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Trade integration, economic geography and productivity: The Indo-Sri Lanka FTA

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Trade integration, economic geography and productivity: The Indo-Sri Lanka FTA

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April 2010

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Abstract:

Although there is much empirical evidence to show that more productive firms become exporters, the literature is less lucid regarding the benefits of exporting. This paper disentangles the direction of the causality to show that exporting improves firm performance. It uses Indian plant-level data (over 1995-2008) for 330 firms across six product categories, which experienced sharp increases in exports to Sri Lanka, which then became an important destination market for these products. I generate measures of total factor productivity by estimating production functions using plant-level physical output data. To deal with the problem of self-selection bias, I use instrumental variables that predict export status but are uncorrelated with unobserved productivity. As a robustness check, I model the exporting decision explicitly and jointly estimate it with the production function. I follow Olley and Pakes (1996) to deal with the self-selection problem, and then follow Levinsohn and Petrin (2003) and use intermediate inputs to deal with the simultaneity problem. I also conduct panel-data regressions at the industry (4-digit NIC) level to estimate the relationship between productivity and measures of international exposure, such as export shares. I also study how firm performance differs with regards to firm location, and model the effects of economic geography variables such as market access and agglomeration. This paper contributes to the empirical literature by measuring the effects of learning-by-exporting, and makes the case that these effects are more significant for firms that enjoy the advantages of geography.

I Introduction

Total factor productivity measures the economic and technical efficiency with which resources are converted into products. It has been argued that exporting helps firms to achieve higher levels of productivity. The implication is not that exporters are more productive than non-exporters, but that exporters increase their productivity advantage after entry into the export market. The first issue is simply that of self-selection – exporters may be more productive than their counterparts who only supply the domestic market, simply because only more productive firms are able to engage in export activity and compete in international markets. The second, more important mechanism, and one which the paper will focus on, is learning-by-exporting by firms, in other words, post-entry productivity benefits.

The second part of the paper will then study how these changes in productivity are not uniformly distributed across all exporting firms, and will investigate the determinants of such productivity differences owing to economic geography characteristics, focussing especially on market access – i.e. proximity to the final market. The main finding of the paper is that exporting leads to a rise in productivity, after controlling for self-selection and simultaneity biases. In addition, this paper finds that tariffs had a statistically negative impact on productivity measures for exporting firms, after controlling for firm and industry heterogeneity. The economic geography finding of the paper is that productivity of exporters varies by location and that access to markets has a significant and positive impact on firms' productivity.

The remainder of the paper is organised as follows: The next Section provides a descriptive overview of the theoretical and empirical literature on exporting and firm productivity. Section III introduces the Indo-Sri Lanka Free Trade Agreement and lays out the economic logic for the choice of industry and firms. Section IV outlines the theoretical model to estimate unbiased production function estimates, and the next section then relates these to liberalisation gains from the trade agreement. Section VII introduces the literature on economic geography, and elaborates on the econometric framework to study how business environment and market access affect firms' performance. The last section discusses the results from the economic geography estimation and concludes.

II Theory and Literature

A common argument put forth by proponents of trade liberalisation is that exposure to international competition results in a rise in domestic efficiency. These gains in efficiency flow through particular channels:

- Economies of Scale: Put simply, this is a positive association between the growth of output and the growth of productivity¹, based on the existence of economies of scale. Firms move to a lower point on the average cost curve since a rise in output

¹ Verdoorn's Law, when expressed in terms of labour productivity.

is accompanied by a less than proportionate rise in average costs. This argument is mainly put forth for the case of export expansion.

- Technical spillover effects: Liberalisation could boost within-plant productivity by allowing for international technological diffusion, especially when domestic plants gain access to imported intermediate inputs, and/or more efficient capital goods. There could be a rise in industry-level productivity because individual firms' R&D efforts could spillover to positively affect the total stock of knowledge for all firms, thus raising aggregate productivity.
- Incentives effects: A firm can also shift its average cost curve downwards by choosing to undertake fixed-cost investments in anticipation of larger export volumes, or because of the existence of increased competition through lower-priced foreign goods. These investments, such as those in R&D, would enhance productivity since firms are pushed to pursue true technical progress.
- Share/re-allocation effects: (Melitz 2003) As low productivity firms exit the output and employment are reallocated towards higher productivity firms and average industry productivity increases. In other words, industry-level productivity is expected to increase because of the exit of less-efficient firms and because of the higher productivity of the surviving firms. Simply put, average industry-level productivity rises because more productive firms now account for a larger proportion of total output.

The channels mentioned above are not mutually exclusive, and it is not the point of this paper to distinguish between the relative importance of each factor in contributing to growth in total factor productivity.

The empirical literature on productivity and exporting over the years has grown quite rapidly. There are many studies that find no or little evidence of learning-from-exporting effects. For instance Bernard and Jensen (1999) find that the benefits from exporting are unclear. Although employment, growth and profitability are higher for exporters, productivity and wage growth is not superior. Kim (2000) finds only marginal increases in productivity following trade liberalisation in Korea. Delgado et al (2002) finds evidence of higher productivity for exporters versus non-exporters, and evidence of self-selection of more productive firms into the export market. However, they do not find much evidence to support the learning-by-doing hypothesis, and if so, only for younger exporters. Other studies, such as Isgut (2001) and Clerides et al. (1998), which use a variety of econometric methods and data from several countries also conclude in favour of the self-selection and against the learning-by-exporting hypothesis. Only the most productive firms have a sufficient cost advantage to overcome transportation costs and compete internationally. Exporters are more productive than non-exporters, not because there are any benefits associated with export activities, but they are simply more productive from the outset.

Hung et al (2004) find that exporting activity itself does not seem to promote productivity, and that it is import competition that attributed for the largest part of labour productivity in manufacturing during 1996-2001. Fernandes (2007) finds that trade liberalisation has a strong positive impact on plant productivity in Columbia –

but does not differentiate between the channels through which this productivity gain could have taken place.

However, some studies have reached the opposite conclusion and there is now growing empirical support for post-entry productivity gains. For instance, Kraay (1999) for China, Bigsten et al (2004) for sub-Saharan Africa, and Aw et al (2000) for Taiwan, find evidence supporting learning-by-exporting. Loecker (2005) finds that Slovenian export entrants become more productive once they start exporting, and that the productivity gap between exporters and their domestic counterparts rises further over time. He also finds that productivity gains are higher for firms exporting towards higher-income regions. Biesebroek (2005) finds evidence that exporting sub-Saharan firms are more productive than their counterparts who only serve the domestic market, and that the former enjoy increasing rates of productivity growth – in support of the learning-by-exporting hypothesis. Other examples of some studies are Castellani (2002), Baldwin and Gu (2003, 2004), Blalock and Gertler (2004), Girma et al. (2004) and Greenaway and Kneller (2008). However, not all studies are able to describe the source of these learning effects. A notable exception is Baldwin and Gu (2004). From their analysis of Canadian plants they conclude that exporters learn from participation in export markets through channels that include new innovations, as well as technology transfer from abroad and investments in absorptive capacity such as human capital.

