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"Does Africa trade less than it should and why? The role of market access and domestic factors".

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Does Africa trade less than it should and why? The role of market access and domestic factors

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1. Introduction

Trade as a means of poverty alleviation in Africa has assumed greater importance especially after the initiation of the Doha Round for development. In recent years, there has been an increasing skepticism on the effectiveness of foreign aid (Easterly 2006). Trade and aid have often been viewed as substitutes for one another. But recently "aid for trade" has gained prominence which views aid and trade as complements rather than substitutes. Proponents of "aid for trade" argue that the capacity of developing countries to take advantage of any market access gains in the Doha round is currently hampered by several supply side bottlenecks and costs, administrative constraints, and poor institutions. Aid for trade, thus, refers to additional aid devoted to tackling the trade-related constraints and adjustment costs in developing countries (Evenett 2005).

In debates about globalization, the utilization of trading opportunities by Africa has always been under contention. In terms of the share of Africa in world exports, there has been a sharp decline over time. From a share of about 5.5% in 1975, the share of African exports in world exports fell to about 2.5% in 2002 (World Development Indicators 2005). At one level, this declining share points to an increasing marginalization of Africa in world trade. At a deeper level, this raises the question whether the observed pattern is consistent with the changing determinants of exports from Africa.

Determinants of exports imply the level of predicted trade that depends upon income levels of trading partners and trading costs between countries. Hence, if the income growth in Africa is relatively slower than the rest of the world, then the observed patterns would be consistent with expected trade and hence not amount to under-

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trading. Similarly, depending upon whether the trade barriers are higher or lower than the rest of the world, Africa would be predicted to trade lower or higher than the rest of the world.

With under-trading defined relative to the predicted trade which is model and data specific, the evidence from the existing literature on trading status of Africa has been mixed. The question whether or not Africa has been under-trading has produced different answers depending on the region (developed country to developing country or developing country to developing country trade for example) considered, the time period included or the methodology used for analysis.

Sachs and Warner (1997) argue that Africa has missed out on globalization. World Bank (2000) states that Africa's loss in world trade has cost it almost $70 billion a year, reflecting a failure to diversify into new products as well as a falling market share for traditional goods. Subramanian and Tamirisa (2001) also find support for under-trading by Africa. Dividing Africa into Central and West Africa (Francophone Africa) and Eastern and Southern Africa (Anglophone Africa), they find that Francophone Africa is a serious under-trader and the degree of under-trading has increased overtime.

On the other side of Africa trade pessimists, there exists a relatively well developed literature that argues Africa has been trading in line with predicted trade or even has been over-trading (trading more than its predicted trade). In this view, Africa has taken advantage of trading opportunities in line with changes in factors determining trade. In a pioneering study, Foroutan and Pritchett (1993) showed that there was no evidence that intra-sub-Saharan Africa (SSA) trade flows were differentially low either because of policy or infrastructural weakness and observed trade tallied with levels of predicted trade. The low degree of trade among the sub-Saharan African countries could be explained by the countries' low levels of GDP.

According to Rodrik (1998), Africa participates in international trade as much as can be expected according to international benchmarks relating trade volumes to income levels, country size, and geography. Coe and Hoffmaister (1998) supported Rodrik's results by estimating a gravity model of bilateral trade between developing countries and industrial countries. Their results indicate that in the early 1990s, Africa actually overtraded compared with developing countries in other regions. However, Coe and Hoffmaister (1998) do point to a trend decline in African north-south trade over the past 25 years in marked contrast to the trend increase in Latin America and the broadly stable pattern in Asia. Subramanian and Tamirisa (2001) critique Coe and Hoffmaister (1998) for not controlling for a key variable in their analysis — the preferential trading arrangement between EU and Africa under the Lome Convention.

Thus, the issue whether Africa has been under-trading or not in an increasingly globalized world is highly debated. Several papers as discussed above have focused on identifying whether or not Africa under-trades but not on exploring the causes for under-trading by Africa if established in their analyses.

In this paper we revisit the issue of under-trading by Africa. In defining under-trading, it is important to get correct levels of predicted trade as they serve as the benchmark. Predicted trade depends fundamentally on trade costs of which trade barriers (like tariffs) are a significant part. Thus, it is crucial that measurement of market access for countries be accurate.

We significantly improve upon the existing measures of trade protection by employing the latest and comprehensive MAcMap database on trade protection due to Bouët et al (2007). The highlight of this dataset is that it captures a more extensive set of trade protection measures viz. ad valorem equivalent (AVE) of specific tariffs, AVE of tariff rate quotas and AVE of anti dumping duties and it allows also to capture country specific levels of market access. With this dataset, we first evaluate the levels of existing market access for Africa. By measuring trade protection only partially in terms of ad valorem tariffs, existing studies on trade by Africa and for that matter all studies that rely on trade protection lend themselves to serious measurement errors. Not only are the levels of trade protection significantly different with and without this larger set of trade barriers, more importantly the distribution of protection across countries gets altered in a significant way as well.

