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Does Trade Policy Explain Total Factor Productivity Differences Across Countries?

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Abstract: This study examines whether variations in restrictiveness of trade policy on the flow of international trade explain Total Factor Productivity (TFP) differences across countries. The study employs Trade Restrictiveness Indices (TRIs) to measure trade policy. The TRIs are aggregated using data at the tariff line level, which enable the study to overcome the aggregation bias characterizing the commonly used trade policy measures such as average tariff and import-weighted average tariff. TRIs for Non-Tariff Barriers on imports (NTB), import tariffs and export restrictions are used to show the relative restrictiveness of various types of trade policy on TFP. In line with the political economy literature, the trade restrictiveness measure based on NTB is instrumented using past trade shares while identifying the former's effect on TFP. Using IV regression, the study shows that trade restrictiveness based on NTB explains a significant variation in TFP across countries while trade restrictiveness based on import tariff or export restrictions does not have a significant effect on TFP. Hence, countries should reduce NTBs on their imports to allow a gain in TFP associated with trade. Besides, the findings suggest that countries should substitute the more restrictive and less transparent trade policy, i.e., NTBs with the less restrictive and more transparent trade policy, i.e., Tariffs.

Keywords: Export restrictions, import Tariffs, NTBs, TFP, trade policy, TRIs

INTRODUCTION

Disparity in standards of living across countries remains very high. Recent development accounting exercises such as Hall and Jones (1999) and Klenow and Rodriguez-Clare (1997) have shown that a greater proportion of the per capita income variation across countries is explained by differences in their Total Factor Productivity (TFP). Their findings highlight the need to understand why such a significant difference in TFP exists.

Among other factors, international trade is considered to be a deep determinant of TFP. Trade facilitates the process of technology adoption (Holmes and Schmitz, 1995) and it promotes resource reallocation from less efficient to more efficient firms, thereby promoting overall productivity (Melitz, 2003). A country's trade performance, however, is an outcome of a number of factors such as its trade policy, per capita income, whether it has access to the sea, etc. From a policy making view point, an effort to investigate the role of trade for TFP, therefore, needs to ask whether the determinants of trade (and not trade itself) could influence TFP. That is what the current study does. It asks whether trade policy explains significant TFP variation across countries.

Analyzing the effect of trade policy on TFP necessitates a proper measure of trade policy. The commonly used trade policy measures include trade share, Sachs-Warner index, average tariff and import-weighted average tariff. All of the above measures, however, have drawbacks as to their proper measurement of the relative restrictiveness of trade policy across countries. As stated earlier, trade share, being an outcome measure, cannot properly index trade policy. The use of average tariff on the other hand deems a country as more open when it reduces tariffs while substituting it with higher Non-Tariff Barriers (NTBs). Moreover, using average tariff attach equal economic importance for trade in different goods while import-weighted average tariff underestimates the restrictiveness of trade policy in the presence of prohibitive tariffs. Sachs-Warner index measures a broader macroeconomic policy which makes it difficult to use as a measure of trade policy per se. The current study measures trade policy using recently constructed Trade Restrictiveness Indices (TRIs) that are estimated using tariff, non tariff barriers, imports and exports at the tariff line level. Moreover, import demand elasticities, measuring the economic importance of the good are used as weights while aggregating trade distortions from the tariff line level. Both features render the use of these trade restrictiveness indices to measure trade policy as more theoretically sound. No previous study has used the TRIs to measure trade policy in a TFP regression. The study uses TRIs constructed using import tariffs by a country on its own

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imports; tariff by trading partners on a countries exports and NTBs by a country on its own imports.

Consistent with the political economy literature, the study treats NTBs as endogenously determined. As such, NTB is instrumented using past trade shares. Tariffs, however, are usually bound by bilateral or multilateral agreements. For this reason, the study treats tariffs as exogenous. OLS, 2SLS, LIML estimation techniques are used while trying to identify the effect of trade policy on TFP.

Using the newly constructed and more theoretically sound TRIs as a trade policy measure, this study aims to examine if part of the variation in TFP across countries is explained by the differences in the restrictiveness of their trade policies. The findings suggest that variation in the levels of import restrictions by NTBs explain significant differences in TFP, while variations in the levels of import restrictions by tariff or export restrictions by tariffs does not explain a significant difference in TFP across countries.

The remaining sections of the study are organized as follows. Section two makes a brief review of the literature on the TFP-trade policy nexus. Section three specifies the model, presents the data and discusses the estimation strategy. Section four discusses the findings while section five concludes.

THE TFP-TRADE/TRADE POLICY NEXUS: THEORY AND EMPIRICS

The mechanisms identified by most of the existing theories on how trade/trade policy impacts TFP include technology diffusion, learning by doing, market size (economies of scale) and competition through entry and exit, thereby facilitating intra industry resource reallocation.

Evidences show that only few developed countries can afford to make the huge research and development (R&D) investment cost to benefit from the use of advanced technology[1]. Allowing movement of technology embodying goods and interaction of individuals, trade enables technology diffusion thereby enhancing TFP in areas that may otherwise produce with old and inefficient technology. Trade policy orientation, being one determinant of trade volume, either facilitates or impedes the process of technology diffusion with a resulting impact on TFP or long run per capita income (Grossman and Helpman, 1991; Parente and Prescott, 1994; Holmes and Shimitz, 1995; Rodriguez-Clare, 1996). Another mechanism by which openness affect TFP is through reallocation of resources from less efficient to more efficient firms (Melitz, 2003). The role of trade policy that promotes openness in this case would thus be to facilitate reallocation of resources from less efficient to more efficient firms, thereby enhancing aggregate productivity.

Empirically, various studies have found a significant positive effect of openness on TFP or TFP growth (TFPG) (Hall and Jones, 1999; Alcala and Ciccone, 2004; Miller and Upadyay, 2000; Choudri and Hakura, 2000; Jonsson and Subramanian, 2001). In order to set a stage for the analysis in the subsequent sections, section 3 below specifies the model and discusses issues related to data, identification strategy, estimation techniques and inference.

MODEL SPECIFICATION, DATA AND ESTIMATION TECHNIQUES

In line with the common practice in the literature, the TFP equation is specified as in (1) below where TFP depends on trade policy, institutions and geographic characteristics[2]:

$$LogTFP_i = \beta_0 + \beta_1 TRADE\ POICY_i + \beta_2\, INST_i + \beta_3 GEOGRAPHY_i + \varepsilon_i \quad (1)$$

$LogTFP_i$ is the natural logarithm of TFP in country$i$. It is derived from a Cobb- Douglas production function as a residual, where real GDP per worker is disaggregated in to capital intensity and human capital per worker, following Hall and Jones (1999) (henceforth HJ). The formal derivation of TFP is shown in Appendix B. $TRADE\ POICY_i$ represents the restrictiveness of trade policy in country i on the flow of its international trade. As will be discussed later, the study employs three trade policy variables that proxy restrictiveness of trade policy on import or export. $INST_i$ Measures governance quality in country$i$; $GEOGRAPHY_i$ represents measures of geographic characteristics. The study controls for a measure of distance from the equator, a dummy for being land locked and continent dummies. ε_i is an error term.

Description of 'core' determinants:

Trade policy: To measure the role of trade policy on TFP that could be channeled through the former's effect on import, I have included two trade policy indices that measure the restrictiveness of a country's trade policy on its imports. The first index measures the restrictiveness of a country's non tariff barriers on its imports. It measures the restrictiveness of a core NTB across a tariff line for which there is a core NTB in the country. It is named in the current study as the overall trade restrictiveness index based on Non Tariff Barriers (OTRI-NTB). The core non tariff barriers used in the computation of OTRI-NTB include quotas, technical regulations and other non tariff barriers (Kee *et al*., 2009). The second index measures the restrictiveness of a country's tariff barriers on its imports. It is named as overall trade restrictiveness index based on tariff (OTRI-TARIF)[3]. To measure the effect of trade policy

that runs through the other channel of openness, namely export, we have included a trade policy index that measures restriction on a country's export by all trading partners of the home country. The index is known as Market Access Overall Trade restrictiveness index (MA-OTRI). This measure is a proxy for trade policy of all trading partners of the home country for the latter's exports[4]. The country level data on the three trade policy measures are aggregated using import, export and trade policy data at the tariff line level. This reduces the aggregation bias present in using average tariffs, for example, for the latter implicitly assumes equal restrictiveness of tariffs in different tariff lines. As far as we know, no study so far has used this family of trad restrictiveness indices to identify the role of trade policy on TFP.

All the three trade policy variables are expected to have a negative effect on TFP through their restrictive role on openness.

Institutions: In the current study, INST measures institutional quality (government effectiveness). Governance quality in a country pertains to the process by which governments assume power and are held accountable; government's capacity to formulate and implement sound policies; and the respect of the state and citizens for the social and economic institutions (Kaufman *et al*., 2009).

The governance indicator has the following six dimensions by which it reflects the aforementioned features: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. The measure of institutions used in the current study (INST) is a simple average of the above six indicators[5].

A difference in the quality of governance is believed to explain substantial TFP variation across countries, triggering differences in the return to economic activity. They matter to TFP in a manner by which checks and balances for governments against expropriation are established; governments ensure an economic climate that could increase confidence among the private sector and increase (expected) return to economic activity. A significant correlation between the trade policy variables and the measure of governance quality means that we should control for the effect of the latter while trying to identify the effect of trade policy on TFP.

A country with higher quality of institutions compared to another one is expected to have higher TFP, other things being equal. Thus, β_2 in Eq. (1) above is expected to be significantly positive.