The next section will underscore the reason behind the focus of the study on the Indo-Sri Lanka bilateral trade relationship and will outline the descriptive trends in trade that point towards further analysis of firm-level effects.

III Indo-Sri Lanka FTA

The Indo-Sri Lanka Free Trade Agreement (ISLFTA) was signed in December 1998 and became operational in March 2000. The Agreement provides for duty-free as well as preferential access for goods manufactured in the two countries. Parts of the Agreement were renegotiated in mid-2002, following a mid-term review. And so even though the FTA was signed in 1998, it took over 15 months for proper implementation.

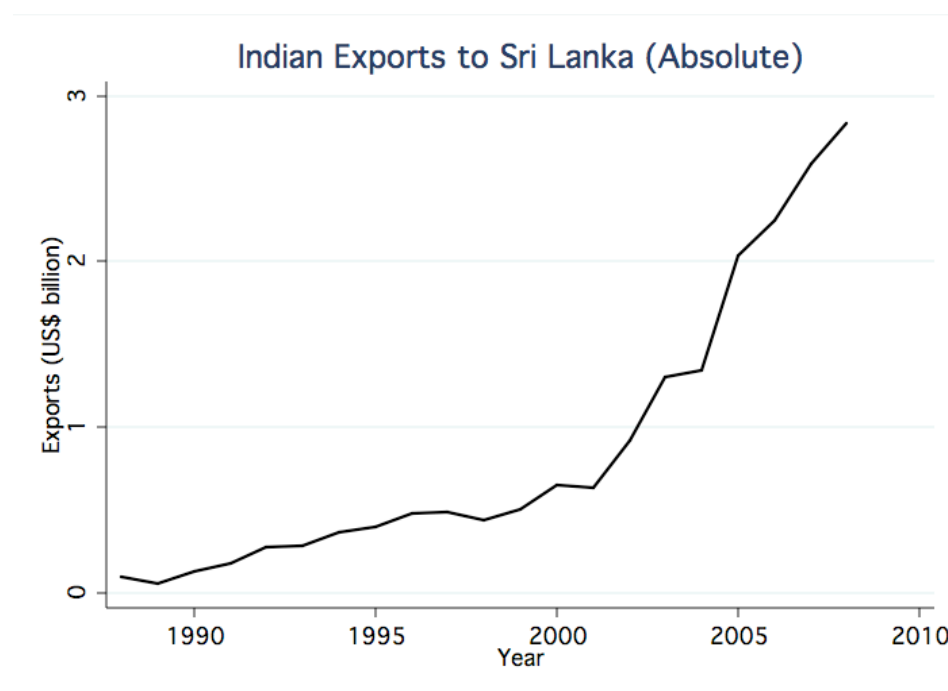
The ISLFTA is interesting since the trade agreement was negotiated on a negative basis², and because both sides agreed to significant tariff reductions regarding manufacturing goods. For more information on the nature of the commitments undertaken by each side, see Mukherji et al (2004). The Agreement also provides for a dispute settlement mechanism, and has been implemented more expeditiously, when compared to the regional FTA – the South Asian FTA within the South Asian region involving the two countries.

² Under the ‘positive list’ approach each party catalogues the individual commodities for which it would grant preferences. Under the ‘negative list’ approach, each country extends concessions/preferences to all commodities except for those indicated on its negative list.

According to Baysan et al (2006), although the FTA excluded many of the products in which the countries had comparative advantage, imposed tariff-rate quotas³ and strict rules of origin, it still led to a substantial expansion of bilateral trade between the two countries, in both directions. As they document, much of the increase in trade was in products that were not previously traded or traded in marginal quantities, and thus presumably escaped the sectoral exclusions⁴.

As outlined by CEPA (2003), exports from India to Sri Lanka saw a sharp increase after the implementation of the FTA – from US\$ 601 million in 2001 to US\$ 835 million in 2002 (a 39 per cent increase).

There is much evidence of a sharp increase in bilateral trade between the two countries following the establishment of the free trade agreement. India's trade with Sri Lanka saw a brisk increase since the signing of the FTA (although imports from Sri Lanka grew faster than exports to Sri Lanka) – see the following graph. What is interesting is that India's exports to Sri Lanka saw an increase across all categories of products negotiated under the FTA – be it zero duty, phased or negative-list products. Mukherji et al (2004) show that following the implementation of the FTA, products under the residual list⁵ accounted for 44 per cent of India's exports to Sri Lanka, whilst those under the negative list accounted for 37 per cent.



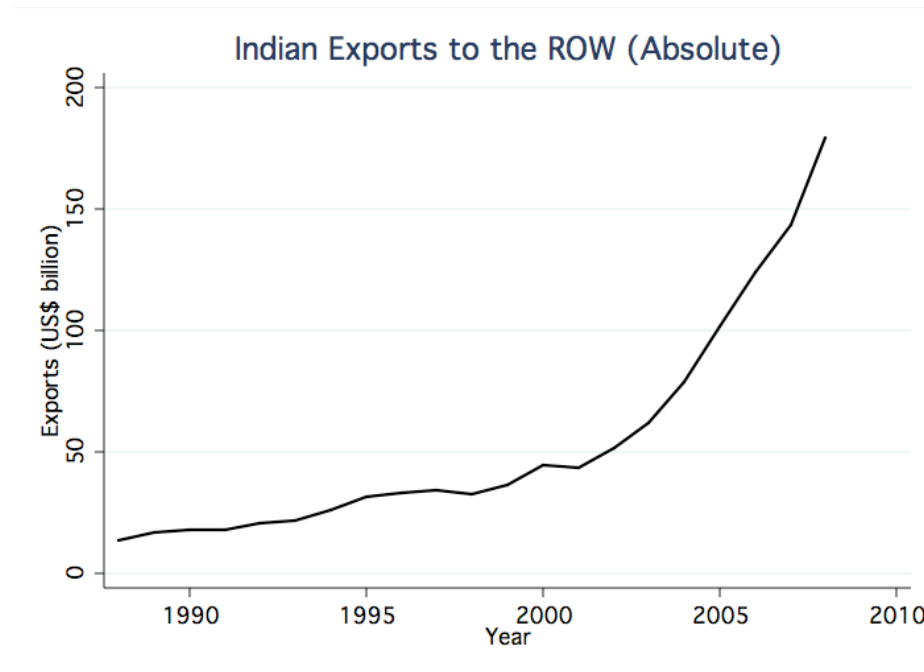
Source: Based on COMTRADE data

³ Tariff rate quotas imply that the preferential tariff is applied up to a pre-specified quota while the Most Favoured Nation (MFN) tariff is applied imports over and above the minimum quota.

