Manufacturing Productivity Spillover in Agricultural Exports in the Post-liberalization Context

This is preliminary and incomplete and is not for circulation.

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Manufacturing Productivity Spillover in Agricultural Exports in the Post-liberalization Context

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Abstract

Using firm level panel dataset from 21 transition economies, this paper re-evaluates the post liberalization trade gains in agriculture sector by examining any productivity spillover from manufacturing sector. The results show that there exists positive spillover from manufacturing to agriculture sector for these transition economies. Further, there is associated trade gains in agriculture sector from this productivity spillover.

Key words: Trade Liberalization, Productivity Spillovers , Productivity Decomposition

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International trade has far exceeded world GDP growth since the early 1970s. This impressive growth in world trade has been possible, due in part to policy-led trade liberalization programs. Trade theories based on heterogenous firms emphasize that firms with higher productivities export and that trade liberalization increases aggregate productivity of the industry (see for e.g., Bernard et al. 2003, Melitz 2003, and Armenter and Koren 2009). Firm selection, reallocation of resources and activities across firms, and within-firm upgrading are the key channels through which trade induces productivity growth. At the same time, there is a robust branch in economic growth theory which highlights that productivity growth in a sector is transmitted economy wide through multiple channels. The recent proliferation in preferential trade agreements between countries then gives rise to an important economic question: has there been any positive productivity spillover from manufacturing to agriculture sector due to trade liberalization?

In 1962, Raul Prebisch[2] kick started this literature by advocating that developing countries must specialize in exporting manufacturing products because not only it would lead to export expansion, but through 'linkage effect', it would also induce investment in related sectors of the economy (See Graham 1978, Santos, Fariah and Cunha 2005).[3] This argument is based on the hypothesis of 'export-led growth' in developing economies which

[2]Raul Prebisch is an influential Argentine trade economist who served as the Secretary-General of the United Nations Economic Commission for Latin America and later became the Director General of United Nations Conference on Trade and Development during its formative years

[3]This argument formed a definitive case for the formation of unilateral trade liberalization program in early 1970's.

states that export stimulates economy through technological spillover or other externalities (Marin 1992). Empirical trade research focusing on technology or productivity spillover across countries are not scant. For example, empirical research have focused on inter-country productivity spillover due to foreign direct investment or knowledge spillover due to trade in commodities (see for e.g., Javorcik 2004, Haskel et al. 2002, Keller and Yeaple 2003, Blalock 2001, Schoors and Tol 2001, Verspagen 1997, Coe and Helpman 1995). However, this particular 'linkage effect' from manufacturing to agriculture sector for developing countries has not yet been empirically tested.

Theoretically, effects of trade liberalization pertain to changes in tariffs or trade costs. In absence of misallocation (in resources or in market shares), decline in export costs increases exports demand. However, market frictions such as financial or labor market constraints can amplify or dampen the effects of trade liberalization through associated productivity changes (Melitz and Redding 2014, Arkolakis, Costinot and Clare 2012, Bustos 2011 and Helpman, Itskhoki and Redding 2010). Of particular interest are the transition and developing economies which are often characterized by imperfect institutions and thus are likely to experience market frictions in factor and product markets. While the factor mobility or labor reallocation in response to productivity differences across sectors is known to have triggered structural changes and economic prosperity in developing/transition economies, empirical research have shown that, in developing countries, trade liberalization has not always produced only the desired results (see for e.g., Diao, McMillan and Rodrik 2017, Krugman 1979, Krugman 1980). This has lead policy makers to question the benefits of trade liberalization efforts.

This paper re-evaluates the post liberalization trade gains in agriculture sector by examining any productivity spillover from manufacturing sector.[4] This is accomplished through following two objectives. First, I estimate the changes in aggregate productivity in manufacturing sector considering firm level differences in productivity and associated market share allocation. Second, I use the estimated productivity parameter for manufacturing sector in a gravity like equation to estimate the productivity spillover to agricultural exports demand. So, as to allow higher productivity changes in manufacturing sector over time I use firm level (panel) data set specifically from transition economies to compute changes in aggregate manufacturing productivity.

The remainder of this paper is organized as follows: In the next section, I discuss aggregate productivity estimation and its decomposition to account for market share reallocations. The empirical model for estimating productivity spillover is also discussed. In the following section, I describe the firm level and country level panel data sets for 21 transition economies used in the analysis. In the fourth section, I discuss results from empirical estimation. The fifth and last section concludes.

