes (1994) shows that the investment function, $i_{it} = i_t(\omega_{it}, k_{it})$, which is a function of two state variables, capital and productivity, is monotonically increasing in productivity. Inverting the investment function gives an expression for productivity as a function of capital and investment,

$$i_{it} = i_t(\omega_{it}, k_{it}) \tag{3}$$

Substituting equation (3) into (2) allows estimation of the variable input coefficients using nonparametric techniques. In a second step, the survival probability of a plant is predicted from a nonparametric probit regression and, finally, the coefficient on the state variable, capital, are recovered using semiparametric nonlinear least squares.

Substituting the unobserved productivity term out in equation (2) gives a partial linear model:

$$y_{it} = \beta_l l_{it} + \beta_m m_{it} + \alpha_t(i_{it}, k_{it}) + \mu_{it} \tag{4}$$

In the first stage we obtain consistent estimates of β_l and β_m . We use a series estimator using a fourth order polynomial in investment and capital. To identify the coefficient on capital we model survival as a function of capital and investment. The estimation algorithm details present in appendix.[1]

The estimated input coefficients obtained from estimating equation (2) with OLS, and with Olley-Pakes are reported in Table 1. Typically the labor and material coefficients are over-estimated with OLS, which is what can be expected if labor, material usage and productivity shocks are positively correlated.

The productivity measure used here is a productivity index which is constructed by creating a deviation of output t and input from the group mean in the reference year (1997 in this paper), a method which was used in Pavcnik (2002) and Aw et al. (2001)[2]. The productivity measure can be written as:

$$\ln TFP = y_{it} - \bar{y}_{97} - \hat{\beta}_{ls}(ls_{it} - \bar{l}s_{97}) - \hat{\beta}_{lus}(lus_{it} - \bar{l}us_{97}) - \hat{\beta}_m(m_{it} - \bar{m}_{97}) - \hat{\beta}_k(k_{it} - \bar{k}_{97}) \tag{5}$$

Where $\bar{y}_{97}, \bar{l}s_{97}, \bar{l}us_{97}, \overline{m}_{97}$ and $\bar{k}_{97}$ are the respective group means of the logarithms of real sales, skill labor, unskilled labor, materials and capital and $\hat{\beta}_{ls}$, $\hat{\beta}_{lus}$, $\hat{\beta}_m$, $\hat{\beta}_k$ are the estimates obtained from Olley&Pakes method.

1- Levinsohn-Petrin (2003) build on the Olley-Pakes approach, but use intermediate inputs instead of investment as a proxy for unobserved productivity shocks. One drawback of their approach is that exit is not explicitly modelled, while in Olley-Pakes it is. We have experimented with this alternative approach and our results remain robust.

2- A detailed discussion of the index number approach can be found in Good et al. (1997) .

3-1- Status of Trade liberalization in Iran

Until the end of the 1990s, Iranian trade policy meant extremely high nominal tariffs and a huge amount of nontariff barriers. Nominal tariffs were in general redundant. The price difference between domestic and international prices was much lower than the tariffs suggested. Imports were restricted not because of high nominal tariffs but mainly by huge nontariff restrictions like the lists of prohibited imported goods, difficult access to government import authorization, and the limits on imports for each firm. On the other hand, there were several exception rules that reduced both the tariff and the non tariff barriers for the imports of some specific goods.

In 1990, there was the first attempt to rationalize trade policy. Some of the non tariff barriers were extinguished (elimination of some taxes on imported goods and some of the special regimes faced by several industries), and nominal tariffs had a small reduction. In 1993, the newly elected government announced a new trade policy that would change substantially the old regime. At first, all but a few non tariff barriers were eliminated. Trade policy thereafter would rely mostly on tariffs and on the exchange rate management, although the exchange rate regime was much more flexible than before.