⁴ In other words, goods that the partner country does not supply at the time of negotiating do not pose an obvious threat and therefore manage to receive significant references.

⁵ Products under the Residual List underwent tariff cuts of 10 per cent in the first year, 20 per cent by the second year, and 35 per cent by the end of the third year. Tariffs are meant to be brought down by 70 per cent by the sixth year, and 100 per cent by the end of eight years.

However, what is more important is that India's exports to the rest of the world (i.e. its total exports to the world less its exports to Sri Lanka) also saw a sharp rise after the year 2000, as shown below. Thus, it is difficult to claim that the relationship between Indian exports to Sri Lanka and the timing of the implementation of the FTA is at all interesting.



Source: Based on COMTRADE data

And so, the next logical step is to look at whether Indian exports to Sri Lanka relative to its total exports saw an increase following the implementation of the FTA – this could provide some indication of the strengthening of ties between Indian exports and the Sri Lankan market. As the graph below shows, however, not only has Sri Lanka been a marginal export market for India, its relative share saw only modest increases following the implementation of the FTA. The share of Sri Lanka in Indian exports has risen modestly under different categories since 1999-2000. Products under both the residual and the negative list increased their share (exports to Sri Lanka relative to the rest of the world) from 1998-2002. Textile and textile products fall under the residual list, and accounted for almost 42 per cent of Indian exports in 2001-2002 (Mukherji et al 2004). In other words, there is evidence to show that at a macro-level, the trends are not very interesting, but that there are wide variations at the level of individual commodities.



Source: Based on COMTRADE data

And so it makes sense to look at particular products, and I will concentrate on those products for which two important requirements are fulfilled:

- The percentage share of Indian exports to Sri Lanka, for that product category, should show an increase following the implementation of the FTA
- Sri Lanka should be an important destination market – in other words, the percentage share, for that product category, should be high enough.

I choose the following six product categories, and the following graphs illustrate how these products meet the conditions outlines above.

Table 1: Chosen Product categories

HS	HS Classification
31	Fertilisers
37	Photographic and cinematographic equipment
47	Pulp of wood, fibrous cellosic material, waste
60	Knitted and crocheted fabrics
66	Umbrellas, walking sticks, seat-sticks, whips etc
78	Lead and articles thereof

According to CEPA 2003, around 1/3rd of India's total exports to Sri Lanka were items that came under Sri Lanka's negative list.

Indian Exports to Sri Lanka (Relative)



Source: COMTRADE data

The graphs illustrate that there was a clear jump of average exports to Sri Lanka as compared to the pre-FTA implementation period. But, more important, as can be seen from the y-axis, Sri Lanka also happens to be an important market for these products. For instance, in the case of the HS-category 60 (Knitted and Crocheted fabrics), only 2-3% of total exports from India were for the Sri Lankan market – whilst this figure jumped to 36% in 2008. To put this in perspective, of all the knitted and crocheted fabrics exported by India, more than 1/3rd ended up in Sri Lanka.

The next step is to relate these macro-level trends to the micro-level data at my disposal. I use the Prowess database of rich firm-level panel data collected by the Centre for Monitoring of the Indian Economy (CMIE). Firstly, I choose all firms that

fall into the 6 chosen product categories. This provides me with a total of 330 firms for the years 1989 to 2008, and these give me a total of 6363 observations. I describe the main characteristics of the firm-level data below:

Table 2: Data Summary

	Total	NIC 31	NIC 37	NIC 47	NIC 60	NIC 66	NIC 78
Firms (#)	313	121	47	38	75	4	28
Observations (#)	6363	2437	944	777	1575	64	566
Average sales	3541	5230	1572	809	1199	306	8354
Average capital	3485	5774	1239	1307	1772	238	4282
Average labour	149	228	80	59	57	98	238
Raw materials	1301	2241	744	347	679	150	681
Electricity	300	577	15	138	81	19	190
Age	19	31	23	34	23	59	32

At this stage, I only graphically present the location of the firms in my dataset – see Figure 1. This information will be especially important for the economic geography part of my analysis. The following map displays the state and district boundaries of India, and displays the how the firms in my sample are clustered. What is important to note at this point is that the firms are quite evenly spread out over the North, South, East and West of the country, and that there is much evidence of geographical concentration in a few particular districts.