[4]Manufacturing and Non-agriculture sector are used synonymously in this paper.

Productivity Spillover

Suppose F is a disjoint collection of set A and set M.

Method

Using firm level manufacturing dataset (panel) from Enterprise Survey[5], this paper first estimates total factor productivity (TFP) as the residual of the firm-level production function regression as follows:

$$lnTFP_{it} = lnY_{it} - \beta_1 lnK_{it} - \beta_2 lnI_{it} - \beta_2 lnL_{it} \tag{1}$$

where Y_{it}, K_{it}, I_{it} and L_{it} denote the gross output, intermediate inputs, capital and labor employment of firm i in peritod t, and β_1, β_2 and β_3 represent the regression coefficients for capital, intermediate inputs and labor. This productivity metric is rooted in the log-linearized Cobb-Douglas production function shown below:

$$lnY_{it} = \alpha_0 + \alpha_1 lnK_{it} + \alpha_2 L_{it} + \epsilon_{it} \tag{2}$$

$$\epsilon_{it} = \Omega_{it} + \eta_{it} \tag{3}$$

where α_1 and α_2 represent the regression coefficient for the production function equation, Ω_{it} denotes the unobserved productivity (TFP) and η_{it} is the stochastic error term.

[5]www.enterprisesurveys.org

Then, TFP in equation (1) is what cannot be expalined by the above input variables. For consistent and unbiased estimation, this unobserved productivity (TFP) shock has to be accounted for. While the literature on the production function estimation is vast, I follow Levinsohn and Petrin (2003) (hereafter LP) to recover this unobserved productivity.[6] That is, I use material inputs as a proxy for unobserved productivity in the above equation. Then, the production function is estimated using Generalized Method of Moments (GMM) following *levpet* routine.[7]

Theoretically, TFP and gross output in the Cobb-Douglas production function are quantity based variables, however the estimating equation uses revenue based variables. This is because using industry level price index to deflate the value based output at the firm level have been known to depress the measurements of the the physical output of entrants relative to survivors. As Foster et al. (2008) note, the entering firms may charge lower price relative to the incumbents.

The aggregate productivity (Φ_{mt}) in manufacturing sector (m) for period t is then decom-

[6] Olley-Pakes (OP) approach also solves simultaneity and selection bias issue. This approach uses investment as a proxy for unobserved productivity. Since, my data set has no complete information on investment, I am not able to use OP approach.

[7] I also provide OLS and fixed effect estimates (FE) in the results for benchmark comparisons.

posed following Olley-Pakes (1996) decomposition:

$$\Phi_{mt} = \frac{1}{N_{mt}} \sum_{f=1}^{N_{mt}} \phi_{fimt} + \sum_{f=1}^{N_{mt}} \left(\theta_{fimt} - \bar{\theta}_{imt}\right) \left(\phi_{fimt} - \bar{\phi}_{imt}\right) \tag{4}$$

where θ and ϕ represent the market share and unweighted productivity respectively for firm f in sector m. Aggregate productivity is thus a function of average productivity and the covariance of market share reallocation and firm productivity. Then the change in aggregate productivity is simply a shift in the first and the second moment.

$$\Delta\Phi_{mt} = \Delta\bar{\phi} + \Delta Cov(\theta, \phi) \tag{5}$$

The above Olley-Pakes decomposition is further accommodated for entry and exit as in Melitz and Polanec (2015). A notable feature of this accommodation is that it allows one to isolate contributions to aggregate productivity changes of entrants (E), exiters (X) and survivors (S). Then the final estimating equation for the changes in aggregate productivity from $t1$ to $t2$ is:

$$\Delta\Phi_{mt} = \Delta\bar{\phi}_s + \Delta Cov(\theta, \phi) + \theta_{Et2}\left(\Phi_{Et2} - \Phi_{St2}\right) + \theta_{Xt2}\left(\Phi_{St1} - \Phi_{Xt1}\right) \tag{6}$$