Geography: The core specification controls for the effect of geography related measures, namely distance from the equator (absolute latitude); whether a country is landlocked; and continent specific effects. The fact that most poor countries (e.g., about 90% of Sub-Saharan Africa) are located within the tropics and most of the prosperous nations lie in the temperate zones could be immediate observational evidence that geography matters for economic performance. The well known explanations for such dichotomy often relates to agricultural productivity and disease prevalence. Crop productivity in the tropics is very low compared to the temperate regions. Maize productivity, for example, is about three times higher in the temperate region than in the tropics (Gallup *et al*., 1999). Malaria prevalence is widespread in the tropics holding back labour productivity growth, especially farmers' productivity in many countries where agriculture is the mainstay of the economy. The favorable climate for infestation of crop pests and insects is an additional impediment to the already low productive agricultural sector in the tropical region. The current study employs a measure of distance from the equator (LATITUDE) as a proxy for variations in the above mentioned latitude related features in order to account for the resulting influence on TFP.

The second measure of geography relates to whether a country has access to the sea. Sea transport is the cheapest means to transport goods across countries. Thus, landlocked countries face higher transportation cost which would reduce the level of international trade and the associated productivity gains from trade, other things held constant. To account for the contribution of having access to the sea on TFP, the study controls for a dummy (LANDLOCK) which takes a value of one if the country is landlocked and zero otherwise. To capture the effect of other geography related factors that can not necessarily be accounted for by the above two geographic measures, the study also controls for continent specific effects by defining CONTINENT dummies (AFRICA, ASIA, EUROPE, AMERICAS and OCEANIA). Higher latitude and being landlocked respectively are expected to have a positive and negative effect on TFP.

The fact that geography enters significantly in different specifications for measures of economic performance implies that failure to control for this variable may cause omitted variable bias. Particularly, by omitting geography we may overstate the role of policies on economic growth (Gallup *et al*., 1999)[6].

Data: The study is constrained by data availability especially for human capital, which is required to compute TFP from the Cobb-Douglas production function; and the trade policy variables. The sample initially includes 25 low income, 32 middle income and 9 high income countries with a total of 66 countries[7]. However it is only 52 countries for which both average years of schooling and Trade policy data are available, which has forced us to do most of the analysis using data for those 52 countries, which finally comprises of

16 low income, 27 middle income and 9 high income countries. All countries included in the sample are non oil countries based on the classification in Mankiw *et al*. (1992).

In the TFP specification, average values of TFP for the years 2001-2003 is used for two reasons:

- The TRIs are estimated based on average import and export data for 2001-2003; and average tariff and NTBs data for 2000-2003. The trade policy indices used in the study are proxy for restrictiveness of trade policy measured by the response of import or export for which average data for the years 2001-2003 is used. Thus, it is appropriate to use the corresponding average Figures for TFP in a specification where we estimate the impact of trade policy on TFP.
- In a cross section setting, using average of TFP would reduce business cycle effects by smoothing out short run fluctuations.

Average data for 2001-2003 is used for the remaining variables except explicitly stated otherwise. Population, investment share, real GDP per capita and real openness data are from Penn world table version 6.2. Real GDP and investment data are constructed using information on population, real GDP per capita and investment share data. Labour force data is available in World Development Indicator (2008) CD ROM. Recent data on average years of schooling for the year 2000 is obtained from Barro and Lee (2000). The parameter values for capital share is assumed to be one-third ($\alpha = 1/3$) as in HJ. Capital stock is estimated using perpetual inventory method[8].

Estimation, Identification and Inference:

Estimation: The TFP equation is first estimated using OLS to see the partial correlations between TFP and its 'core' determinants including trade policy. In the presence of possible feedback effect from TFP to the measure of Non Tariff Barriers, the OLS estimates might not speak of causality that runs from the later to TFP. Likewise, TFP may affect INST where the latter is included in the TFP equation. To account for the possible endogeneity of these variables, 2SLS estimation technique is employed. In the presence of weak identification, the Limited Information Maximum Likelihood (LIML) estimator performs better than 2SLS. For this reason, an alternative estimation for the 'core' TFP equation is made using LIML.

Identification: Reverse causality is a main challenge plaguing identification of the effect from one of our variables of interest i.e., OTRI-NTB on TFP. The political economy literature underscores the fact that protection is endogenously determined through the influence of lobbying groups on policy makers (Lee and Swagel, 1997; Trefler, 1993).

Among the various dimensions, trade patterns affect the nature of protection. Different arguments are made to support this claim. One view is that higher past imports may trigger various interest groups to lobby policy makers for an increased protection in which case NTBs on imports of an industry would rise in response to an increase in imports share of goods in the industry. Based on this argument, NTBs and past import shares would have a positive association. As this may induce retaliation by trading partners, however, policy makers may depend their decision on the importance of imports measured by share of imports in domestic use; and the importance of exports measured by export share in the output of each industry (Lee and Swagel, 1997). The latter argument would imply a reduction in import restrictions as a result of increased export share of an industry, implying a negative association between NTBs on imports of an industry and past export shares in the industry[9]. In line with the above arguments, the current study uses past import, past changes in import and past export (all as a share of GDP) to instrument Non tariff barriers. The theoretical justification to use export share of output in each industry normally requires industry level data on NTB and export shares. Due to data availability, the study employs NTBs, export shares and import shares data aggregated at the country level. As will be seen later in the analysis, NTBs is associated with past export shares and the past import shares significantly with a sign consistent with the theoretical arguments. The additional instrument used is the share of NTBs in the tariff lines where a core-NTB is binding (share of tariff line for which ad-valorem equivalent of NTB is statistically different from zero at 5% level) (Kee *et al*., 2009)[10]. The OTRI-NTB equation below is estimated in the first stage regression:

$$OTRI\_NTB = \gamma_0 + \gamma_1 EXP99_i + \gamma_2 IMP99_i + \gamma_3 dIMP00_i + \gamma_4\, Sh\_NTB_i + X_i + u_i \qquad (7)$$

where, EXP99, IMP99, dIMP00 and Sh-NTB denote export share of GDP in 1999, import share of GDP in 1999, change in import share of GDP in 2000 and the Share of NTBs respectively are the excluded instruments where as X_i represents the included instruments. u_i is an error term.

The remaining two trade policy measures are the tariff barriers of a country on its imports (OTRI-TARIF) and export restrictions by all trade partners (MA-OTRI). The latter is believed to be exogenous and is not influenced by home country's TFP. A country's tariffs on imports are also usually bound by bilateral or multilateral agreements (Lee and Swagel, 1997; Trefler, 1993). Among others, examples of such agreements include GAAT, WTO and the South African Customs Union (SACU). Under such agreements import tariffs are determined externally[11]. For this reason, the current

study also assumes the trade policy index based on import tariffs i.e., OTRI-TARIF, as exogenous[12].

INST, measuring governance quality is the other variable to which feedback effect may run from TFP. Countries with higher TFP may have the incentive and capacity to set up enabling economic environment that enhance the confidence of private investors and households, on which the measurement of institution in the current study basically depends. To account for this feedback effect, the study employs the widely used language instruments from Hall and Jones (1999) i.e., proportion of the population speaking English at birth (EngFrac) and proportion of the population speaking one of the major European languages at birth (EurFrac). Equation 8 below is estimated in the first stage regression for INST:

$$INST = \theta_0 + \theta_1 EngFrac_i + \theta_2 EurFrac_i + X_i + \mu_i \quad (8)$$

where, INST is a proxy for institutional quality (government effectiveness) , EngFrac and EurFrac are as defined above, while X_i denotes the included instruments. μ_i is an error term.

In a situation where, some of the instruments in the first stage regression have a strong effect on both INST and OTRI-NTBs, the predicted values for both endogenous variables will have considerable collinearity in the second stage regression. This creates difficulty in identifying the individual effects from INST and NTBs (Dollar and Kray, 2003). For this reason, the TFP equation is estimated excluding INST in some of the specifications where a test for over identification is used to see if the instruments for OTRI-NTB are not terribly correlated with the excluded INST.

Inference*:* Various diagnostic tests are made to test whether the statistical requirements related to our instruments are met whereby we can make reliable inference.

A test for instrument relevance is made using two methods: First, when either OTRI-NTB or INST is included separately in the TFP estimation, the F-statistics from the first stage regression is used to see if there is a concern for weak identification[13]. Second, when TFP is Estimated controlling for both INST and OTRI-NTB, the F-statistics from the first stage Regression is not informative of whether instruments are weak (Staiger and Stock, 1997) and hence we rely on an alternative method. In the latter case, a test for weak identification is made using a test statistic by Stock and Yogo (2002) which is based on the Cragg and Donald (1993) F-statistics (Stock and Yogo, 2002). Critical values are tabulated in Stock and Yogo (2002) for test of weak identification that depends on the estimator being used, whether the concern is bias or size distortion and the number of instruments and endogenous variables. When the concern of weak identification is bias, the Cragg-Donald (hence forth C-D) statistics can be compared with the critical values that correspond to a certain threshold level of bias from using IV relative to OLS. On the other hand, when instruments are weak, the Wald test for significance of the coefficients of the endogenous variables rejects very often (Baum *et al*., 2007). Thus, if the concern of weak identification has to do with the performance of the Wald test statistics (size distortion), the test statistics is compared with the critical values corresponding to the tolerable level of rejection rate when the standard rejection rate is 5%. To test the presence of weak identification, the C-D statistics is compared to the critical values for size distortion. This will suggest whether to rely on the individual significance of the endogenous variables from the standard t-test. Since the C-D statistics assumes i.i.d., errors, the pagan-Hall hetroscedasticity test result is also reported together with the C-D statistics. If the weak instruments lead to high rejection rate of the Wald test, we cannot rely on the standard individual t-statistics to tell about the individual significance of NTBs in explaining TFP variation. In such a situation, an alternative test which is robust to the presence of weak instruments is used to test whether the endogenous variables are jointly insignificant. The Andersen-Rubin (A-R) test statistics serves this purpose. The A-R test has a null hypothesis that the coefficients of the endogenous variables are jointly equal to zero. Rejection of the null, where both INST and OTRI-NTB enter in to the TFP equation would mean that at least both INST and OTRI-NTB together have a significant effect on TFP. Tests for the validity of the instruments are made using Hansen statistics. The Hansen statistics, which is robust to violation of homoscedasticity, tests whether the excluded instruments are orthogonal to the error term.