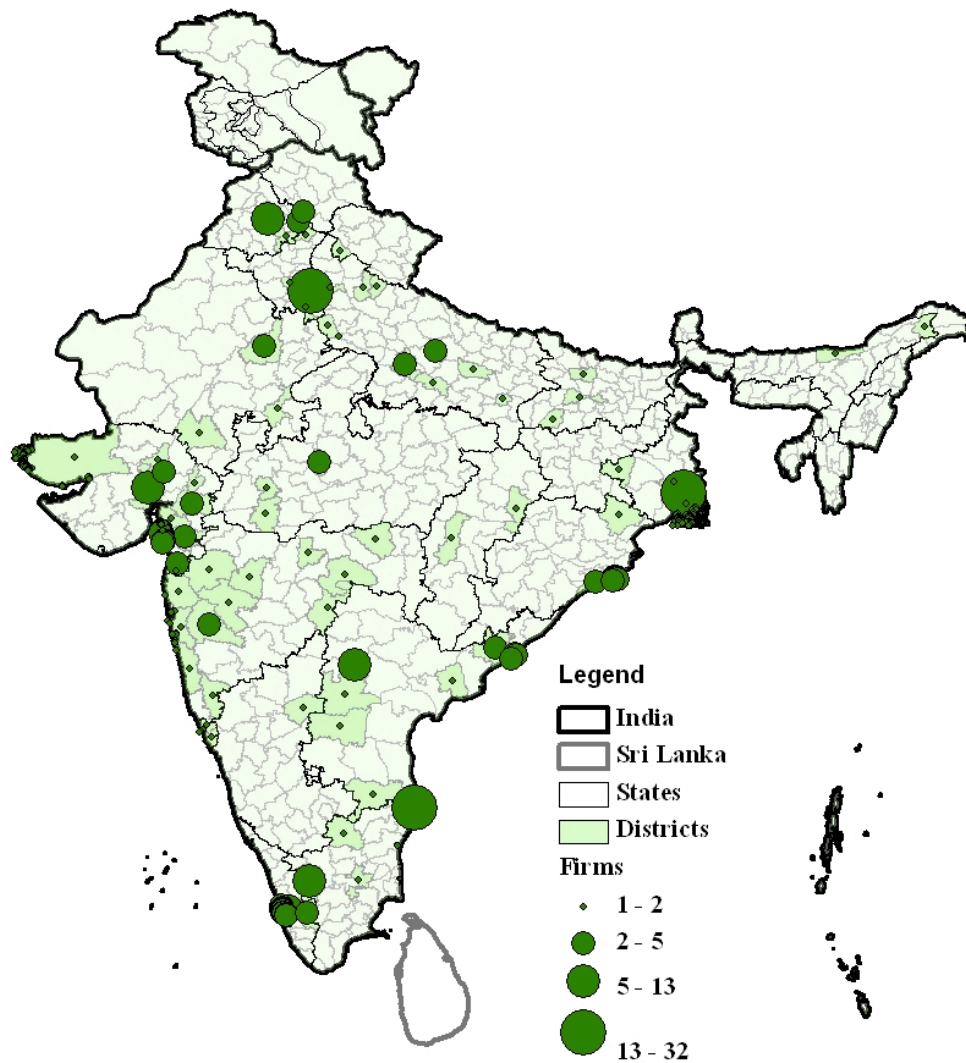
Some caveats should be mentioned here. The Prowess database of firm level panel data collected by the CMIE is used for this analysis and I exploit the panel features in our estimation. Firms in the sample include both exporters and non-exporters. The analysis of productivity effects is taken from a sample of plants based disproportionately from the large end of the size distribution. As Tybout and Westbrook (1994) points out, a lot of productivity growth comes from larger plants, so a more comprehensive study might have found smaller average residual effects.

There is a large degree of firm heterogeneity in terms of size, location and age. The most serious limitation of the dataset is that it is not mandatory for firms to supply data to the CMIE, and one cannot tell exactly how representative of the industry is the membership of the firms in the organisation. It is true, however, that large firms, which account for a large percentage of industrial production and foreign trade, are members of the CMIE. I also exclude plants for which any of the data for capital stocks, labour and intermediate goods (in this case, raw materials) are either not available or reported as zero values. After cleaning the data, the final dataset contains information on 313 firms for the year 1989 – 2008, yielding a total of 6363 observations. On average there are 19 years of data on each firm.

Additionally, although there is clear evidence that Indian exports of particular products to Sri Lanka have seen a rapid increase, it remains to be seen whether this increase is with a lower or higher unit cost in relation to imports to Sri Lanka from the rest of the world. In case of the former, there would be a trade creation effect, whilst the latter would imply a trade diversion effect. In case of a trade diversion effect, one

would not expect to see any large productivity gains for Indian exporters owing to lack of competitive pressures⁶.

Figure 1: Location of Firms



Source: FAO and Prowess

⁶ See Annex 21 of Mukherji et al 2004, for a full list of trade creation versus trade diversion effects.

IV The Theoretical Model

There is much debate in the literature regarding the estimation of production functions. Hasan (2002) details the choice of the appropriate estimation algorithm that deals with the simultaneity bias. The appropriate method will depend on the properties of the error term, $\varepsilon = \eta + \omega$, the first term corresponds to time-invariant technical efficiency of firms and the second term captures the residual variation in output. If η is not correlated with the regressors, then OLS estimates are consistent. If ω is assumed to be identically and independently distributed over all firms and time periods and is uncorrelated with the regressors, then the production function can be estimated using a fixed effects model. More importantly, however, if firms observe ω before making their input choices, then these choices may be conditioned on ω , leading to biased and inconsistent estimates. Consistent estimates can be obtained by using an instrumental variables estimator, and an appropriate instrument would need to be correlated with the potentially endogenous inputs but not with ω . Access to panel data could use the Generalised Method of Moments (GMM) instrumental variables procedure of Arellano and Bond (1991) which uses lagged values of the potentially endogenous regressors.

Since each firms' inputs and outputs are simultaneously chosen, the inputs will be correlated with any shocks, say demand or productivity shocks, that would be captured in the error term and the co-efficient estimates will be biased. Under fairly general assumptions⁷, Olley and Pakes (2005) and Levinsohn and Petrin (2003) show that under simple OLS estimations the labour co-efficient will be upward biased and the capital co-efficient will be downward biased, implying that productivity estimates will be upward biased for more capital-intensive firms (such as exporters).

Many alternatives to Ordinary Least Squares (OLS) estimates of production functions have been proposed. These are fixed effects, the Blundell-Bond (GMM) estimator (which is mainly a lagged-input instrumental variables estimator) etc. This paper follows Olley and Pakes (1996) and Levinsohn and Petrin (2003) to obtain consistent production function estimates to control for the self-selection and for the endogeneity problem. The self-selection problem is generated by the relationship between the unobserved productivity variable and the shutdown decision. In other words, firms' choices on whether to liquidate depend on their productivity. In this case, firms' choices on whether to exit the export market depend on their productivity. The second problem, i.e. the simultaneity problem is that inputs are endogenous to productivity. Levinson and Petrin (2003) show the conditions under which an intermediate-inputs proxy controls for correlation between input levels and the unobserved productivity shock. They build upon the paper by Olley and Pakes (1996), who use investment as a proxy. Levinsohn and Petrin (2003) show that intermediate inputs can also be used to

⁷ Levinsohn and Petrin (2003) consider the bias in three different cases: when only labour responds to the shock and capital is not correlated with labour (the labour co-efficient will be biased upwards, and the capital co-efficient will be unbiased); when only labour responds to the shock and capital and labour are positively correlated (the labour co-efficient will be biased upwards, and the capital co-efficient will be biased downwards); when labour and capital respond to the shock, the two are positively correlated and labour responds more strongly to the shock (the labour co-efficient will be biased upwards and the capital co-efficient will be biased downwards).

correct for the simultaneity between inputs and productivity. Taking intermediate inputs, and not investment as a proxy, has two main benefits: since a number of firms in the Prowess dataset report zero investment, I would have to truncate a large number of observations if I were to use investment. Just like in the case of L-P, firms in the Prowess dataset almost always report positive values of intermediate inputs, such as raw materials or electricity. Intermediate inputs have the added advantage that they are typically cheaper and thus can be adjusted more easily in response to productivity shocks⁸.