The above aggregate productivity metric is used in a gravity like equation of trade to measure the productivity spillover in agricultural exports demand using annual bilateral agricultural trade data. Then, the following gravity equation augmented with various panel fixed effects is estimated as a bench mark model:

$$X_{ijtk} = exp\left(\upsilon_i + \upsilon_j + \upsilon_k + \upsilon_t + \beta_1 lnGDPit + \beta_2 lnGDPjt + \beta_3 ln\Phi_{imt}\right)\varepsilon_{ijtk} \tag{7}$$

$$\varepsilon_{ijkt} = \alpha_{ijk} + \eta_{ijtk} \tag{8}$$

where the parameters υ denote origin (υ_i), industry(υ_k), destination (υ_j) and time effects (υ_t), Φ_{imt} is the aggregate productivity of the manufacturing sector at time t in exporting country i, the epsilon is the composite error term and is sum of country-pair-industry specific latent variable (α_{ijk})[8] and idiosyncratic error (η_{ijtk}), and the dependent variable (X_{ijtk}) is agricultural exports. To account for the zero flows and to allow more flexibility in heteroskedastic function, I estimate pseudo maximum likelihood estimation as in Silva and Tenreyro (2006). To evaluate the productivity spill over in post liberalization context, three scenarios will be evaluted: bilateral, symmetric reduction in tariff, unilateral reduction in export costs, and a unilateral reduction in import costs. These effects will be evaluted through numerical simulations which is in progress at this moment.

[8]Ideally, country pair -industy-changing variable would be suited. However, considering the size of the sample for this estimation this is subsumed in the error term.

Data Description

This research uses two different data sets. The first data set contains information on firm identity, annual sales, physical capital, material inputs, and labor employment for manufacturing firms.[9] This data set is retrieved from the *World Bank's Enterprise Surveys (ES)* portal which provides information on nationally representative samples of firms across different regions in the world economies.[10] Since the *ES* use standardized survey intruments and a uniform sampling methodology globally, the data set from this portal is suited for comparing firm level information across countries. Further, the *Surveys* re-interview the firms every three to four year to build a panel data set. I use a firm level panel data set of 21 countries spanning from 2002 to 2009 to estimate the labor productivity and total factor productivity (as described in Model section) for non-agriculture sector.[11] Table 1 provides the list of countries this data set spans.

Survey responses are often characterized by zero observations. But in this case, zeroes could arise from non-responses or from firms exiting due to low-productivity. The non-responses, however, affects the probability of inclusion in the sample frame. Starting in 2005-2006 though, the *ES* data sets include information on sampling weights which can be used to adjust for these changed probabilities. This information is particularly relevant

[9] These variables are available in value terms.

[10] For a given economy, geographic regions or cities with most economic activities are sampled for the ES survey. Please, refer to *ES Methodology* in the following link for further details. http://www.enterprisesurveys.org/methodology

[11] To the best of my knowledge, the *World Bank's ES* do not cover agriculture sector.

in this research because the productivity decomposition here follows Olley-Pakes dynamic decomposition which takes into account survivors, exiters and entrants. Also, the first wave of survey sample used in this reserach is the one immediately preceeding 2005-2006 wave.

Table 2 reports summary statistics for the first and last year of the sample (2002 and 2009). The number of firms in the sample increases from 4,532 to 6,851, that is by 51.1 percent between 2002 and 2009. There were 1,533 survivors, 5,318 entrants and 4,231 exiters in transition from 2002 to 2009. The average size of the firms, as measured by labor employment, decreased from 132 to 103 labors in those years. However, the decline of average employment of surviving firms was much less. In this case, the employment reduced from 95 to 81 employees. For the new entrants, however, the average employment of entrants was 106 in 2009. Therefore, in the sampling period the changes in average size and productivity of the firms would be driven by the entrants.

The second data set contains information on agricultural exports for 15 agricultural sector. The trade data are obtained from United Nation's COMTRADE database (United Nations, 2015) at the HS-6-digit level. Then, HS-6-digit products are aggregated into 15 gricultural sectors using a sector concordance retrieved from United Nations International Trade Statistics Knowledgebase (UNSD, 2015). Table 3 lists these 15 agricultural industries. Data on Gross Domestic Product (GDP) are from World Banks database on World

Development Indicators[12]. This data set also spans the same 21 countries over a period from 2002 to 2009.

Preliminary Results and Discussion

This section is orgainzed into three sub-sections. First, I discuss the production function coefficients by comparing OLS, FE and LP estimates. Second, I present the results based on aggregate manufacturing productivity decomposition and show productivity contribution from the three groups of firms (survivors, entrants and exiters) in the data set. Finally, I examine the manufacturing productivity spillover to agricultural exports in the context of unilateral trade liberalization programs.