ESTIMATION RESULTS AND DISCUSSION

In an effort to test the main hypothesis of whether trade policy has a significant effect on TFP, the 'core' TFP equation is estimated using OLS, 2SLS and LIML[14]. The current section discusses the estimation results. The discussion approach is in such a way that a question that led to estimation of various specifications is raised first, followed by discussion of the results using evidence from the findings.

Estimating the openness equation:

OLS and 2SLS:

Does trade policy affect openness? In line with the hypothesis laid out by the theoretical discussions made before, the current study assumes that trade policy affects TFP mainly through its impact on openness. It would thus be an obvious interest to test if

Table 1: OLS and 2SLS estimation results for the openness equation

Variables	OLS	OLS	OLS	OLS	2SLS	2SLS
Lny	0.14**	0.17***	0.11*	0.13**	0.18***	0.17***
	(2.08)	(3.03)	(1.710)	(2.204)	(2.63)	(2.91)
Otri-Ntb	-0.85***	-0.75***			-2.16***	-1.98***
	(-2.92)	(-3.49)			(-4.468)	(-4.25)
M-Elast	0.16***	0.15***	0.14***	0.14***	0.16***	0.15***
	(8.84)	(11.91)	(9.170)	9.132)	(11.04)	(11.57)
Land Lock	-0.10**	-0.09*	-0.19***	-0.20***	-0.06	-0.06
	(-2.30)	(-1.813)	(-2.892)	(-2.745)	(-1.227)	(-1.43)
Lnpop		-0.10**	0.09*	0.01	-0.17***	-0.14***
Lnsize		(-2.465)	(1.875)	(0.205)	(-3.880)	(-3.36)
		0.01	-0.08***	-0.05	0.04*	0.04
		(0.462)	(-2.987)	(-1.419)	(1.732)	(1.64)
Otri-Tarif			-0.54***	-0.47*	-0.35	
			(-2.706)	(-1.982)		(-1.60)
Ma-Otri			-0.84**	-0.57		
			(-2.706)	(-1.982)		(-1.60)
			(-2.141)	(-1.632)		
Continents	No	Yes	No	Yes	Yes	Yes
Hansen J-			0.63	0.52		
A-R(P-Value)			0.0001	0.0000		
N	52	52	54	54	51	51
R^2	0.750	0.873	0.742	0.777	0.78	0.81

Dependent variable is logTFP; *,** and*** denote significance level of coefficient estimates at 10%,5% and 1%, respectively ; t-statistics based on robust standard errors in parenthesis; a constant is estimated, but not reported; CONTINENTS are as defined in Table 1;P-H refers to Pagan-Hall and tests a null hypothesis of homoscedastic errors; C-D refers to the Cragg-Donald statistics which is compared to the Stock- Yogo (2005) critical values for testing weak identification ; Hansen J-statistics tests a null hypothesis that the excluded instruments are orthogonal to the error term; and A-R refers to Andersen–Rubin test for weak instrument robust inference which tests a null hypothesis that the endogenous variables are jointly insignificant

Table 2: OLS estimation results for the 'Core' TFP Equation

Variables	1	2	3	4	5	6
Otri-Ntb	-1.49***	-1.41***			-1.22**	
	(-3.120)	(-2.969)			(-2.969)	
Inst	0.13***	0.08	0.22***	0.12*		
	(3.451)	(1.509)	(5.219)	(1.729)		
		0.39		0.38	0.66**	0.72***
Latitude		(1.177)		(1.339)	(2.286)	(2.845)
Land Lock		-0.23*		-0.22**	-0.22*	-0.25***
		(-1.799)		(-1.799)	(-1.799)	(-1.799)
Otri-Tarif		0.89*		0.59	0.59	0.11
			(1.968)	-0.93	-0.84	-0.84
			(-0.650)	(-0.650)	(-0.981)	(-2.336)
Continents	No	Yes	No	YES	YES	YES
Yes	53	53	57	57	52	57
R-Squared	0.320	0.443	0.344	0.474	0.431	0.436

Dependent variable is logTFP; *,** and*** denote significance level of coefficient estimates at 10%, 5% and 1% respectively ; t-statistics based on robust standard errors are in parenthesis; a constant, is estimated, but not reported; CONTINENTS are as described in Table 1

trade policy indeed has the expected effect on openness, so that we have a background idea to later interpret as to how trade policy influences TFP. For this reason, as a first pass exercise, an openness equation is estimated controlling for its major determinants and including the three trade policy variables using OLS and 2SLS. The first stage results for the 2SLS estimation are reported in Table 5, where Sh-NTB and EXP99 are the excluded instruments for OTRI-NTB. Both columns show that OTRI-NTB is weakly identified based on the rule of thumb. Thus, the t-statistics in the second stage estimation cannot be used to make inference about the significance of OTRI-NTB. We rather rely on the A-R test to tell whether OTRI-NTB have a significant effect on openness. Table 1 shows the results for the second stage regression.

Columns (1)-(4) show the OLS results, while (5) and (6) are the 2SLS results. Overall trade restrictiveness index based on non tariff barriers (OTRI-NTB) and overall trade restrictiveness index based on Tariffs (OTRI-TARIF), both measuring restriction on imports; and Market Access -overall trade restrictiveness (MA-OTRI), measuring restriction on exports of the home country by all trading partners, are all included in different specifications in Table 1[15]. Real GDP (lny) and import demand elasticity (M-elast) are proxies for domestic demand. Both enter significantly with the expected sign in most of the specifications. Following Frankel and Romer (1999), Population (in POP) and country's land area (in SIZE) are also introduced, with the expectation that both would have a negative impact on the openness of the home country. Population in columns (2) and (5); and country's size in

column (3) are shown to have a significant negative association with openness. NTBs are shown to have a strong negative association with openness in columns (1) and (2). The A-R test in columns (5) and (6) also suggests that NTBs have a significant negative impact on openness. Columns (3) and (4) show a significant negative association of tariff barriers with openness although the finding is not robust in alternative specifications. Particularly, in column (6), once we control for NTBs, the effect of Tariffs on openness becomes insignificant. Likewise, column (3) shows a strong negative association between export restrictions and openness, but the correlation becomes insignificant when continent specific effects are taken in to account in column (4).

Table 1 clearly shows that even after controlling for the major determinants of openness (as can be seen from fairly high R^2), the three trade policy measures have a negative association with openness. Unlike Tariffs and export restrictions which have a less significant and inconsistent effect on openness, NTBs have a consistently significant downward pressure on openness. Other studies that have also shown a relatively stronger effect of NTBs on trade include (Trefler, 1993; Feenstra, 2004; Haveman and Thursby, 2000).

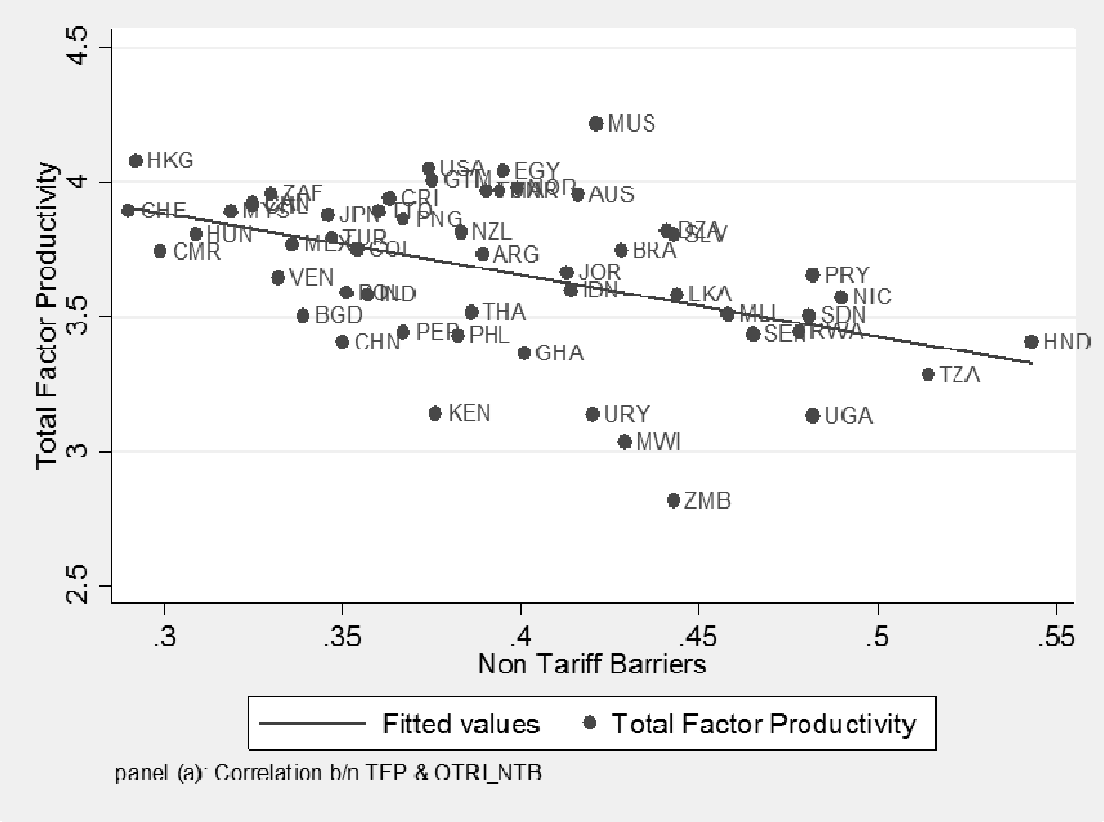
The relatively more restrictive power of NTBs compared to Tariffs suggested by the current evidence can be understood using support from theory. It is argued in Feenstra (2004) that when markets are not perfectly competitive, Tariffs and NTBs aimed at achieving the same level of import would have different impact on price of imports, i.e., NTBs would raise import price at a higher magnitude than do Tariff barriers. This is because in the case of imperfect competition, NTBs allow market power to importing firms to influence the domestic price. Feenstra (2004) also argued that under imperfect competition, where firms could treat their foreign markets as segmented and charge different prices in each market, it is very likely that a foreign exporter will absorb part of the import tariff imposed by the importing country. In such a case, import prices do not rise by the full amount of the tariff. The above two theoretical arguments render NTBs as more restrictive than Tariffs. Feenstra (2004) supplement his second theoretical argument above with an empirical evidence showing that in 1983/84 , Japanese car firms absorb a portion of the import tariffs imposed by the US-of the 21% rise in Import tariffs , only 12% (0.58*21%) was reflected as an addition in US prices , while the remaining 9% was absorbed by Japanese firms. Using industry level data, Trefler (1993) found a very strong downward pressure of NTBs on US imports for 1983. He neglected Tariffs in the analysis assuming that they are dominated by NTBs during the period, emphasizing the restrictive role of the later. Haveman and Thursby (2000), using a disaggregated trade policy and agricultural trade volume data, showed that NTBs have a very larger reduction effect on overall trade volume than do Tariffs. The above theoretical arguments, the subsequent empirical evidences together with the current evidence show that NTBs have a more restrictive role on openness than do Tariffs. As will be seen later in the analysis, the relatively more restrictive role of NTBs on openness will also be reflected in the TFP regression, where trade policy is assumed to influence TFP mainly through openness.