Second, a 5-year schedule of tariff reductions was announced. After these years, the tariff range would be between 0% and 40%. The average tariff would decrease from slightly lower than 50% in 1989 to 14% in 1994. At first there was no discrimination among industries except for a higher protection for the production of goods with high technological requirements, such as computers, some chemical sectors, and biotechnology. The tariff structure was designed according to the comparative advantage, the initial tariff level and tariff on inputs. There were some exceptions, but the result was a much more rational tariff structure.

With a latest Trade (MFN)[1] Tariff Restrictiveness Index (TTRI) score of 13.1 percent, tariff protection in Iran has been one of the most restrictive, substantially higher than an average Middle East and North Africa (MENA) and lower-middle-income country. Both the MFN applied and the import-weighted average tariffs (26.2 percent and 19.2 percent respectively) have been above the regional and income group comparator means. MFN duty-free imports accounted for only 8.4 percent of all imports in the early 2000s. A number of nontariff barriers recently have been replaced by their tariff equivalents. Characterized by an active public sector, the country has made limited progress with the market reform plans put forth by preceding administrations since the early 1990s. The government provides large energy

1- Most Favored Nation.

subsidies to domestic businesses. Efforts are ongoing to diversify the country's export sector through investments in non-oil sectors, including in free trade zones (Chabahar and the Qeshm and Kish Islands).

3-2- Data and preliminary analysis

The data are taken from the Iranian Central Statistical Office in the manufacturing sector between 1994 and 2006. We have used data of 13038 firms at 1994 year to 15997 firms at 2005 year for 22 various levels of manufacturing (ISIC 4digits). The export status- at every point in time- provides information whether a firm is a domestic producer, an export entrant or a continuing exporter.

Between 1994 and 2005 average growth of total real exports in Iran's manufacturing is about16%, while the average growth number of firms entering export markets was about 6%.

Table 1: Number of active firms and entry/exit rates in Iranian manufacturing

Annual average (1994–2005)	
Number of active firms	13674
Number of exporters	742
Number of starters	48
Entry rate	6.5%
Exit rate	1.3%
Growth rate of active firms	1.9%
Growth rate of exporters firms	6.2%

Source: Authors

Table 1 shows the average number of firms that we observe and those that are exporting. While in 1994 about 606 firms were exporting, by 2005 about 1062 did so or this represents an increase of 75%.The average number of entire firms over this period is roughly 41 firms resulting in a net increase of the share of exporters in Iran's manufacturing Industry.

In row three we show the number of firms that started exporting. On average 6% of the exporting firms are new entrants in the export market and in total we observe 576 firms that enter the export market at different points in time. The latter is crucial in order to control for time effects when analyzing the impact on the productivity path. It is important to note that only 8% of the export entrants are new firms entering the market. It is this unique setting that allows us to verify the impact of starting to export on productivity by comparing (productivity of) export entrants with similar domestic firms in terms of past productivity shocks and other firm specific observables. The identification of the learning parameter is as such based on models like Melitz (2003) that indicate that more productive firms become exporters as we control for pre-export productivity shocks of new exporters.

The industry composition of exports has been fairly stable over time where Chemicals (41%), basic metal product (28%), Food and Beverages (9%) and nonmetal mineral products (4%) comprise around 82% of total exports.

The structural change that has kept going on in Iran's manufacturing is also revealed by the patterns of enterprise turnover. In Table 1 we show the market entry and exit patterns in the data. Over the sample period we find an annual average exit rate of 1.3%, which is comparable to exit rates found in other developing regions. For instance, Clerides, Lach and Tybout (1998) report annual average exit rates for Colombia of 1.7%, for Morocco of 3.7% and for Mexico of 1.5%. The entry rate is much higher, on average 6.5% per year. This compares to entry rates of 2.7%, 4.9% and 4.8% reported for Colombia, Morocco and Mexico respectively. The high entry rates in the Iranian economy are not that surprising taking into account that the entry of new firms was an important component of the restructuring and the transition process. Under government policy, entry of new firms has been virtually non existent. With the transition to a market economy also the entry of new enterprises was encouraged and has potentially played an important role in the transition process (e.g. Bilsen and Konings, 1998).