Production function coefficients

Table 4 reports the estimated production function coefficients. All three columns use firm level observations and thus account for differences in technology across firms and countries (the sample spans 21 transition economies). Also, all the estimates are obtained from unbalanced panel and thus allowing for implicit entry and exit of the firms in the sample (which is an essential feature of the dynamic Olley-Pakes decomposition).

Column 1 reports the OLS estimates, which do not take into account any simultaneity

[12] World databank. 2015. World development indicators: popular indicators (GDP at market prices) Accessed at: `http://databank.worldbank.org/data/reports.aspx?Code=NY.GDP.MKTP.KD.ZG&id=af3ce82b&report_name=Popular_indicators&populartype=series&ispopular=y`

and endogeneity bias associated with the production function (discussed in model section). Column 2 reports the fixed effect estimates (FE). Theoretically, this estimate would correct for simultaneity and selection bias. If the materials inputs are increasing in productivity, the coefficient on variable inputs - labor and material inputs - from FE estimation are expected to be lower in magnitude compared to the OLS estimates. The results show that the capital elasticy is 0.27 and 0.19, the material inputs elasticity is 0.34 and 0.35, and the labor elasticity is 0.04 and 0.56 in the OLS and the FE estimates respectively. Although the FE estimates are not lower in mangnitude, the estimates are within the range reported in literature (see for e.g., Beveren 2010, Fonseca, Lima and Pereira 2016). Column 3 reports the LP estimates. This estimates use material inputs as a proxy for unobserved productivity and thus the coefficient on this variaable is recovered in the second stage estimation unlike in the other two estimates. In this case, the capital elasticity (0.38) and material inputs elasticity are higher in magnitude compared to that obtained from FE estimates. The labor elasticity (0.4), however, is lower in magnitude compared to the FE estimates.

Aggregate manufacturing productivity

As discussed in the model section, the firm level productivity is estimated as a residual of firm-level production function regression. I use coefficients from LP GMM approach (hereafter LP) to retrieve this productivity[13] as in specification (1).The kernel density plots for the TFP (in logarithmic form) obtained using OLS, FE and LP approach is

[13] TFP is retained in logarithmic form

shown in figure 1. Each of these densities are right tailed and exhibit a hump. The hump indicates there is some linear/non-linear dependence and needs further exploration.[14]

The aggregate productivity is a weighted average of productivity at firm levels. As a result, the changes in this metric over time may arise due to changes in market share allocation among surviving firms and/or due to entry and exit of firms. Therefore, I decompose the aggregate productivity following the dynamic Olley-Pakes decomposition (specification 6). To account for market share reallocation across each groups (entrants, exiters and survivors), I use output share as weights. The productivity changes over time relative to 2002 with respective contribution from these groups are then reported in table 5.

In this sample of tranisition economies, the results show that contribution from entering (2.25) and exiting firms (2.24) in the productivity changes is similar in the year 2005. The contribution from surviving firms is much higher (3.15). Concurrently, the aggregate productivity of both surviving (4.56) and entering firms (5.84) has grown in 2009. The high contribution from entering firms is expected because (as shown in top panel of table 1) in the year 2009 there are large number of new entrants compared to other two groups of firms.

Further, the aggregate productivity changes over time are estimated by country and Industry. For brieviety,[15] only the changes and not the contributions by groups are shown

[14]This work is in progress.
[15]available upon request

in table 6. The productivity changes are based on log scale and are relative to year 2002. In the top panel of table 6, I show the productiviy changes by countries. The productivity changes range from zero (in case of Azerbaijan) to 3.96 (in case of Montenegro) and from 3.63 (in case of Kyrgyz Republic) to 8.00 (in case of Romania) in 2005 and 2009 respectively. This preliminary estimates suggest that there has been productivity growth across these transition economies from 20002 to 2009.

The aggregate productivity changes over time by industries are reported in the bottom panel of table 6. The productivity changes range from 1.33 (in case of service sector) to 3.10 (in case of wholesale and retail trade, and from 2.86 (in case of hotels and restaurants) to 10.12 (in case of other services). This preliminary estimates suggest that there has been a vast productivity growth in service sector from 2002 to 2009.