Having demonstrated the negative association of trade policy in general with openness and a significant downward pressure on openness from NTBs, the next question would thus be to ask if trade policy has a strong effect on TFP.

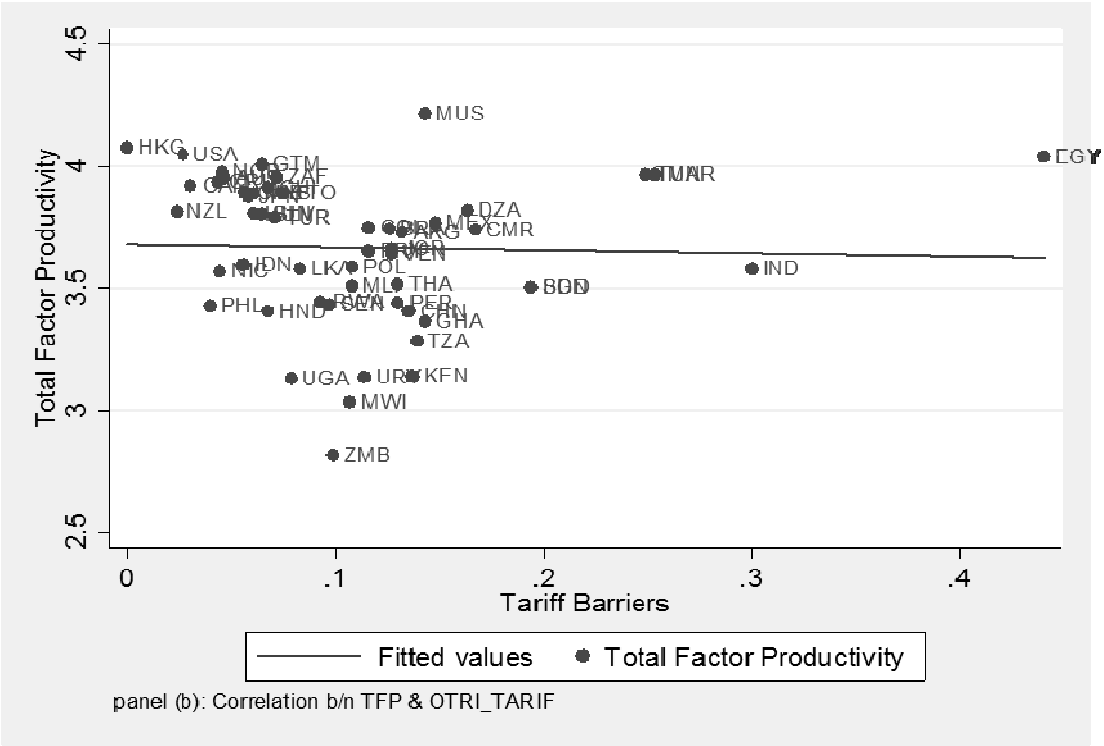
Does Trade policy affect TFP? To examine how Trade policy is associated with TFP and identify the effect of trade policy on TFP, a TFP regression equation is estimated using OLS, 2SLS and LIML. The following section discusses the results for each estimation technique.

Estimating the 'core' TFP equation: OLS: Table 2 shows the results for the OLS estimation where TFP is estimated with and without geography; including institutions and NTBs together and separately; and controlling for Tariffs and export restrictions. NTBs are shown to have a negative association with TFP after controlling for institutions (column 1) and institutions and geography (column 2). In column (5), all the three trade policy variables, i.e., OTRI-NTB and MA-OTRI are correlated with TFP, being correctly signed. Tariffs and export restrictions are not significant, however, as in column (4) where they enter with institutions and geography. While export restrictions are always signed correctly, tariffs mostly enter with the wrong sign sometimes being significant. Columns (1), (3) and (4) show that countries with better governance quality (institutions) have higher TFP, other things being equal. Location farther from the equator is also strongly associated with higher TFP in columns (5) and (6). Due to the tendency to find better institutions with higher latitudes, however, the latter two are highly correlated which can be seen from columns (2) and (4) where both loose much significance compared to the cases where they enter individually. Other things being equal, landlocked countries have lower TFP as suggested by columns (2), (4), (5) and (6).

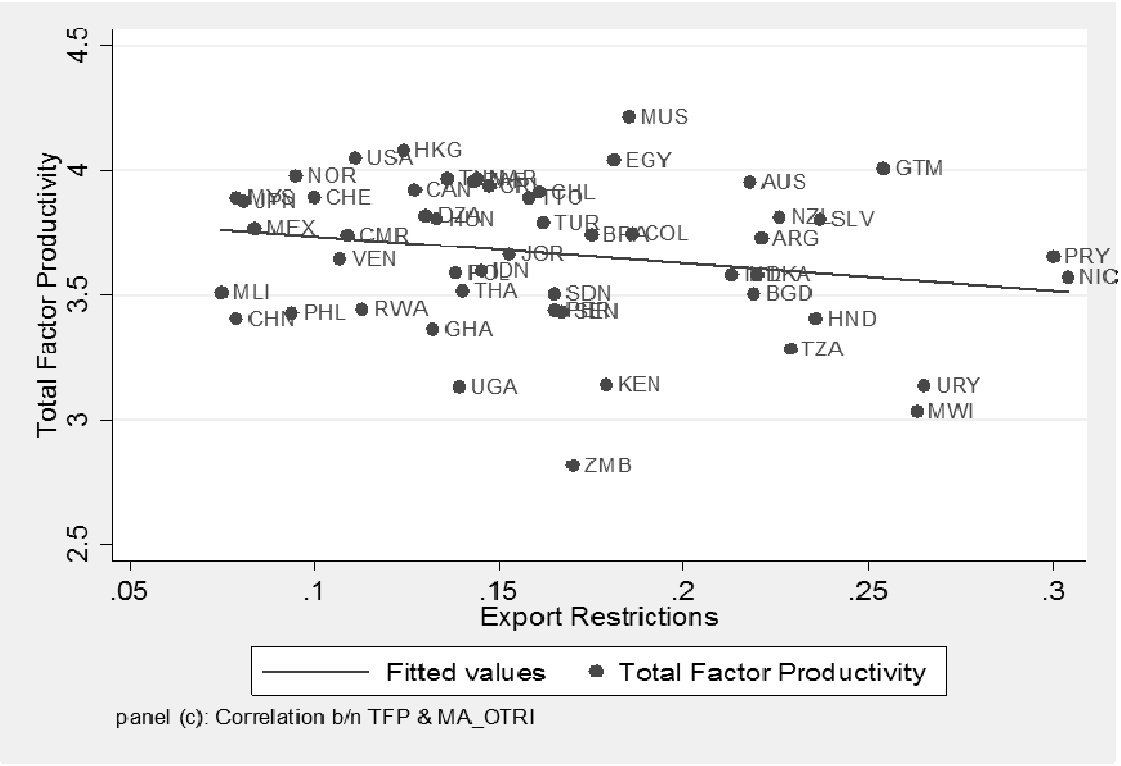
The results in Table 2 show the partial correlations between TFP and its 'core determinants' including trade policy. NTBs have a strong negative association with TFP after controlling for institutions, geography and other trade policy variables. Tariffs and export restrictions, on the other hand, do not have significant correlation with TFP in most of the cases. A graphical


Total Factor Productivity
Non Tariff Barriers
Fitted values
Total Factor Productivity
panel (a): Correlation b/n TFP & OTRI_NTB