4- Model and Estimation Strategy

To determine the effect of trade liberalization on productivity, we consider a plant with a Cobb-Douglas production function,

$$Y_{it} = A_{it}(\tau) LS_{it}^{\beta_{ls}} LUS_{it}^{\beta_{lus}} K_{it}^{\beta_k} M_{it}^{\beta_m} \tag{1}$$

Where output in firm i at time t , Y_{it}, is a function of skilled labor, LS_{it}, unskilled labor, LUS_{it}, capital, K_{it}, and materials, M_{it}. We are interested in assessing whether the productivity of plant i is a function of trade policy, denoted by τ. So the first step is to estimate plant level productivity, and in the second stage we specify how productivity can be affected by trade policy.

4-1- Empirical effect of Trade Liberalization

In the second stage, we specify the possible links between trade liberalization and plant level productivity. Using the plant level measures of TFP from equation (5), we estimate the following equation:

$$\begin{array}{llllll} LTFP & = 0.06\,LTFP_{t-1} & +\,0.03\,LX & -\,0.1 Year & -\,0.02\,Exit & +\,0.11\,IMPP \\ \text{t - Statistic} & = 5.29 & 5.42 & -\,49.8 & -\,2.55 & 3.04 \end{array} \qquad (6)$$

Where LX, Year, Exit and IMPP are the respective logarithms of real export, year effect, exit dummy variable and import penetration and estimates obtained from Arrelano and bond dynamic panel data method.

This results show that the effect of import penetration is more pronounced than that of export. This implies a reduction in tariff and non-tariff barriers affect properly TFP, while it is not affected originally by a trade policy.

Table2: Production function estimates: Fixed Effect and OP estimation results

Variables	OP	Fixed Effect
Lk	0.14	0.098
Lls	0.26	0.32
Llus	-0.1*	0.09*
Lmat	0.72	0.52
Year	-0.13	-.011

* Only these coefficients are not significant
Source: Authors

5- Conclusion

This paper has analyzed the effects of export and import penetration on TFP of Iran's manufacturing industry. In a period of 6 years exports have become more than doubled, the number of firms that started exporting over this period has increased dramatically but this effect on TFP has been very little. One reason refers to performance of trade liberalization which could not affected on TFP accompanied with increasing new export firm.

We start our analysis by showing that exporters have different characteristics than non exporters. We suggest an estimation algorithm to estimate total factor productivity allowing us not only to estimate productivity consistently, but also to take into account potential selection of firms. The traditional technique adopted to estimate the production coefficients and hence compute TFP starting from a (log-linearized) production function in ordinary least squares. However, this technique is affected by several problems, among which the most serious is the so-called simultaneity bias.

Olley and Pakes have finded semi-parametric estimation procedures to overcome these problems (Simultaneity bias and selection bias).

This techniques suppose that the productivity term can be decomposed into two terms, $\omega_{it} + \mu_{it}$,

Where ω_{it} is a productivity shock observed by the firm (but not by the econometrician) that is able to change the input choices while μ_{it} is a white noise uncorrelated to inputs. The key point in both the OP and the LP estimators is to "turn unobservable into observables", namely to find an observable proxy for the productivity term ω_{it}. In particular, the OP methodology uses investment as proxy and supposed to be function of capital and productivity.

The second stage of this paper is about the trade liberalization on TFP. Although the Growth rate of exporters firms more than the Growth rate of active firms, but it is seem those exporter firms can not very good stimulated productivity in Iranian manufacturing industry and TFP can be affected by reduce high nominal tariffs and a huge amount of nontariff barriers.

Appendix A. Data description

The Firm-level data have been taken from the Iranian Central Statistical Office and cover the full annual company accounts of firms operating in the manufacturing sector between 1994 and 2005. The unit of observation is that of an establishment (plant). We have information on 7915 firms and it is a balanced panel including information on market entry and exit and export status.

If we only take into account those (active) firms that report employment, we end up with a sample of 6391 firms or 29,804 total observations over the sample period.