Manufacturing productivity spillover in agricultural exports

To identify any productivity spillover from manufacturing to agricultural exports, I estimate the gravity equation in specification (7). The results are shown in table 7. All the columns include exporter, importer, time and product binary variables. Column 1 does not consider potential productivity spillover from manufacturing sector. The results show that the coefficients on GDP are both positive and significant as expected. Column 2 includes country and time varying manufacturing sector aggregate productivity and is of primary interest to this research. The results indicate that a unit increase in manufacturing sector productivity increases the exports by about 0.9 units.[16] This is a preliminary indication that there is positive productivity spillover from manufacturing to agricultural sector.

Summary and Conclusion [17]

Using firm level (panel) dataset, I show that there is in fact increase in productivity by countries (ranging from 3.63 to 8.00) and by industries (2.86 to 10.12) for the sample of 21 transition economies over the sampling period. I use this manufacturing sector aggregate productivity in gravity like equation to estimate its impact on agricultural exports. Preliminary results show that a unit increase in manufacturing sector productivity increases the agricultural exports by about 0.9 units for the current sample of 21 transition economies. Further, a unit increase in the productivity increases agricultural exports for exporters receiving unilateral trade liberalization benefits by about 0.4 units relative to non-beneficiaries. These preliminary findings suggest that there is associated trade gains in agriculture sector from the manufacturing productivity spillover.

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[17] This paper is in progress at this point in time

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Table 1: Countries Included in Analysis

Albania	Kazakhstan
Armenia	Kyrgyzstan
Azerbaijan	Latvia*
Belarus	Macedonia
Bosnia and Herzegovinia	Moldova
Bulgaria	Montenegro
Croatia*	Poland*
Czech Republic*	Romania*
Estonia*	Serbia
Georgia	Slovak Republic*
Hungary*	Slovenia*

*As defined in the World Bank country classification, for these countries transition period is complete by the end of the sampling period.

Table 2: Firms Interviewed in the Sampling Period

Number of	Year	
Group	2002	2009
All firms	4,532	6,851
Surviving firms	1,533	1,533
Enterng firms	-	5,318
Exiting firms only	4,231	-

Table 3: HS-2 digit Agricultural Products Classified into 15 Industries

Live animals	Live trees, plants, bulbs,roots,ornamental flowers	Prepared foodstuffs
Meat and edible meat offal	Edible vegetables, roots and tubers	(Beverages, spirits
Dairy produce; eggs, honey	Edible fruit and nuts, peel of citrus/melons	and vinegar,
Other products of animal origin	Cofee, tea, and spices	tobacco and substitutes)
Animal or vegetable fats and oils	Products of milling industry	Cereals
Oil seeds and Oleaginous fruits, medicinal plants, fodder	Lac; gums, resins and other vegetable saps and extracts	
Vegetable plaiting materials		

Notes: This categorization is broadly based on the HS-2 classification system. It includes chapters in agriculture section I to IV (excluding chapter 03 Fish and crustaceans, molluscs and other aquatic invertebrates). Agriculture section IV (chapter 16-24) is grouped into a single industry 'Prepared Food stuffs'

Table 4: The Production Function Estimates

	(1)	(2)	(3)
Variables	OLS	FE	LP
Log of Capital	0.27***	0.19***	0.38***
	(0.01)	(0.03)	(0.09)
Log of Material Inputs	0.34***	0.35***	0.44***
	(0.01)	(0.035)	(0.13)
Log Labour Employment	0.04***	0.56***	0.40***
	(0.02)	(0.19)	(0.04)
No. of Observations	9,532	9,532	9,532

Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively.
FE estimates include country, industry and year binary variables.
This estimation uses manufacturing firm level data set.

Table 5: Aggregate Total Factor Productivity Decomposition

Year	Surviving Firms	Entering Firms	Exiting Firms
2005	3.15	2.25	2.24
2009	4.56	5.84	-

Notes: All productivity changes are relative to 2002 and expressed in log percent.

Table 6: Aggregate Productivity Changes across Countries

Country	$\Phi_{kt_1} - \Phi_{kt_2}$	
	2005	2009
Armenia	1.82	7.45
Azerbaijan	0.00	4.41
Belarus	0.72	5.47
Bosnia	2.01	4.92
Bulgaria	3.28	4.41
Croatia	2.89	3.99
Czech Republic	1.71	6.76
Estonia	1.91	6.85
Georgia	2.40	4.07
Hungary	2.57	3.88
Kazakhstan	2.67	4.81
Kyrgyz Republic	2.03	3.63
Latvia	2.33	5.17
Macedonia	1.86	5.56
Moldova	1.67	4.93
Montenegro	3.96	5.21
Poland	2.58	4.58
Romania	2.41	8.00
Serbia	3.00	4.06
Slovak Republic	1.67	6.19
Slovenia	2.72	5.37
Industry		
Mining, quarrying, and manufacturing	2.36	3.78
Construction	1.74	5.65
Repair of motor vehicles and household goods	2.74	5.49
Wholesale and retail trade	3.10	6.37
Hotels and restaurants	2.29	2.86
Transport, storage and communication	2.21	6.015
Education, health and other social services	2.91	4.38
Other services	1.33	10.12

Notes:All productivity changes are relative to year 2002 and expressed in log percent.