Output is expressed as a function of the log of inputs and the shocks:

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_i i_t + \beta_{ex} EX_{t-1} + \omega_t + \eta_t \quad (1)$$

Where y_t is the log of gross sales in year t , k_t is the log of the plant's capital stock, l_t is the log of labour input, and i_t is the log of the intermediate input, and EX_{t-1} is the lagged export status dummy. Inputs are divided into a freely variable one (l_t) and the state variable capital (k_t). ε_t is assumed to be additively separable in a transmitted component (ω_t) and an i.i.d. component (η_t). The key difference between the former and the latter is that the former is a state variable and hence impacts the firm's decision rules, while the latter has no impact on the firm's decisions.

Following Loecker (2005), and Van Biesebroeck (2006), I incorporate the lagged export dummy in the Olley and Pakes (1996) estimation algorithm, which results in estimates of productivity that control for the firm's export status. The intermediate input's demand function is given by:

$$i_t = i_t(\omega_t, k_t, EX_{t-1}),$$

where EX_{t-1} is the lagged export status. The policy function for intermediate input is now an unknown function of the three state variables, productivity, capital and lagged export status. The intermediate input must be monotonic in ω_t for all relevant k_t to qualify as a valid proxy. Assuming that monotonicity holds, the input demand function can be inverted to obtain ω_t as a function of intermediate inputs, lagged export status and capital:

$$\omega_t = \omega_t(i_t, k_t, EX_{t-1})$$

My estimation strategy is similar to Olley and Pakes (1996) except for the fact that the first stage estimation and the survival equation now include the lagged export status as a dummy and all terms interacted with the dummy. The first stage of the estimation algorithm is in fact almost identical to introducing lagged export status as an input, however, it is now also interacted with all terms of the polynomial in capital and the intermediate input as given in equation (2) below

⁸ As Levinsohn and Petrin (2003) explain, if adjustment costs for investment imply that firms do not respond smoothly to productivity shocks, then there will be kinks in the investment demand. This in turn may result in residual correlation between the regressors and the error term. On the other hand, intermediate inputs are typically cheaper, and thus the firm may adjust these more fully in response to productivity shocks.

Thus, one could re-write (1) as

$$y_t = \beta_l l_t + \phi_t(i_t, k_t, EX_{t-1}) + \eta_t \quad (2)$$

where

$$\phi_t(i_t, k_t, EX_{t-1}) = \beta_0 + \beta_k k_t + \beta_i i_t + \omega_t(i_t, k_t, EX_{t-1}) \quad (3)$$

A first-stage estimator that is linear in l_t , and non-parametric in ϕ_t can be used to obtain a consistent estimate of β_l . If one were only concerned with the marginal productivities of the variable inputs (but not the co-efficient on the proxy variable) one could stop here. To obtain a capital co-efficient, a plant-level measure of productivity a more complete model for $\phi_{e,t}(\cdot)$ will be required since capital enters it twice.

In the second estimation step, the probability that a firm exits the sample is captured by the probability that the end-of-period productivity falls below the exit threshold: Prob (exit after period t) = Prob $[\omega_{t+1} \leq \omega_{t+1}(K_{t+1}, EX_t) | \underline{\omega}_{t+1}, \underline{\omega}_t]$. This can be written as an unknown function of current observables by substituting the transition equations for the state variables and the previously used expression for productivity:

$$\text{Prob (exit)} = P_t(K_{t+1}, EX_t, \omega_t) = P'_t(K_t, i_t, EX_{t-1}, \Delta EX_t), \text{ or equivalently, } \\ P''_t(K_t, i_t, EX_{t-1}, EX_t)$$

Both the lagged and the current export status are needed because next period's productivity depends on current productivity and lagged export status belongs in the equation that predicts the unobservable ω_t . Current export status belongs in the exit-threshold, because it moves the production function, hence also the profit function, for the next period. The production function co-efficients of both state variables, capital and lagged export status, are recovered in the last estimation step.

The equation for the last stage is:

$$y_{t-1} - \beta_l l_{t+1} = \beta_k k_{t+1} + \beta_{ex} EX_t + g(P_t, \varphi_t - \beta_{ex} EX_{t-1} - \beta_k k_t) + \eta_{t+1}^* \quad (4)$$

where, $\eta_{t+1}^* = \xi_{t+1} + \eta_{t+1}$, i.e. the error term is decomposed into the i.i.d. shock and the innovation in productivity (ξ_{t+1} ⁹).

The polynomial in the three variables will improve the estimation in the last stage when identifying the capital co-efficient. When introducing the lagged export status dummy as an input in the production process, one has to identify the co-efficient on the lagged export status in the third stage as well. This implies that one has to assume that export status only affects the average future of the productivity distribution and hence leaves no scope for learning by exporting to be a heterogenous process across firms. In addition, it also implies that the effect is time-invariant or that every year

⁹ ξ_{t+1} is the innovation in productivity over the current period's expectation, given by $\xi_{t+1} = \omega_{t+1} - E[\omega_{t+1} | \omega_t]$.

exporting raises output (conditioned on capital and labour) by the co-efficient estimated on the export dummy.

It is clear that the estimation algorithm that controls for export status has an impact on the estimated production function coefficients. Compared to the standard Olley and Pakes (1996) or Levinsohn and Petrin (2003) approach, it is expected that the labour co-efficient will be lower since export status is strongly correlated with the productivity shock. In addition to the intermediate input and capital, export proxies for productivity shocks that are unobserved. The identifying assumption to estimate the capital co-efficient in the standard OP/LP method is that any shock in productivity between period t and $t+1$ is uncorrelated with the capital stock at $t+1$. If export status is not controlled for, part of the unobserved productivity shock (at time t) correlated with the export status end up in the error term.

The simultaneity problems are addressed by using the intermediate input proxy for unobserved time-varying productivity shocks, and the selection problems are dealt with by using survival probabilities.

Following Loecker (2005) with the coefficients of the production function in hand, I then recover a productivity measure for the firm i in industry j at time t ¹⁰:

$$\omega_{ijt} = y_{ijt} - \beta_l l_{ijt} - \beta_k k_{ijt}$$

It is these measures of productivity that I will use in the next section of the paper to study the effects of the a decrease in bilateral tariffs and the relationship between firm's economic performance and their location, both within the country and in relation to their main export market, Sri Lanka.