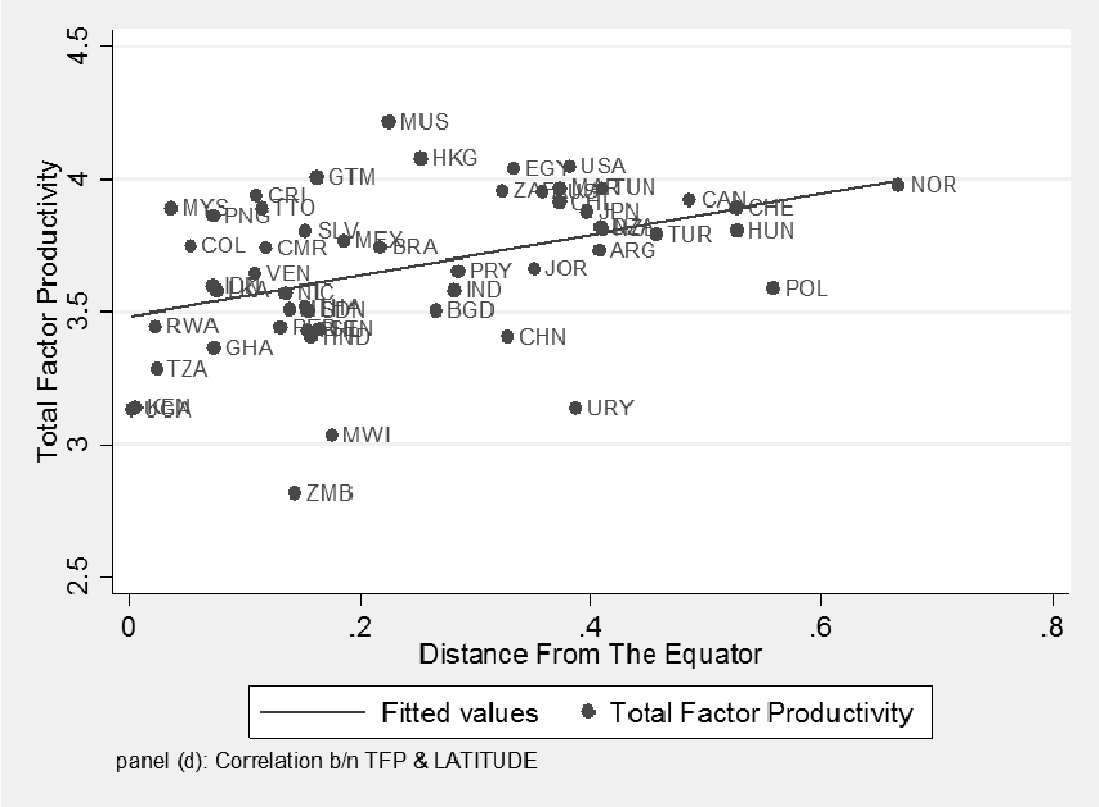
(a)


Total Factor Productivity
Tariff Barriers
Fitted values
Total Factor Productivity
panel (b): Correlation b/n TFP & OTRI_TARIF

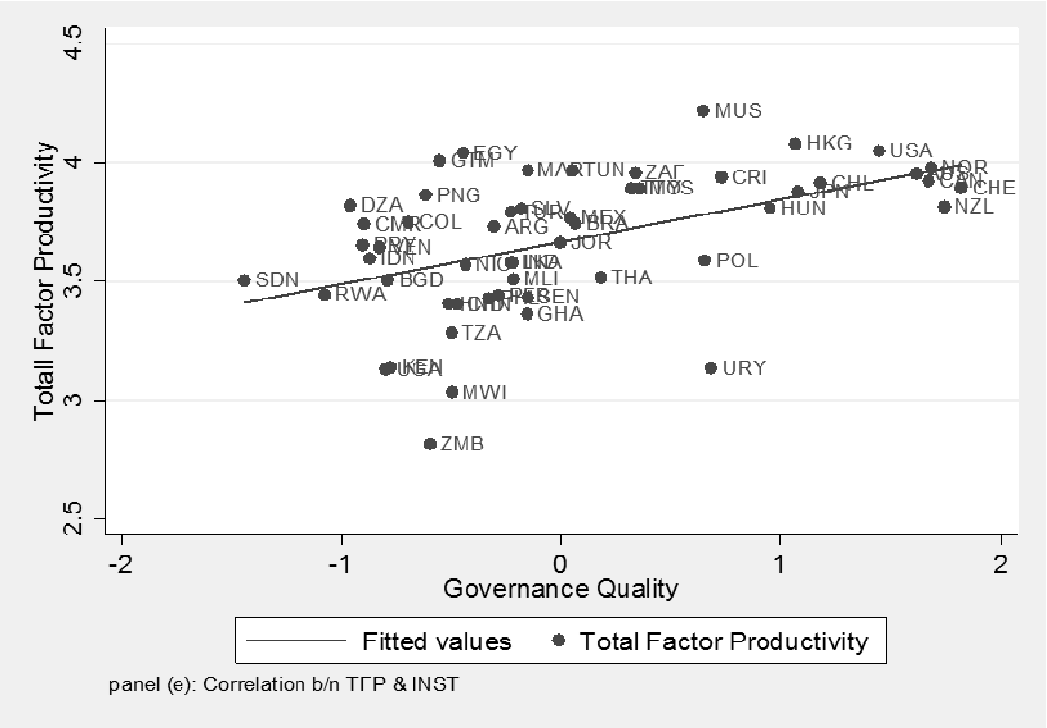
(b)


Total Factor Productivity
Export Restrictions
Fitted values
Total Factor Productivity
panel (c): Correlation b/n TFP & MA_OTRI

(c)


Total Factor Productivity
Distance From The Equator
Fitted values
Total Factor Productivity
panel (d): Correlation b/n TFP & LATITUDE

(d)



(d)

Fig. 1: Simple correlation between TFP and its Core determinants

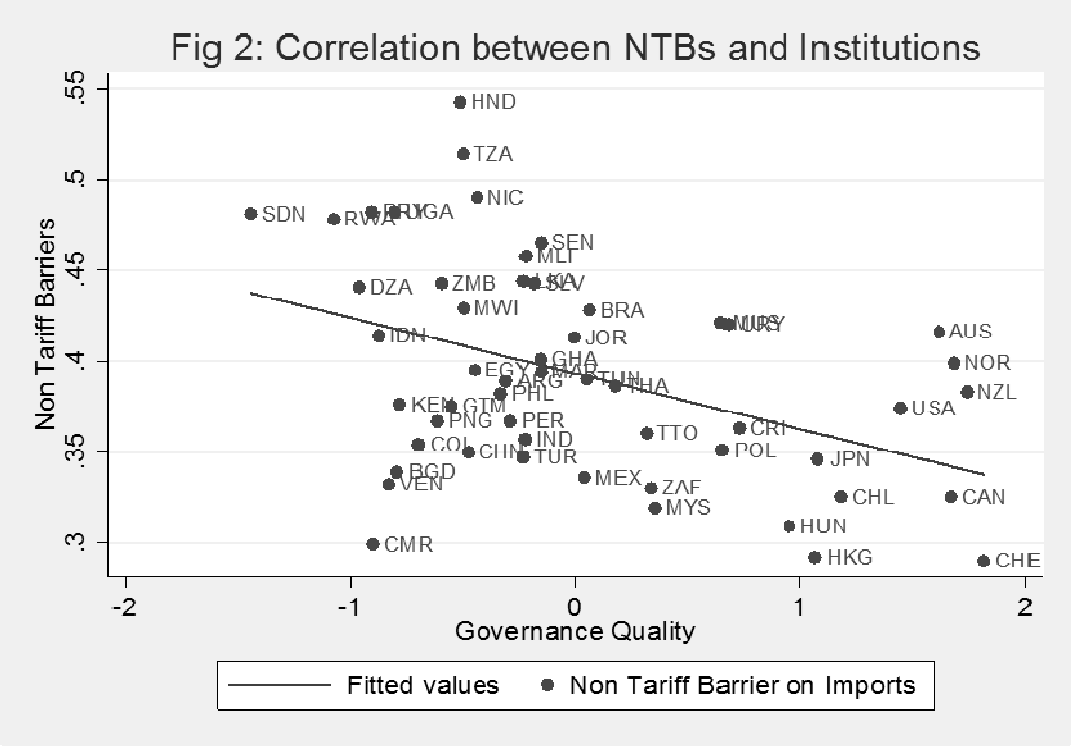


Fig. 2: Simple correlation between NTBs and Institutions (Governance quality)

demonstration of the correlation between TFP and its 'core determinants' in Fig. 1 also tell more or less similar story as the partial correlations in Table 2 do.

Estimating the 'core' TFP equation: 2SLS: The OLS regression results in Table 2 do not tell about the causal effect of OTRI-NTBs on TFP due to the presence of a possible feedback effect from the latter to OTRI-NTB. Likewise, reverse causality may have also run from TFP to INST. To identify the causal effects of NTBs and Institutions on TFP, 2SLS regression is made and the results are reported in Table 3[16].

As in the OLS case, TFP is estimated including INST and OTRI-NTB together and separately; with and without geography. The first two columns show the results when institutions and NTBs are included together, with geography (in column 2) and without geography (in column 1). In both columns (1) and (2), the C-D statistics indicate that we cannot reject a maximum size distortion of 20%. The corresponding critical values needed to reject a maximum size distortion of 20% for 2 endogenous variables and 6 excluded instruments should exceed 9.10 (Stock and Yogo, 2002). The A-R test in both columns rejects the null hypothesis that both INST and OTRI-NTB are jointly insignificant. Thus, we can make the inference that at least both institution and NTBs jointly have a significant effect on TFP. As lower level of institutions(lower governance quality) may result in higher NTBs, it is difficult to see the effect of NTBs when both institutions and NTBs are included together in the TFP equation. This is also reflected in the data as shown in Fig. 2 where countries with higher governance quality (institutions) have lower NTBs compared to those with lower governance quality.