All monetary variables are deflated by the appropriate two digit industry deflators. The industry classification is similar to the ISIC industry classification in the USA and the various industries with corresponding code are: Food and Beverages Products (15), Tobacco Products (16), Textiles (17), Wearing Apparel (18), Leather and Leather Products (19), Wood and Wood Products (20), Pulp, Paper and Paper Products (21), Publishing and Printing (22), Coke and Petroleum Products (23), Chemicals(24), Rubber and Plastic Products (25), Other non-Metallic Mineral Products (26), Basic Metals(27), Fabricated Metal Products (28), Machinery and Equipment n.e.c. (29), Office Machinery and Computers (30), Electrical Machinery (31), RTv and Communication (32), Medical, Precision and Optical Instruments (33), Motor Vehicles (34), Other Transport Equipment (35), Furniture and Manufacturing n.e.c. (36) and Recycling (37).

We observe all variables every year in nominal values, however, investment is not reported accurately so we calculate it from the other information. Value added is obtained using sales and material costs in thousands of Rials, employment is measured by the number of full-time equivalent employees in a given year. Capital is proxy by total fixed assets in book value in thousands of Rials. Investment is calculated from the yearly observed capital stock in the following way $I_{ijt} = K_{ijt+1} - (1-\delta)K_{ijt}$ where δ is the appropriate depreciation rate (5%–20%) varying across industries j. Furthermore, we deflate value added with Iranian producer price index (PPI). This is not enough to control for the fact that output and factor prices might be different and/or evolve different over time for exporting firms.

We now present the number of active firms by industry over the sample period. It is clear that some sectors have very few observations and do not provide us with enough information to verify the production function parameters.

Table 1: Average number of firms and LTFP 1994–2005 per industry

Industry	Average Number	Average LTFP	Industry	Average Number	Average LTFP
15	2203	0.600	27	408	0.503
16	2	1.305	28	1041	0.628
17	1640	0.394	29	1047	0.618
18	300	0.652	30	35	0.887
19	306	0.579	31	381	0.666
20	185	0.654	32	70	0.853
21	219	0.607	33	133	0.701
22	275	0.784	34	399	0.812
23	72	0.807	35	117	0.0738
24	710	0.743	36	367	00.643
25	654	0.606	Total	13674	0.705
26	3110	0.724			

Source: Authors

Appendix B. Estimating productivity algorithm

We begin the construction of firm-level productivity by estimating the coefficients of the production function. Assuming that a firm’s production can be characterized by Cobb-Douglas technology, we follow Pavcnik (2002) and specify the production function as:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \mu_{it} \tag{1}$$

Where y is the logarithm of output, l, m and k are the respective logarithms of inputs of labor, materials and capital, ω_{it} is the firm productivity that the producers know but econometricians do not, and μ_{it} is a productivity shock which is not anticipated by either the firms or econometricians. Since firms may already have knowledge of their productivity levels (ω_{it}) when making their input decisions, there is clear potential for the problem of simultaneity arising, which can then lead to biased coefficient estimates when estimating the production function.

In order to correct for the potential problem of simultaneity in this study, we estimate the production function using the approach developed by Olley and Pakes (1996). In this model, the investment decisions of a firm depend on its productivity and capital stock; therefore, its investment demand function can be specified as:

$$i_{it} = i_t(\omega_{it}, k_{it}) \tag{2}$$

If the investment demand function can be inverted, the unobserved productivity can be written as a function of investment and capital stock:

$$\omega_{it} = i_t^{-1}(i_{it}, k_{it}) = \varphi(i_{it}, k_{it}) \tag{3}$$

Substituting Eq.(1) into (3) we can obtain:

$$y_{it} = \beta_l l_{it} + \beta_m m_{it} + \alpha_t(i_{it}, k_{it}) + \mu_{it} \tag{4}$$

Where

$$\alpha_t(i_{it}, k_{it}) = \beta_0 + \beta_k k_{it} + \varphi(i_{it}, k_{it}) \tag{5}$$

After controlling for unobserved productivity, we can then estimate the partially linear Eq(4) and obtain consistent estimates of β_l and β_m.