VI Productivity and the Free Trade Agreement

The coefficients generated by the Olley and Pakes (1996) measure are provided below. Column (1) provides simple OLS estimates, while columns (2) and (3) provide estimates using O-P estimations, using raw materials and electricity respectively, as proxy variables. As mentioned earlier, intermediate inputs (as shown by Levinsohn and Petrin 2003), serve as a better proxy to control for endogeneity as they respond better to productivity and other shocks. As mentioned earlier OLS estimates are expected to produce biased estimates for two main reasons – that these do not control for the entry and exit of firms (and thus over-estimate industry level productivity) and that they do not control for the simultaneity problem, i.e. when each firm's inputs and outputs are chosen simultaneously. Thus, the labour coefficient is meant to be upward biased and the capital coefficient downward bias using simple OLS estimations. This result is borne out in the production function coefficients compared across OLS and O-P methods.

¹⁰ It should be noted here that this measure of productivity is not the true unobserved productivity shock. It also includes the i.i.d. component which is assumed to be zero on average.

Table 3: Production Function Coefficients

Variables	OLS	OP (raw materials)	OP (electricity)
	(1)	(2)	(3)
(log) Capital	.626*** (.016)	.864*** (.104)	.604*** (.179)
(log) Labour	.369*** (.016)	.233*** (.038)	.213*** (.047)
Export dummy	.090*** (.040)	.064* (.043)	.072* (.040)

2819 2581 2635
(Bootstrap standard errors are in parenthesis)

The sign of the coefficient on the export dummy is also on particular relevance, and provides evidence for the learning-by-exporting theory. Recall that the export dummy is a lagged dummy variable for whether the firm exported in the last period.

Following Fernandes (2007), as a robustness check, I also conduct panel regressions of the measures of productivity, generated above, on measures of international exposure at the level of the industry, controlling for the age of the firm. I use data on tariffs (Sri Lankan tariffs imposed on the HS-digit industry product) for the impact of the Indo-Sri Lanka free trade agreement on firm-level productivity. The different models used below illustrate how the coefficients vary when state, district and industry-level effects are controlled for. The impact of the lagged tariff continues to be negatively and significantly related to firm-productivity across the different models. And so overall, the results from the different approaches support the theory of TFP gains from tariff liberalisation.

The next section will study how productivity for the selected firms in the sample is related to economic geography characteristics - i.e. measures of agglomeration and of location.

Table 4: Productivity and Openness

Model	O-P			
	(1)	(2)	(3)	(4)
<i>Regressor</i>				
l_age	3676.445*** -916	4816.622** -921	2558.78** -884	5203.418*** -1132
lag_tariff	-2212.709*** -450	-2286.655*** -460	-2256.513** -922	-1282.197* -812
Constant	-4236.641 -3236	-7829.894 -3274	-488.1995 -3342	-11050.86 -4010
State dummy	Yes			Yes
District dummy		Yes		Yes
Industry dummy			Yes	Yes
P-value for F- test State	0			
P-value for F- test District		0		
P-value for F- test Industry			0	
P-value for F- test State, District, Industry				0
Adj R^2	0.16	0.13	0.07	0.4
#	729	729	729	729

Standard errors in parenthesis. * significant at 10%, ** significant at 5%, *** significant at 1%.

VII The Economic Geography Effect

Brulhart (1998) categorises location theory into three broad theoretical schools and lists their principal distinguishing features. According to neo-classical theory, location is determined exogenously, implying that some regions are favoured by economic activity by virtue of their endowments or proximity to rivers, coasts, ports and borders. These models are characterised by perfect competition, homogenous products and non-increasing returns to scale. Models of the new trade theory, on the other hand, emphasise the interaction between economic agents and in particular the increasing returns to scale that is created through dense interactions. Everything but market size is endogenous in these models. The new economic geography models illustrate the possibility of self-organising spatial patterns of production, based on agglomeration effects rather than on differences in climate, transport costs or ecology – in short, location becomes entirely endogenous.

An overall large size of the urban agglomeration and its more diverse industry mix is also thought to provide external benefits beyond those realised within a single sector

or due to a tight buyer-supplier network (Henderson 2003). Chinitiz (1961) and Jacobs (1969) proposed that important knowledge transfers primarily occur across industries and the diversity of local industry mix is important for these externality benefits. These benefits are typically called urbanisation economies. These include access to specialised financial and professional services, availability of a large labour pool with multiple specialisations, inter-industry information transfers and the availability of less costly general infrastructure. Larger cities also provide a larger home market for end products, make it easier to attract skilled employees who are attracted by urban amenities not available in smaller towns, and support a large number of complementary service providers such as financial and legal advisers, advertising and real estate services.

This section will draw heavily on a few studies in the literature that carry out an empirical estimation of the location-based factors that affect firms' productivity. The underlying specification of the econometric model is based primarily on Crozet et al (2004) and Deichmann et al (2005). The former paper studies the determinants of location choice by foreign investors, comparing the importance of agglomeration effects with that of regional policies. The latter examine the spatial concentration of manufacturing industry in Indonesia, and their model mainly differentiates between natural advantages (such as transport infrastructure) and production externalities (such as localisation and urbanisation economies).

The model that I propose to study the factors affecting the location of services across India follows the Bayer and Timmins (2003) equilibrium model of location choice to study industrial development. The estimation framework is largely based on the location decision model wherein individual firms compare potential productivity across different locations. Following the approach of many others mentioned before, it is assumed that a firm evaluates alternative locations in India at each time period, and would consider relocation if its productivity in another place exceeded that at the current location. This methodology, by reviewing past location decisions as being under constant review by firms, allows an investigation in what location benefits are embedded in the firm's current production technology. In reality, relocation is not costly and firms need to take account of sunk investments in production capacity, and other costs of moving. However, these relocation costs are not considered in the model.

The deterministic component of the function consists of the various attributes of the location that can influence the productivity of a firm in that particular location, and the random component consists of the unobserved characteristics of the location, and measurement errors. Thus, the underlying location decision model for each firm determines productivity as a function of observable location specific advantages, market access, agglomeration economies, and a set of unobserved local attributes of the district.

The model assumes a set $J = (1, 2, \dots, j, \dots, n)$ of possible locations (districts) and that location j offers productivity level ω_{ijk} to a firm i in industry k .

There are two types of determinants of location. In order to capture the attractiveness of location j to the representative firm (common to all firms, independent of time of

entry, or type of sector), a fixed effect is introduced for each location, denoted by θ_j . Second, there is a set of variables Z_{ijk} representing observable characteristics of location j that vary across firms.