Also, some of the instruments in the first stage regression have a strong predictive power for both institutions and NTBs[17]. In such a case, a considerable collinearity between the predicted values of institutions and NTBs create a difficulty to see the effect of NTBs in the second stage regression (Dollar and Kray, 2002). One way to consider is to estimate TFP excluding

Table 3: 2SLS estimation results for the 'core' TFP equation

Variables	1	2	3	4	5	6
Otri-Ntb	-1.00	-1.14	-1.99***	-1.64***		-1.45**
	(-1.295)	(-1.417)	(-3.161)	(-2.667)		(-2.43)
Inst	0.20***	0.12			0.27***	
	(4.246)	(1.440)			(3.273)	
Latitude		0.31	0.61**	0.56***	-0.09	0.62***
		(0.899)	(2.501)	(2.903)	(-0.299)	(3.16)
Landlock		-0.24*	-0.21*	-0.24**	-0.19**	-0.19**
		(-1.901)	(-1.810)	(-2.349)	(-2.251)	(-2.39)
Otri-Tarif					(2.163)	(-0.336)
Ma-Otri					-0.29	
					(-0.458)	
Continents	No	Yes	Yes	No	No	No
P-H(P-Value)	0.94	0.72	-	-	-	-
C-D Statistic	4.88	3.19	-	-	-	-
Hansen J Stat	4.88	0.13	0.13	0.23	0.52	0.27
A-R (P-Value)	0.00	0.0006	0.0000	0.0003	0.0012	0.0013
N	52	52	52	52	57	51
R^2	0.286	0.434	0.413	0.376	0.394	0.386

Dependent variable is logTFP; *,** and*** denote significance level of coefficient estimates at 10%,5% and 1%, respectively ; t-statistics based on robust standard errors in parenthesis; a constant is estimated, but not reported; CONTINENTS are as defined in Table 1;P-H refers to Pagan-Hall and tests a null hypothesis of homoscedastic errors; C-D refers to the Cragg-Donald statistics which is compared to the Stock- Yogo (2005) critical values for testing weak identification ; Hansen J-statistics tests a null hypothesis that the excluded instruments are orthogonal to the error term; and A-R refers to Andersen–Rubin test for weak instrument robust inference which tests a null hypothesis that the endogenous variables are jointly insignificant

Table 4: LIML estimation results for the 'core' TFP equation

Variables	1	2	3	4	5	6
Otri-Ntb	-0.88	-0.96	-2.18**	-1.70*		-2.24**
	(-0.826)	(-0.792)	(-2.114)	(-1.897)		(-2.13)
Inst	0.21***	0.14			0.27**	
	(2.875)	(1.575)			(2.129)	
Latitude		0.28	0.60**	0.56**	-0.10	0.64**
		(-2.386)	(-2.041)	(-2.491)	(-2.183)	(-2.20)
Otri-Tarif					1.07	-0.17
Ma_Otri					(1.423)	(-0.34)
					-0.44	
Continents	No	Yes	Yes	No	No	Yes
P-H(P-Value)						
C-D Statistic	4.87	3.19	8.67	11.16	7.29	8.34
A-R(P-Value)	0.001	0.02	0.005	0.04	0.06	0.004
Hansen J-Stat	0.30	0.13	0.12	0.23	0.43	0.10
N	52	52	52	52	52	51
R2	0.272	0.427	0.408	0.375	0.364	0.38

The dependent variable is log TFP;*, **and*** denote significance level of coefficient estimates at 10, 5 and1%, respectively; t-statistics in parenthesis; a constant is estimated but not reported; CONTINENTS and diagnostic tests are as described in Table 3

Table 5: First stage regression (Corresponding to the 2SLS results in Table 1)

Variables	Otri-Ntb	Otri-Ntb
Sh-NTB	0.31*	0.34*
	(1.65)	(2.42)
Exp99	-0.002***	-0.002***
	(-3.748)	(-3.475)
Otri-Tarif	-0.1	
	(-1.13)	
Lny	0.07**	0.07**
	(2.21)	(2.13)
M-Elast	0.02**	0.02**
	(2.551)	(2.59)
Landlock	0.02	0.02
	(0.756)	(0.72)
	(-3.04)	(-1.76)
Lnsize	0.02**	0.01
	(2.35)	0.89
Continents	YES	
F	5.46	5.01
N	51	51
R-Squared	0.57	0.58

*, ** and*** denote significance level of coefficient estimates at 10, 5 and 1%, respectively; t-statistics based on robust standard errors in parenthesis; a constant is estimated but not reported

institutions and test whether the excluded instruments for NTBs are not terribly correlated with the omitted institutions. The test for over identification is suggestive in this regard. This is done in columns (3), (4) and (6).

Column (3) and (4) show the results when TFP is estimated controlling for NTBs with and without geography respectively. In both columns the over identification test accepts at 10% level. NTBs in column (3) are however weakly identified based on the rule of thumb. Nonetheless, the A-R test suggests that NTBs have a generally significant impact on TFP. In column (4), when CONTINENTS are not controlled the F-statistics for the first stage regression becomes barely above the rule of thumb level (with F = 11.08)[18]. Thus, column (4) shows a negative significant (at 1 % level) negative effect of NTBs on TFP. More specifically, a country with a 0.01 unit higher OTRI-NTBs compared to another country would have a 1.64% lesser TFP, other things being equal.

Column (6) is similar to (4) except that the former controls for Tariffs. The F-statistics in the first stage regression (column 8 of Table 6) shows that identification is weak but the A-R test suggests that inference is possible. As in the OLS case, Tariffs have a mixed sign. It is significant with a positive sign in column (4). Likewise, export restrictions have a negative but insignificant impact on TFP. The data suggests that countries that face higher restriction on their export also impose higher NTBs on their imports making the two trade policy variables highly correlated (Table 8). For this reason, NTBs and MA-OTRI both become insignificant when they are included together in the 2SLS regression (not reported).

In column (5), institutions are shown to have a strong positive effect on TFP[19]. Similar to the OLS case, when LATITUDE is included with INST(column 2 and 5), it doesn't appear to be significant. On the other hand, in columns (3), (4) and (6), where INST is excluded, LATITUDE becomes significant at conventional levels.

Similar to the OLS case, columns (2) - (6) show that other things being equal, land locked countries have lower TFP than those who have access to the sea. In the theoretical review section, it is argued that trade

Table 6: First stage regression (corresponding to the 2SLS results in Table 3)

Variable	(1)	(2) OTRI-NTB	(3)	(4) Otri_Ntb	(5) TRI_NTB	(6) Otri_Ntb	(7)	(8) Otri_Ntb
Exp 99	0.03**	-0.003***	0.01	-0.002***	-0.003***	-0.003***		-0.003***
	(2.381)	(-5.348)	(1.646)	(-3.729)	(-4.214)	(-4.765)		(-4.585)
Imp 99	-0.02	0.003***	0.003	0.003***	0.003***	0.003***		0.003***
	(-0.389)	(4.325)	(0.540)	(3.000)	(3.313)	(3.617)		(3.53)
Dimp 00	0.001	-0.003**	0.01	-0.003*	-0.003*	-0.003*		-0.003**
	(0.0695)	(-2.178)	(0.571)	(-1.804)	(-1.765)	(-1.981)		(-1.87)
Sh_NTB	-1.01	0.19	-3.04**	0.30**	0.30**	0.30**		0.31**
	(-0.883)	(-2.178)	(0.571)	(-1.804)	(-1.765)	(2.649)		(2.61)
Engfrac	1.71***	0.00	1.22***	0.01			0.71***	
Eurfrac	(6.618)	(0.152)	(4.409)	(0.340)	-0.09**	-0.11***	(2.77)	-0.08***
Latitude	0.48*	-0.02	1.18***	-0.02			0.4* (1.9)	
	(1.716	(-0.984)	(5.870	(-0.954)			2.75***	
				-0.09*				
			(3.585)	(-2.010)	(-2.240)	(-3.097)	(6.71)	(-1.78)
Landloc			-0.02	0.01	0.01	0.01	0.22	0.01
Otri-Tarif			(-0.135)	(0.614)	(0.633)	(0.707)	(-1.35)-	(0.662)
Ma-Otri							3.55***	-0.09
Continents	No	No	Yes	Yes	Yes	No	(-2.99)	(-1.36)
								Yes
F					6.67	11.08	35.88	5.93
N	52	52	52	52	52	5	5	5
R^2	0.517	0.501	0.820	0.605	0.599	0.578	-0.71	0.70

*,** and*** denote significance level of coefficient estimates at 10,5 and 1% ,respectively ; t-statistics based on robust standard errors in parenthesis; a constant is estimatated but not reported.EXP99, IMP99 , dIMP00& Sh-NTB respectively refer to export share in 1999, import share in 1999 , change in import share in 2000 and the share of tariff lines for which there is a core NTB, while EngFrac and EurFrac are proxies for the fraction for the population speaking English and one of the major European languages at birth. NTINENTS are as described in Table 1. Description of the variables can also be seen from Appendix A

Table 7: Summary statistics (Major variables)