In order to obtain estimates of the capital coefficient, we first have to consider the conditional expectation on $y_{i,t+1} - \beta_l l_{i,t+1} - \beta_m m_{t+1}$:

$$E(y_{i,t+1} - \beta_l l_{i,t+1} - \beta_m m_{t+1} | k_{i,t+1}) = \beta_0 + \beta_k k_{i,t+1} + E(\omega_{i,t+1} | \omega_{i,t}) \tag{6}$$

Where $\omega_{i,t+1}$ consists of an expected element and an unexpected element $(v_{i,t+1})$ so that $E(\omega_{i,t+1} | \omega_{i,t}, k_{i,t+1}) = \omega_{i,t+1} - v_{i,t+1}$

The expectation of $\omega_{i,t+1}$ is associated with the current productivity level $(\omega_{i,t})$

It therefore can be written as a function of $\omega_{i,t}$ and expressed as $g(\omega_{i,t})$. We can then substitute Eq. (3) into this function and show $E(\omega_{i,t+1} | \omega_{i,t}, k_{i,t+1})$ as :

$$E(\omega_{i,t+1} | \omega_{i,t}, k_{i,t+1}) = g(\alpha_t - \beta_k k_{it}) - \beta_0 \tag{7}$$

We can then substitute (7) into (1) for period t + 1 and obtain :

$$\begin{aligned} & y_{i,t+1} - \beta_l l_{i,t+1} - \beta_m m_{t+1} = \\ & \beta_0 + \beta_k k_{i,t+1} + E(\omega_{i,t+1} | \omega_{i,t}, k_{i,t+1}) + v_{i,t+1} + \mu_{i,t+1} = \beta_k k_{i,t+1} + g(\alpha_t - \beta_k k_{it}) + v_{i,t+1} + \mu_{i,t+1} \end{aligned} \tag{8}$$

In addition to the appropriate correction for simultaneity, Olley and Pakes (1996) also incorporated a correction for potential selection bias induced by the exit of firms; however, our unbalanced panel data is characterized by firm entry, not firm exit; thus, the incorporation of a correction for the potential problem of selection bias is not appropriate for our analysis.

When estimating Eq (4) which is partially linear, α_t is approximated by using a fourth-order polynomial expansion in k_{it}, i_{it}. By estimating this equation, we obtain estimates of β_l, β_m

which can be denoted $\hat{\beta}_l, \hat{\beta}_m$, as well as predicted values of α_t for each firm and it is denoted as $\hat{\alpha}_{it}$ .Finally, we apply these estimates to Eq. (8) to obtain a consistent estimate of β_k. Specifically, we use a fourth-order polynomial expansion in $\hat{\omega}_{it} = \hat{\alpha}_{it} - \beta_k k_{it}$ to approximate g( ) After applying $\hat{\beta}_l, \hat{\beta}_m$ and the approximation of g() to (8) and lag it by one period, it can be specified as:

$$y_{i,t+1} - \hat{\beta}_l l_{i,t+1} - \hat{\beta}_m m_{t+1} = c + \beta_k k_{it} + \sum_{j=0}^{4} \beta_j (\hat{\alpha}_{i,t-1} - \beta_k k_{i,t-1})^j + u_{it} \tag{9}$$

Where $u_{it} = v_{it} + \mu_{it}$. Since this equation is non-linear in β_k, we estimate Eq. (9) using the non-linear least squares method and obtain a consistent estimate of β_k $(\hat{\beta}_k)$

In the empirical implementation, output is measured by real total sales, labor input is measured by the number of employees, material input is measured by the value of aggregate material deflated by the wholesale price index for materials, and capital is measured by real net fixed assets.