So the resulting productivity equation yielded by location j to a firm i in industry k is:

$$\omega_{ijk} = \theta_j + \mathbf{B}Z_{ijk} + \xi_j$$

where \mathbf{B} is the vector of unknown coefficients to be estimated and ξ_j measures unobserved characteristics of the district which can affect the firm's productivity.

It is assumed that i th firm will choose district j if $\omega_j^i \geq \omega_l^i$ for all l , where l indexes all the possible location choices to the i th firm. The result is that the probability that any firm will choose to locate in a city j :

$$P(\omega_{ij} \geq \omega_{il} \forall l \neq j) = \frac{e^{\theta_j + \mathbf{B}Z_{ijk}}}{\sum_{m=1}^J e^{\theta_j + \mathbf{B}Z_{ijk}}}$$

In the estimation it is assumed that each firm takes attributes associated with each city as given and makes rational location choice decisions. Using this formula for the probability for locating in each location, the co-efficient on each variable is then estimated by maximum likelihood. The expected signs and magnitudes of these coefficients are dictated by equation (2).

The observables in this model are:

$$Z_{ijk} : U_j, MA_j, W_j, R_j, X_j, Ed_j$$

Where:

U_j represents urbanisation economies in location j

MA_j summarises accessibility to the export market

Other regional characteristics include:

W_j a vector of factor input price variables in location j

R_j measures various aspects of regulatory quality

X_j captures the quality and availability of infrastructure

Ed_j measures the level of human capital in location j

ξ_j measures unobserved characteristics of the district which can affect the firm's productivity. Each firm considers these factors at the time it is making its location decision, but these are not captured in the data. The specifics of the endogeneity problem are dealt with in more detail below.

The economic geography variables in this model are represented by market access (MA_j) and urbanisation economies (U_j). The variables representing business environment are R_j (regulatory quality), X_j (quality and availability of infrastructure) and Ed_j (educational attainment). The remainder of this section is dedicated to a detailed description of each of the variables used in the model.

In principle, improved access to consumer markets (including inter-industry buyers and suppliers) will increase the demand for a firm's products, thereby providing the incentive to increase scale and invest in cost-reducing technologies. The classic gravity model, which is commonly used in the analysis of trade between regions and countries, states that the interaction between two places is proportional to the size of the two places as measured by population, employment or some other index of social or economic activity, and inversely proportional to some measure of separation such as distance. In this paper, I simply use a measure of distance between the location of the firm and its export market (here, Sri Lanka), and generate an accessibility indicator (MA_j). Theory would dictate that this measure be inversely related with firm-level measures of productivity.

I plan to use the well-known Herfindal measure to examine the degree of economic diversity, as a measure of urbanisation (U_j) in each region. The Herfindal index of a region j (U_j) is the sum of squares of employment shares of all industries in region j :

$$U_j = \sum_k \left(\frac{E_{jk}}{E_j} \right)^2$$

Unlike measures of specialisation, which focus on one industry, the diversity index considers the industry mix of the entire regional economy. The largest value for U_j is one when the entire regional economy is dominated by a single industry. Thus a higher value signifies lower level of economic diversity. To simplify things, Koo and Lall (2004) use urban population density (i.e. the ratio of the urban population to the urban area in the district) as an indicator for urban scale economies.

W_j is a vector of factor input-price variables in location j , and following Deichmann et al (2005), I use nominal district-level wage rates (non-agricultural hourly wages) as an indicator of input costs.) I define R_j as a measure of regulatory quality defined as the degree of labour regulations, since excessive regulation of industrial relations has often been singled out as an important factor affecting the competitiveness of Indian industry. I also plan to use indicators of labour regulations developed by Besley and Burgess (2004) for states in India. Lall and Menigstae (2005) code these amendments by state as pro-worker, neutral or pro-business. I include data on the enrolment numbers and rates at the district level for high schools, and at the state level for engineering schools, to define the education variable - Ed_j .

I use the variable ξ_j , described earlier, which controls for unobservable sources of natural advantage. In verifying whether characteristics of a location and the level of

agglomeration economies enhances performance inevitably faces the major difficulty that causality could run both ways. If a particular location offers some inherent features that improve the productivity of certain economic activities, firms will be attracted to that location. Such inherent features may be related to natural endowments or regulatory specificities, but they could also have to do with essentially un-measurable factors such as local business cultures. How to isolate the effect that runs from agglomeration to performance thus represents a considerable challenge. With regard to the proposed analysis, the presence of these unobservable sources of a location's natural advantage complicates the estimation procedure, particularly in identifying the contribution of production externalities to the location decision of firms.

I propose to deal with the problem following Lall and Mengistae (2005) who address this problem by using historic land revenue institutions set up by the British and detailed by Bannerjee and Iyer (2005) as instruments. Land revenue was the most important source of government revenue and the British instituted three systems defining who was responsible for paying the land taxes. These were (a) landlord based systems (zamindari), (b) individual cultivator-based systems (raiyyatwari) or (c) village-based systems (mahalwari). These institutions are of interest to the analysis for a three reasons. First, the British decision on which land tenure system to adopt depended more on the preferences of individual administrators rather than a systematic evaluation of region-specific characteristics. Thus, the choice of institutional arrangements is largely exogenous to regional attributes. Second, landlords were allowed to extract as much as they wanted from their tenants, thus making their behaviour predatory, leading to high inequality and low general investment in their districts. Further, as most wealthy landlords were not cultivators themselves, this reduced pressure on the state to deliver services important to farmers as well as general public goods. The consequences of this system are observed in terms of lower education and health infrastructure and outcomes. Third, rural institutions have considerable bearing on urban and industrial development (Rao and Woolcock 2001). Rural class structures and social networks do not disappear once people move to cities. Thus, as Lall and Mengistae argue, these land-tenure systems serve as good instruments since they have been found to influence agricultural investment, productivity and general district-level development indicators in the post-independence period, and since their choice was largely exogenous, they are not correlated with any observable features of the underlying natural geography of the region.

It is prudent at this point to list the various data sources that I draw on for the purposes of this research. Firm-level data on sales is drawn from the Prowess database¹¹. District-level data on wages and employment by NIC-industry type (which are then used to estimate measures of agglomeration) are drawn from employment surveys of the National Sample Survey Organisation (NSSO) and the Central Statistical Organisation (CSO). The latter is also my main source of data for input-output matrices, and for educational attainment and power generation by state.

¹¹ Prowess is a corporate database that contains normalised data built on a sound understanding of disclosures of over 18,000 companies in India. The database provides financial statements, ratio analysis, fund flows, product profiles, returns and risks on the stock market etc.