Variable	Obs	Mean	S.D.	Min.	Max.
Lntfp	53	3.67	2.81	4.21	
Otri-Ntb	53	0.39	0.05	0.29	0.54
Otri-Tarif	52	0.11	0.07	0	0.44
Ma-Otri	52	0.16	0.05	0.075	0.30
Inst	53	0.02	0.83	-1.44	1.18
Latitude	53	0.24	0.16	0.00	0.66
Landlock	53	0.15	0.36	0	1
Ldcr	53	3.50	1.01	1.24	5.24
Hcap	53	2.22	1.11	4.03	

Table 8: Pair wise correlations (Major variables)

	Lntfp	Otri-Ntb	Otri-Tari	Ma-Otri	Inst	Latitude	Landlock	Ldcr	Hcap
Intff	1								
Otri-Ntb	-0.4534	1							
Otri-Tari	-0.0313	0.0664	1						
Ma-Otri	-0.2146	0.4772	0.0683	1					
Inst	0.5123	-0.4398	-0.4324	-0.2073	1				
Latitude	0.4427	-0.3554	-0.0086	-0.1214	0.6254	1			
Landlock	-0.37	0.2039	-0.1197	-0.016	-0.1027	-0.0501	1		
Ldcr	0.5758	-0.4819	-0.225	-0.2215	0.746	0.5086	-0.2732	1	
Hcap	0.4005	-0.4819	-0.4551	-0.1931	0.8268	0.6442	-0.1188	0.6325	1

Table 9: List of countries in the sample

Low income countries	Middle income countries	High income countries
Bangladesh	Algeria	Australia
Benin	Argentina	Canada
Cameroon	Brazil	Hong kong
Ghana	Chile	Hungary
India	China	Japan
Indonesia	Colombia	New zealand
Jordan	Costa rica	Norway
Kenya	Egypt	Trinidad and tobago
Malawi	El Salvador	United states
Malaysia	Guatemala	
Mali	Honduras	
Rwanda	Mauritius	
Senegal	Mexico	
Tanzania	Morocco	
Uganda	Nicaragua	
Zambia	Papua new guinea	
	Paraguay	
	Peru	
	Philippines	
	Poland	
	South africa	
	Sri lanka	
	Sudan	
	Switzerland	
	Thailand	
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela	

boosts TFP through a number of channels such as through facilitating intra-industry resource reallocation to more efficient firms; technology diffusion, enabling firms acquire new ways of production that makes them competitive; reducing rent seeking activities by enhancing competition. Other things being equal, the fact that the abovementioned benefits of trade are present to a lesser extent in a landlocked country than a one with access to the sea results in a lower TFP in the landlocked country.

Estimating the 'core' TFP equation: LIML: In most of the 2SLS estimations, identification was shown to be weak. In the presence of weak instruments, Limited Information Maximum Likelihood (LIML) performs better than 2SLS[20]. For this reason, the 2SLS estimation of the core TFP equation in Table 3 is re-estimated with the LIML of which the results are reported in Table 4. Using the LIML estimation, we are now able to reject a size distortion of more than 10% or 15% in all columns, which enable us to rely on the standard t-statistics while interpreting the significance of coefficient estimates for OTRI-NTB. In general, the LIML estimates are more or less similar to the 2SLS ones in Table 3 except that the former is less significant[21].

In columns (3), (4) and (6), the C-D statistics imply that we can reject a size distortion of more than 10%. The evidence in columns (3) suggests that after accounting for the effect from geography, NTBs are found to have a negative significant (at 5% level) effect on TFP. In column (6), where Tariffs are now controlled, unlike column (3), NTBs maintain their significant impact while Tariffs are insignificant. Considering column (6), for instance, a country with 0.01 unit higher OTRI-NTB compared to another, has a 2.24% lesser TFP, other things being equal.

The results with regard to other determinants remain more or less similar to Table 3 and thus do not need further explanation. Similar to the OLS and 2SLS estimation, the major finding that stands out with regard to trade policy are the relatively stronger effect of NTBs compared to Tariffs.

Considering the OLS, 2SLS and LIML results, two major findings come out: First, the empirical evidence suggests that imports are more important in channeling the role of trade to TFP than are exports. This is supported by the finding that the export restriction variable is insignificant in most of the cases, while

OTRI-NTB is shown to have a strong downward pressure on TFP. This finding is qualitatively similar to Choudri and Hakura (2000) and Jonsson and Subramanian (2001) in that they found restriction on imports have a significant negative impact on TFP while restriction on export has a relatively little or no role on TFP. In this regard, the current finding can be understood in line with some of the theoretical arguments made in section 2 i.e., higher NTBs impede the process of technology adoption particularly in countries that cannot afford the research and development cost to undertake technological innovation themselves (Rodriguez-Clare, 1996). In a situation where manufacturing firms in most developing countries rely on import of intermediate inputs from the developed world, higher NTBs, raising their cost of production also slows down the process of industrialization. Second, among restriction on imports the empirical evidence suggests that NTBs have a stronger downward pressure on TFP while Tariffs have a mixed, often insignificant impact on TFP. All the OLS, 2SLS and LIML estimations show that NTBs enter always with the correct sign, mostly significant at 1% or 5% levels. The relatively stronger effect of NTBs on TFP can be interpreted using support from theory and other relevant empirical studies: First, the interpretation goes in relation to the relative restrictive power of NTBs and Tariffs on openness through which the former two are mostly expected to impact TFP. In support for the previous empirical evidence in Table 1, where NTBs were shown to have a relatively more restrictive role on openness than do Tariffs, I noted two theoretical arguments in Feenstra (2004): First, when markets are not perfectly competitive Tariffs and NTBs aimed at achieving the same level of imports would have different effect on import price, i.e., NTBs would have stronger effect on import prices. This is because NTBs allow market power for importing firms to influence the domestic price. The second argument was that under imperfect competition, it is very plausible that a foreign exporting firm would absorb part of the import tariff imposed by the importing country in which case import prices do not rise by the full amount of the tariff. Both arguments support a more restrictive role of NTBs compared to Tariffs. The theoretical arguments are also backed by the empirical evidences mentioned before. The second line of argument may work together with the first interpretation to explain the stronger effect of NTBs. In addition to their restrictive role on trade, NTBs are believed to encourage a climate for rent-seeking activities. In countries where import quotas (one type of NTB) are licensed to domestic or foreign firms, the firms are often involved in rent seeking activities to get the license. It is noted in Feenstra (2004) that foreign firms offer a huge amount of bribe to developing country officials to acquire the license. Thus, the 'rent seeking' channel could be taken as supplementary to the 'openness' channel to justify the stronger negative impact of NTBs on TFP.

What do the findings from the 2SLS and LIML estimation tell in relation to the main question posed in the study? In most of the 2SLS estimation, OTRI_NTBs was found to have a generally significant negative effect on TFP. Moreover, the LIML estimation has shown a significant (at 5% and 10% levels) negative effect of NTBs on TFP. Thus, the evidence suggests that differences in the levels of import restrictions by NTBs explain significant differences in TFP across countries. On the other hand, differences in the levels of import restrictions by tariffs and export restrictions by tariffs do not explain significant variation in TFP across countries.

CONCLUSION

This section summarizes the findings in relation to the major questions posed in the study.

Trade Policy, particularly import restrictions by NTBs have a significant downward pressure on TFP. On the other hand, import restrictions by Tariffs and restrictions on a country's export through tariff by all trading partners do not have a strong influence on TFP. Consistent with the theories that link trade with TFP, the study showed that the strong effect of NTBs on TFP can be understood in relation to its strong restrictive impact on openness. Likewise, the study also showed that the insignificant effect of Tariffs and export restrictions on TFP could well be understood in relation to their less restrictive impact on openness. Thus, in general the findings suggest that variation in restrictiveness of trade policy, particularly non-tariff barriers, explain significant TFP differences across countries.

Moreover, the findings also suggest that imports are more important in channeling the TFP gains of trade than are exports. Nonetheless, the study does not believe that all imports are equally important for TFP. Accordingly, a reduction in NTBs on different types of imports has different impact on TFP. No attempt is made, however, to examine the role of industry/product specific NTBs on TFP, which makes the policy implication that can be drawn from the findings a general one, i.e., countries should reduce NTBs on their imports to allow a gain in TFP associated with trade. Besides, the findings suggest that countries substitute the more restrictive and less transparent trade policy, i.e., NTBs with the less restrictive and more transparent trade policy, i.e., Tariffs. This is plausible in the sense that the strong resistance particularly on the side of developing countries to reduce tariffs is partly because it accounts for a large share of government revenue. This makes it difficult to reduce or abandon tariffs without expanding the tax base or other sources of revenue, which is not feasible in the short run.

Moreover, tariffs can be used to exercise a reasonable level of protection, leaving some space for competition while NTBs on the other hand may unreasonably protect highly inefficient domestic firms. Thus, regional and international trade agreements should consider a reduction in NTBs in general and replacement of NTBs with Tariffs in particular.

The evidence also suggests that more restrictive NTBs in general are a regular feature of trade policy in countries with low governance quality, making the distortionary effect of NTB significantly intertwined with lack of good governance. Without improving the political institutions that set incentive for governments to adopt growth enhancing policies, it would still be in the interest of undemocratic governments to maintain higher NTBs. This is especially true when seen in light of the fact that NTBs create a less transparent climate for rent seeking whereby the officials in some developing countries divert huge public resources for their private use.