Overall, to estimate the model, we are able to use the Stata syntax as follow:

. opreg ly, exit(exit) state(lk) proxy(lgi) cvars(year) free(lls lmat llus) vce(bootstrap, seed(1) reps(50))

The Stat result is report by the following:

```
. Olley-Pakes productivity estimator              Number of obs      =     264
Group variable (i): crossid                       Number of groups   =      22
Time variable (t): year
                                                  Obs per group: min =      12
                                                                 avg =    12.0
                                                                 max =      12
                                    (Replications based on 22 clusters in crossed)
------------------------------------------------------------------------------
            Observed   Bootstrap                      Normal-based
              Coef.   Std. Err.      z    P>|z|    [95% Conf. Interval[
------------------------------------------------------------------------------
ly|
         lk |  .1895366   .0549317     3.45   0.001     .0818723    .2972008
        lls |  .2632737   .1547521     1.70   0.089    -.0400349    .5665824
       lmat |  .7263652   .0919991     7.90   0.000     .5460503    .9066801
       llus | -.1093654   .0706115    -1.55   0.121    -.2477614    .0290305
       year | -.1298958   .0050833   -25.55   0.000    -.1398588   -.1199328
------------------------------------------------------------------------------
State:      lk
Free:       lls lmat llus
Control:    year
Proxy:      lgi
```

Fixed effect estimation result:

xtreg ly lk lls lmat llus year , fe

```
Fixed-effects (within) regression               Number of obs      =       264
Group variable: crossid                         Number of groups   =        22

R-sq:  within  = 0.7622                         Obs per group: min =        12
       between = 0.9601                                        avg =      12.0
       overall = 0.9487                                        max =        12
                                                F(5,237)           =    151.93
corr(u_i, Xb)  = 0.1176                         Prob > F           =    0.0000

------------------------------------------------------------------------------
ly |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval[
------------------------------------------------------------------------------
```

lk	.0984545	.0280958	3.50	0.001	.043105	.153804
lls	.3290798	.0527015	6.24	0.000	.2252565	.4329031
lmat	.5202312	.0435842	11.94	0.000	.4343693	.606093
llus	.0953513	.0580804	1.64	0.102	-.0190684	.209771
year	-.1138607	.0046005	-24.75	0.000	-.1229238	-.1047976
-cons	2.507894	.5199582	4.82	0.000	1.483564	3.532224

----

sigma_u | .28324267
sigma_e | .17496582
rho | .72380737 (fraction of variance due to u_i)

F test that all u_i=0: F(21, 237) = 14.59 Prob > F = 0.0000

The effect of export on total factor productivity by using of Arellano-bond method:

Dependent Variable: LTF
Method: Panel Generalized Method of Moments
Transformation: Orthogonal Deviations
Date: 01/06/10 Time: 11:02
Sample: 1 308
Cross-sections included: 22
Total panel (unbalanced) observations: 188
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(LTF,-2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTF(-1)	0.059675	0.011270	5.294965	0.0000
LX	0.030895	0.005694	5.425549	0.0000
YEAR	-0.111982	0.002247	-49.84568	0.0000
IMPP	0.114718	0.037624	3.049061	0.0026
EXIT	-0.027755	0.010862	-2.555231	0.0114

Effects Specification

Cross-section fixed (orthogonal deviations)

R-squared	0.633614	Mean dependent var	0.285481
Adjusted R-squared	0.625605	S.D. dependent var	0.193940
S.E. of regression	0.118668	Sum squared resid	2.577005
J-statistic	18.50363	Instrument rank	22.00000

References

1- Alvarez, R., Lopez, R., (2004). Exporting and performance: evidence from Chilean plants. Working Paper. Indiana University.

2- Arellano, M., and S.R. Bond. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies* 58, 277-97

3- Aw, B., Chung, S., Roberts, M., (2000). Productivity and turnover in the export market: micro evidence from Taiwan and South Korea. *The World Bank Economic Review* 14(1), 1–65.

4- Aw, B., Chung, S., Roberts, M., (2001). Firm-Level Evidence on Productivity Differentials and Turnover in Taiwanese Manufacturing. *Journal of Development Economics*, 66, pp.51-86.

5- Aw, B., Roberts, M. and T. Winston (2005). The Complementary Role of Exports and R&D Investments as Sources of Productivity Growth. NBER Working Paper 11774.