We find that within Africa, market access varies widely across countries even being part of the same preferential arrangement mainly owing to the composition of exports. This challenges the custom of using dummy variables for capturing the effect of membership in preferential trading arrangements in a trade flows equation. Drawing on this result we capture the country specific market access in our empirical analysis by using the actual bilateral tariffs (taking into account the effect of all preferences and measuring protection with an extended set of trade barriers) while testing for under-trading by Africa. Our time period of analysis (2001 and 2004) is able to include the effect of two large scale preferential arrangements for Africa, Everything but Arms Initiative (EBA) of EU and the African Growth and Opportunity Act (AGOA) of the United States in the second time period. In our measure of protection we also include the ad valorem equivalents of non-tariff barriers (NTBs) developed recently by Kee et al (2006).

Our first contribution in this paper is addressing the question whether or not Africa is an under-trading continent? In addressing this question, it is also important that the results be robust to different specifications of the gravity model that we use to explore under-trading. The different specifications follow from the ways in which we account for zero trade flows. Treating zero trade as a corner solution or the sample of countries with positive trade

as a selected sample, we use Tobit and Heckman specification of the gravity model to empirically account for zero trade.

We find robust evidence that globally Africa is an under-trader, exporting less than its predicted level. However, globally Africa is not an under-importer. More importantly, under-exporting by Africa does not hold in a sample of exporting countries that are low income. This hints at factors associated with countries being low income that could potentially explain under-trading by Africa. Motivated by the idea of trade related infrastructure being an important determinant of trade and the evidence that Africa lags behind rest of the world in its quality of infrastructure, we do find that accounting for transport and communication infrastructure in exactly the same sample of countries where Africa emerges as an under-trader, the under-trading by Africa does get reduced and in some specifications it vanishes altogether.

We find that trade facilitating infrastructure like transport and communication at least partially explain the under-trading by Africa. The role of infrastructure in enhancing trade has been widely discussed in policy circles and in descriptive literature but has rarely been studied rigorously in the formal literature. Bougheas et al (1999) and Francois and Manchin (2006) estimate the effect of infrastructure on trade by including infrastructure linearly in gravity model. Quantifying the true impact of infrastructure on trade however is difficult mainly because of the interactive nature of different types of infrastructure. Thus, the impact of greater telephone connectivity depends upon the supporting road infrastructure. Most importantly, the precise way in which way this dependence among infrastructure types occurs is unknown to the researcher and there does not exist any a priori theoretical basis for presuming the functional forms for such interactions.

In this paper, we employ a semi parametric variant of the gravity model that allows for (1) unknown nonlinear impact of infrastructure on trade and (2) complementarity among several infrastructure variables. By estimating this flexible model we believe that we are nearer to estimating the true marginal effect of infrastructure on trade. Empirically, we find that the marginal impact of a given infrastructure varies with the level of that infrastructure and the level of other infrastructure. For a good number of African countries, we find that marginal impacts of infrastructure on trade are significant and compare favorably with other countries especially with other developing countries.

Our results further indicate an important property of infrastructure. We find evidence for complementarity across different types of infrastructure. The established complementarity across types of infrastructure has an important policy implication i.e. higher returns from investment in infrastructure can be realized when several infrastructure are developed jointly rather than in isolation.

The paper is organized as follows. Section 2 discusses the data and summary statistics for the econometric analysis in section 3 based on gravity models. Section 4 presents the results. Section 5 discusses the semi parametric model and the results on the impact of infrastructure on trade for Africa. Section 6 concludes.

2. Data and descriptive statistics

The bilateral export data are obtained from the dataset BACI compiled by Centre d' Etudes Prospectives et d' Informations Internationales (CEPII). For the 2001 and 2004 trade flows, we average the data over three time periods (1998-2001) and 2002-2004 respectively) to control for abnormal trade flows. The distance between the trading partners and whether or not countries share a common border have also been obtained from the CEPII dataset. The distance measure here is the bilateral distances between the biggest cities of the two trading partners weighted by the share of the city in the country's population.

We use the data on trade protection from the MAcMap database for the two time periods viz. 2001 and 2004. Our GDP data are obtained from the World Development Indicators of the World Bank. The information on the transport and communication infrastructure variables is also obtained from the World Development Indicators. We use the transport variable road density defined as the total road length as a proportion of land area and as a proportion of the total population respectively. We also use the number of aircraft departures per capita as an additional variable for transport infrastructure. Communication infrastructure is measured in terms of the phone density in the country viz. mobile and fixed lines per one thousand people.

Trade costs both natural (like distance) and man-made are captured as multilateral trade resistance terms. Multilateral distance for country i is constructed as a weighted sum of the distance from country i to all k countries weighted by their GDPs. Thus, distance to a richer country gets a higher weight. In this sense, the measure captures the remoteness of country i from the world economy. In terms of multilateral distance, Sweden, Denmark, and Norway are the least remote countries in the world while Chile, Australia and New Zealand are the most remote.