Table 7: Manufacturing Productivity Spillover in Agricultural Exports

	(1)	(2)
Variables	PPML	PPML
Log of GDP Importer	0.71***	0.84***
	(0.16)	(0.15)
Log of GDP Exporter	0.77***	0.82***
	(0.15)	(0.12)
Productivity (Exporter)		0.93***
		(0.14)
No. of Observations	2,586	2,586
Pseudo log-likelihood	-6.244e+09	-6.244e+09
R-squared	0.73	0.73

Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively.
All columns include product, importer, exporter and time binary variables.
All columns use aggregate productivity.
This estimation uses agricultural exports data set.

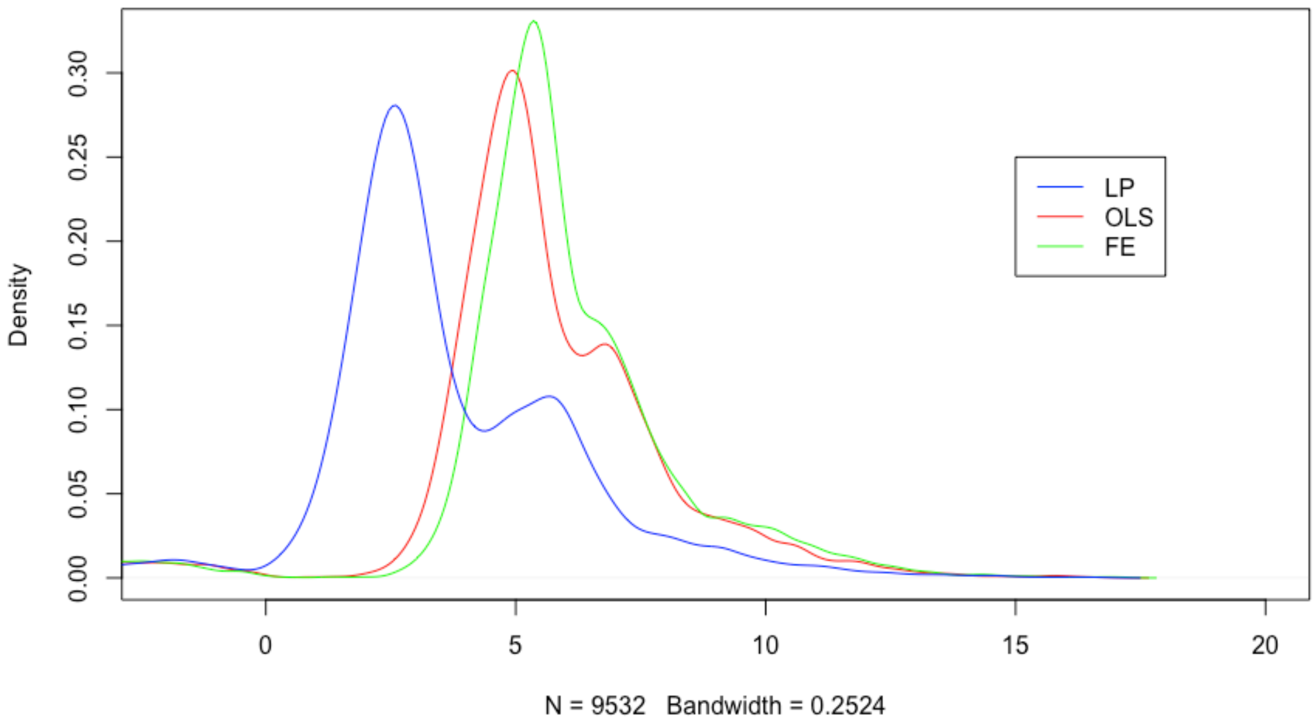

Figure 1: Kernel Density Plots of the Total Factor Productivity.