6- Basu, S. and Fernald, J. (1997). Returns to Scale in U.S. Production: Estimates and Implications. *Journal of Political Economy*, 105, 249–83.

7- Bernard, A.B., Eaton, J., Jensen, J.B., Kortum, S.,(2003). Plants and Productivity in International Trade. *American Economic Review* 93, 1268–1290.

8- Bernard, A.B., Jensen, J.B., (1999). Exceptional Exporter Performance: cause, effect or both? *Journal of International Economics* 47 (1), 1–25.

9- Berry, S., Levinsohn, J., and Pakes, A. (2004). Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Vehicle Market. *Journal of Political Economy*, 112, 68–104.

10- Bilsen, V., Konings, J., (1998). Job Creation, Job Destruction and Employment Growth in Newly Established Firms in Transition Countries: Survey Evidence from Romania, Bulgaria and Hungary. *Journal of Comparative Economics* 26, 429–445.

11- Clerides, S., Lach, S., Tybout, J., (1998). Is learning-by-Exporting Important? Microdynamic evidence from Colombia, Mexico, and Morocco. *Quarterly Journal of Economics* 113, 903–947

12- De Loecker, J., (2006). Product Differentiation, Multi-Product Firms and Estimating the Impact of Trade Liberalization on Productivity. Working Paper. New York University.

13- De Loecker, J., Konings, J., (2006). Job Reallocation and Productivity Growth in an Post-Socialist Economy. Evidence from Slovenian Manufacturing. *European Journal of Political Economy* 22, 388–408.

14- Eaton, J., Kortum, S., (2004). Dissecting Trade: Firms, Industries, and Export Destinations. *American Economic Review*. 94, 150–154.

15- Fernandes, A., (2003). Trade Policy, Trade Volumes and Plant-Level Productivity in Colombian Manufacturing Industries. *World Bank Policy Research Working Paper*, vol. 3064.

16- Girma, S., Greenaway, D., Kneller, R., (2002). Does Exporting Lead to Better Performance? A Microeconometric Analysis of Matched Firms. GEP Research Paper, vol. 2-9.

17- Harrison, A. E. (1994). Productivity, Imperfect Competition, and Trade Reform Theory and Evidence. *Journal of International Economics* 36 (1- 2), 53–73.

18- http://econ.ucsd.edu/seminars/seven_ssrc/muendler_brazprod.pdf (accessed August 1, 2007.)

19- Isgut, A., (2001). What's Different about Exporters? Evidence from Colombian Manufacturing. *Journal of Development Studies* 37, 57– 82.

20- Levinsohn, J. and A. Petrin. (2003). Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies* 70, 317-42.

21- Marschak, J., and W. Andrews. (1944). Random Simultaneous Equations and the Theory of Production. *Econometrica* 12, 143-205.

22- Melitz, M., (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* 71, 1695–1725.

23- Muendler, Marc-Andreas. (2002). Trade, Technology, and Productivity: A Study of Brazilian Manufacturers, 1986–1998. Working paper. Available at

24- Olley, S., and A. Pakes. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica* 64, 1263-98.

25- Pavcnik, N. (2002). Trade Liberalization, Exit and Productivity Improvements: Evidence from Chilean Plants. *Review of Economic Studies* 69, 245-76.

26- Topalova, P. (2004). Trade Liberalization and Firm Productivity: The Case of India. IMF Working Papers 04/28, International Monetary Fund.

27- Trefler, Daniel. (2004). The Long and Short of the Canada–U.S. Free Trade Agreement. *American Economic Review*. 94, 4: 870–895.

28- Tybout, J., (1992). Linking Trade and Productivity: New Research Directions. *World Bank Economic Review* 6, 189 –211.

29- Tybout, J.,(2000). Manufacturing Firms in Developing Countries: How well do They do and Why? *Journal of Economic Literature* 38, 11– 44.

30- Verhoogen, E.A. (2007). Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector. CEPR discussion paper 6385.