Population data at the district level is taken from the 2001 National Census. Road and rail density are taken from the Economic Intelligence Unit of the CMIE – Centre for Monitoring of the Indian Industry.

Table 5: Some Descriptive Statistics

Variable	Expected sign	#	Mean	SD	Min	Max
Urbanisation	-	42	0.1308	0.1247	0.0526	0.7786
Market Access	-	63	1381	590	176	2267
Wages	-	76	151	131	18	567
Power	+	23	35921	18899	925	59764
High School (total)	+	73	102167	59202	5944	223288
Engineering (total)	+	23	30973	26046	580	79122
Rail density	+	21	39	34	5	138
Road density	+	20	3122	5291	387	18590

Urbanisation and market access have been defined at the level of the district. Wages and total number of students enrolled in high school. On the other hand, power, engineering enrolment, road and rail density, and regulation have been defined at the level of the state. One would expect a negative sign for regulation, since it is a dummy variable for whether the location has pro-worker or pro-business laws.

VIII Results and Discussion

The results of the estimations are provided in Table 6 below. Column (1) takes simple OLS estimates of productivity and regresses it across economic geography and other variables. Owing to endogeneity concerns, both in the estimation of total factor productivity and in the estimation of the effect of agglomeration variables, these results are only provided for comparison. Interestingly, the impact of the total number of engineering students within a location seems to be positively related to a firm's productivity. Column (2) takes TFP estimated by L-P (2003) methods, taking raw materials as proxies¹². Columns (1) and (2) use simple OLS methods, and should be compared with Columns (3) and (4) which have been estimated using the same dependent variable as in the first two columns, but using instrumental variable techniques.

One of the concerns in estimating equations by OLS is that the measures of localisation may be endogenous to the outcome variable – endogeneity could arise if the level of localisation in a region were related to the underlying natural geography or resource endowment in the region. In other words, the OLS estimates for localisation would be biased upwards if there were an unobservable driving the clustering of firms in a region. To address this concern I use an instrumental variables strategy (as outlined in the section on identification). I then estimate the equation

¹² Using electricity as a proxy variable also provides broadly similar results, available on request.

using an instrumental variable that is based on the Bannerjee and Iyer (2005) classification of Indian states as landlord or non-landlord. The results indicate that urbanisation (i.e. a measure of industrial diversity) remains a significant and negative determinant of firm location decisions. I also perform the Durbin-Wu-Hausman test to examine if endogeneity of own industry concentration could have adverse effects on OLS estimates, and the results of these how that IV estimates are preferable.

Table 6: Location and Firm productivity

Variables	<i>OLS</i>		<i>IV</i>	
	OLS (1)	OP (2)	OLS (3)	OP (4)
Urbanisation	0.081 (.300)	-.771* (.502)	.027 (.120)	-.757* (.059)
Market access	.898 (1.120)	-9.751*** (4.099)	1.469 (1.432)	-9.484* (1.903)
Wages	1.929 (1.704)	3.652 (2.264)	2.09 (1.730)	2.680 (2.229)
Enrollment	-.006 (.006)	.024** (.008)	-.006 (.007)	.023* (.009)
Engineering	.159*** (.031)	-.194 (.041)	.155*** (.056)	.203* (.072)
Power	-.243 (.044)	.117 (.059)	.241* (.049)	.189 (.065)
Regulation	-5020.412* (1400.759)	-1199.66 (1861.73)	-4910.492* (1882.62)	-538.25 (250.01)
Rail density	-131.245 (41.915)	34.00* (23.68)	-130.05 (44.57)	81.73 (59.23)
Road Density	.254 (.523)	-2.960 (.695)	.365 (1.347)	-3.54 (1.79)
#	87	87	85	85
R ²	0.14	0.16	0.15	0.16

Robust standard errors in parenthesis. * significant at 10%, ** significant at 5%, *** significant at 1%.

The most important result here is that market access has a negative and significant impact on firms' performance. This finds support for the gravity model of international trade that emphasises the role of distance in dampening the trade flows between countries. For instance, Bernard et al (2007) also find that distance has a strong negative effect on the number of firms that sell to an export market as well as the number of products per firm exported. However, more importantly, in this paper, since we are only studying the effect of distance from a single trading partner, it is possible that proximity and a common culture and language¹³ could be reasons also explaining the economic geography effect. Holding inputs and productivity constant, differences in output could also arise from exporters being in particular industries or products. By focussing on a few select industries, I reduce the impact of inter-industry effects.

There is also evidence of, what Lall and Menigstae (2005) call, business environment variables. These are factors related to the business environment of a location which can easily be influenced by policy. For instance, there is evidence that firm productivity is strongly and negatively affected by regulation – which is a dummy variable for whether the local government is pro-worker (1) or pro-business (0) in the particular location. Education, proxied by the number of engineering graduates and the total number of people with a high school degree in a location also has a significant and positive effect on firm productivity, as does access to power and transport infrastructure.

And thus, the empirical analysis finds that economic geography factors do have an important effect on firms' performance, and thus their decision to locate in a particular area. There seems to be a pattern in the data whereby geographically disadvantaged locations seem to compensate partially for their natural disadvantage by having a better business environment than more geographically advantaged locations. It appears that factors such as access to power, regulation and transport infrastructure can have a significant effect on performance. That these factors are well within the scope of policy-makers decisions is a bonus for areas which seem to lag behind in their ability to attract economic activity.

The importance of this research is underscored by two inter-related factors – that exporting has an important effect on firm-level productivity, and that the clustering of economic activity has important implications for how the benefits of exporting are distributed across space. This research also makes an important contribution to the empirical literature on gains from trade and economic geography. There are only a handful of papers that link the effects of exporting to particular markets with economic geography variables.

To conclude, this paper finds empirical evidence for two separate trade theories. One - that exporters increase their performance with exporting behaviour – in other words, it finds evidence of learning-by-exporting effects. And secondly, it finds that such productivity benefits from exporting are not spatially blind. Firms which are in an advantageous location, i.e. they are geographically better-placed in relation to their counterparts, are in a better position to exploit gains from exporting. However,

¹³ Southern states in India, especially Tamil Nadu share a number of cultural and linguistic characteristics with the Sri Lankan population.

geography is not destiny and policy can play an important role in attracting economic activity to geographically disadvantaged locations. Thus, whilst it is already known that gains from exporting are not evenly distributed across all firms, this paper finds evidence that economic geography can have an important role in play in determining the distribution of productivity benefits.

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