APPENDIX A

Data description and sources:

- EngFrac = Proportion of the population speaking English at birth; source: Hall and Jones (1999).
- EurFrac = Proportion of the population speaking one of the European languages at birth; source: Hall and Jones (1999).
- EXP99 = Share of export in GDP in the year 1999; source: World Development Indicators (2008) CD-ROM.
- dEXP00 = Change in Export share in 2000 –Export share in 1999; source: World Development Indicators (2008) CD-ROM.
- Hcap = Human capital in the year 2000, computed as shown in Appendix B; source: Barro and Lee (2000).
- IMP99= Share of import in GDP in the year 1999; source: World Development Indicators (2008) CD-ROM.
- INST= Institution used as proxy for governance quality and measured as the average of six governance indicators; source: Kaufman *et al*. (2009).
- LATITUDE = Absolute latitude (Distance from the equator); Source: Hall and Jones (1999).
- LANDLOCK = measures access to the sea and takes a value of 1 if a country is landlocked ; and 0 otherwise; Source: http:/ /www. wisegeek. com/ what-countries-are-landlocked.htm
- OTRI-NTB = Overall trade restrictiveness index based on ad-valorem equivalent of non tariff barriers. Source: Kee *et al*. (2009).
- OTRI-TARIF = Overall trade restrictiveness index based on tariffs; Source: Kee *et al*. (2009)
- Sh-NTB = Share of Non tariff barriers: measures the share of a core non tariff barrier in the tariff lines where a core non tariff barrier is binding; Source: Kee *et al*. (2009).
- LogTFP = Natural logarithm of Total factor Productivity. Computed as shown in Appendix b.

APPENDIX B

Formal derivation of variables:

Total Factor Productivity (TFP): Production is assumed to take place using the technology:

$$Y_i = K_i^{\alpha}(A_i H_i)^{1-\alpha} \tag{9}$$

where, Y_i, K_i, A_i and H_i denote real GDP , physical capital stock, labour augmenting productivity (TFP) and human capital stock, respectively.

Physical capital stock K_i is calculated using the perpetual inventory method. Human capital in each country is given by:

$$H_i = e^{\emptyset(Ei)} L_i \tag{10}$$

where, an average worker in each country is assumed to have Ei years of schooling. $\emptyset(Ei)$ is a functional form governing the impact of schooling on human capital, while L_i denote number of workers. Raising both sides of (9) by a power of $\frac{1}{1-\alpha}$ gives us:

$$Y_i^{\frac{1}{1-\alpha}} = K_i^{\frac{\alpha}{1-\alpha}} A_i H_i \tag{11}$$

Dividing both sides of (11) by $L_i Y_i^{\frac{\alpha}{1-\alpha}}$, real GDP per worker can be decomposed in to capital intensity , human capital per worker and the TFP term as in (12) below:

$$y_i = \left(\frac{K_i}{Y_i}\right)^{\frac{\alpha}{1-\alpha}} h_i A_i \tag{12}$$

where, $y_i = \frac{Y_i}{L_i}$; $h_i = \frac{H_i}{L_i}$ are output per worker and human capital per worker respectively. Assuming $\emptyset(Ei)$ a piece wise linear from mincerian wage regression and using (10), human capital per worker can be given as:

$$h_i = exp\left(\emptyset_p s_p + \emptyset_s s_s + \emptyset_\tau s_\tau\right) \tag{13}$$

$\emptyset_p$, $\emptyset_s$ and $\emptyset_\tau$ denote Mincerian returns for an additional year of schooling in the primary, secondary and tertiary schooling levels. Using data for Y_i, L_i , K_i , available years of schooling ; and assuming values for the capital share parameter and Mincerian returns, it is possible to compute Total Factor Productivity (A_i). Following HJ, a value of one-third is assumed for the capital share parameter; and mincerian returns to schooling are assumed to be 13.4%, 10.1% and 6.8% for primary, secondary and tertiary schooling levels, respectively.

Trade policy variables:

OTRI-AVE: Ad-valorem equivalent of NTBs: It is a price equivalent of NTBs. The ad-valorem equivalent of NTBs is constructed by transforming the quantity impact of NTBs in to price equivalents. An ad-valorem equivalent is defined as, $ave = \frac{dlog(P^d)}{dNTB}$, where, P^d is domestic price. It is derived by making use of import demand elasticity and the quantitative impact of NTB in an import demand function as shown below:

The quantity impact of NTB can be given by:

$$\frac{dlog(q_{n,c})}{dCore_{n,c}} = \frac{dlog q_{n,c}}{(dlog P^d_{n,c})} \frac{dlog(P^d_{n,c})}{dCore_{n,c}} = \varepsilon_{n,c} ave^{Core}_{n,c} \tag{14}$$

where, $q_{n,c}$ are import quantities ($m_{n,c} = P_n^w q_{n,c}$) ; $Core_{n,c}$ is a binary dummy variable that indicates the presence of a core NTB. P_n^w is the exogenous world price of imports, here assumed to be unity; and $ave_{n,c,k}$ is the ad-valorem equivalent of NTB of type k imposed on good n in country c.

Solving (14) for $ave_{n,c}$s yields:

$$ave^{Core}_{n,c} = \frac{1}{\varepsilon_{n,c}} \frac{dlog q_{n,c}}{dCore_{n,c}} = \frac{e^{\beta^{Core}_{n,c}} - 1}{dCore_{n,c}} \tag{15}$$

where, $\beta^{Core}_{n,c}$ is a parameter in an import demand equation and measures the impact on the import of good n in country c of a core NTB (Kee *et al*., 2009).

Once $ave^{Core}_{n,c}$ is obtained, it can be used together with ad-valorem tariff to compute OTRI.

Define $T_{n,c} = ave_{n,c} + t_{n,c}$ as the overall protection a counry imposes on its imports; where $ave_{n,c}$is the ad-valorem equivalent of

NTB and $t_{n,c}$ is the ad-valorem tariff. Overall trade restrictiveness index in country c is defined as:

$$\text{OTRI}=\frac{\sum_n\left(dm_{n,c}/dp_{n,c}\right)T_{n,c}}{\sum_n\left(dm_{n,c}/dp_{n,c}\right)}=\frac{\sum_n m_{n,c}\varepsilon_{n,c}T_{n,c}}{\sum_n m_{n,c}\varepsilon_{n,c}} \quad (16)$$

Here, OTRIc is defined as the weighted sum of protection levels. Weights in the first equality are the slope of import demand function while in the second equality they are given by import levels and elasticity of import demand. The definition after the first equality solves the downward bias in restrictiveness of trade policy associated with the use of import weighted average Tariffs in the presence of prohibitive tariffs. The bias can be seen in the definition after the second equality.

The OTRI-TARIF is computed using (16) and$t_{n,c}$, the ad-valorem tariff instead of $T_{n,c}$. The measure of OTRI-NTB is the ad valorem equivalent of NTBs computed using (15).

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Endnote:

1: In 1991 for example, industrial countries accounted for about 96% of the world R&D. Within the OECD, the 7 largest economies accounted for 92% of R&D in the same year (Coe *et al* 1997).

2: See for example Hall and Jones (1999) for similar specifications.

3: Appendix B shows a formal definition of the two trade policy variables, i.e., OTRI-NTB and OTRI-TARIF

4: Data on restrictiveness of domestic trade policy on exports was not available among the family of Trade Restrictiveness Indices. Nevertheless, the use of MA_OTRI allows us to draw indirect lesson as to the effect of export restriction on TFP. This is because; the qualitative impact of foreign restriction on home country's exports is similar to that of domestic restriction on a country's exports.

5: Measuring institutional quality as a simple average of the governance indicators implicitly assumes equal contribution to TFP from each indicator. This is used (though may not be appropriate) because, judging otherwise would be speculative. Other studies that use similar method of measuring institutional quality include Easterly (2003).

6: This view is reflected in the data where Latitude has high correlation with the measure of institution and other policy variables (Table 5).

7: The country classification is according to World Bank (2009). Table 9 reports the country list.

8: Description of data and source for the remaining variables is also made In Appendix A.

9: Rodrik (1995) also noted that the investment subsidies such as lifting import restriction to Taiwanese and Korean firms was in practice contingent on the firms' ability to compete in the world market.

10: This variable has a considerable level of correlation with NTB by construction and is used to supplement the above mentioned instruments. The use of this instrument fulfills the statistical requirement of being a source of exogenous variation for NTB.

11: In fact, Lee and Swagel (1997) uses import tariffs as part of their instruments to identify the impact of NTB on imports.

12: Also, the endogeneity test where the null considers OTRI-TARIF as exogenous is always accepted (not reported).

13: The rule of thumb is that an F-statistics of <10% is a cause for concern (Staiger and Stock, 1997)

14: The 'core TFP equation' refers to the TFP equation including the proxy measures for trade policy, institutional quality, latitude and whether a country is landlocked.

15: Note that throughout the paper the terms 'NTBs', 'Tariffs' and 'export restrictions' are used interchangeably with OTRI-NTB, OTRI-TARIF and MA-OTRI, respectively to reduce technicality.

16: The results for the first stage regression are reported in Table 6. EXP99, IMP99, dIMP00 and Sh-NTB are used to instrument OTRI-NTBs while EngFrac and EurFrac are the instruments for INST.

17: This can be seen in columns 1 and 2 of Table 4 where EXP99 is significant in both INST and OTRI-NTB equations; and in columns (3) and (4) where Sh-NTB and LATITUDE enter significantly for both INST and OTRI-NTB equations.

18: See column 6 of Table 4. For 1 endogenous variable and 4 excluded instruments this value can be used to reject a size distortion of more than 20 % (Stock and Yogo, 2002) Table 8).

19: Column (7) of Table 6 also shows that identification is strong.

20: Under the assumption of i.e., Errors, LIML is unbiased estimator of second order in the presence of weak instruments (Stock and Yogo, 2002; Hahn and Hausman, 2004). As a result the critical values for weak identification test in the case of LIML estimation are smaller compared to the 2SLS estimation (Stock and Yogo, 2002).

21: The fact that the LIML estimator does not have a sample mean makes it more dispersed than the 2SLS estimator (Hahn and Hausman, 2004).