The import duty is a bilateral tariff, from the MAcMap database. It includes all preferential schemes and regional agreements prevailing in 2001 and 2004 and other measures of bilateral protection (specific tariffs, tariff rate quotas and anti-dumping duties). Like multilateral distance terms, protection is also measured as a multilateral resistance term by including relative protection variables. The relative tariff on imports of i from j is the bilateral tariff divided by the average tariff by which i taxes world imports. The relative tariff on exports of j to i is the bilateral tariff divided by the average tariff faced by j on its exports to the rest of the world. We also include the ad valorem equivalents of NTBs compiled by Kee et al (2006). These measures have not been computed at a bilateral level and are available only for selected countries.

The summary statistics for the data are reported in Table 1 below. Table A.2 in the appendix presents the same descriptive statistics for the low income exporter sample.

Table 1: Summary of the data in the full sample

Variable	Mean (2001)	Std. Dev. (2001)	Mean for African countries 2001	Std. Dev. for African countries 2001	Mean (2004)	Std. Dev. (2004)	Mean for African countries 2004	Std. Dev. for African countries 2004
Log Distance	8.79	0.83	8.71	0.71	8.84	0.80	8.73	0.71
Contiguity	0.01	0.11	0.01	0.13	0.02	0.15	0.06	0.25
Common Language official	0.17	0.38	0.25	0.43	0.16	0.37	0.18	0.39
Common language (ethnic)	0.17	0.37	0.21	0.40	0.15	0.36	0.18	0.38
Landlocked	0.14	0.34	0.26	0.44	0.19	0.39	0.25	0.43
Bilateral tariff	0.17	0.26	0.16	0.28	0.14	0.22	0.16	0.28
Relative Export protection	0.07	0.04	0.06	0.04	0.06	0.04	0.06	0.05
Relative Import protection	0.10	0.10	0.10	0.09	0.09	0.06	0.09	0.06
NTB protection (data for 2004)	0.07	0.07	0.07	0.07	0.06	0.05	0.06	0.06

Comparing the full sample to the low income exporter sample, on an average, low income countries export to countries nearer to them than the rest of the world. Also, a much greater proportion of the exporting countries in the low income sample are landlocked and a slightly higher percentage of the trade occurs with countries that share a common border. Also the level of bilateral protection is higher for the low income exporters than the rest of the world.

Table 2: Descriptive statistics on infrastructure (full sample)

Variable	Mean (2001) for non-African countries	Std. Dev. (2001) for non-African countries	Mean for African exporters 2001	Std deviation for African exporters 2001	Mean (2004)	Std. Dev. (2004)	Mean for African exporters 2004	Std deviation for African exporters 2004
Aircraft departures per capita	0.01	0.08	0.007	0.03	0.01	0.06	0.001	0.04
Road length per unit of population	0.007	0.008	0.003	0.005	0.007	0.007	0.004	0.007
Road length per unit of land area	0.84	1.33	0.13	0.16	0.75	1.31	0.14	0.17
Percent of road paved	58.87	32.53	27.94	24.55	54.65	32.81	26.60	24.15
Mobile per thousand people	79.75	116.65	4.10	11.42	317.02	291.33	31.62	54.91
Main line per thousand people	229.11	227.31	28.31	49.08	192.44	212.82	34.68	64.21

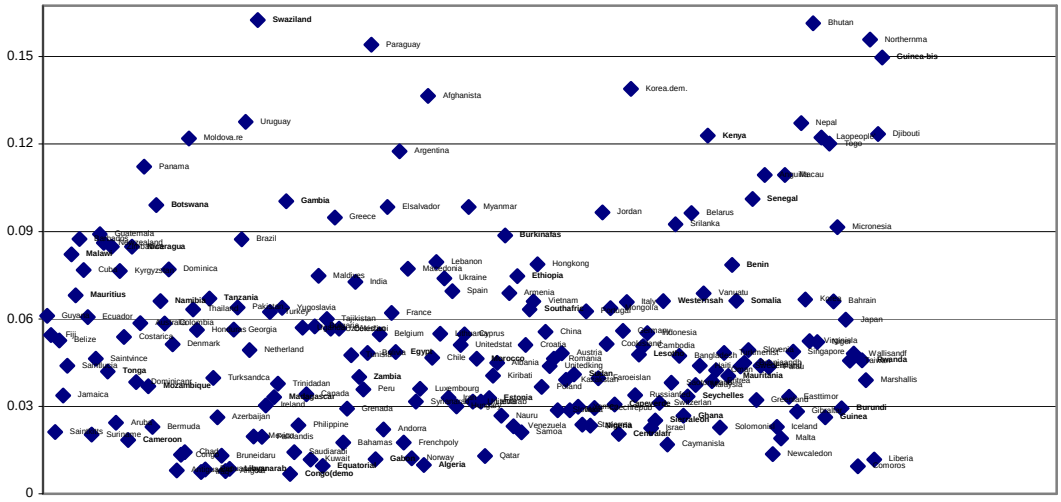
Tables 2 present summary comparisons across different types of infrastructure between Africa and the rest of the world. The same kind of comparison for the low income exporter sample is presented in the table A.3 in the

appendix. Clearly, the level of infrastructure in both the 2001 and 2004 sample is lower for Africa. Road and air infrastructure are slow to change and one does not expect significant changes between 1998 (the period for which the infrastructure for 2001 is included) and 2002 (the period for which the infrastructure for 2004 is included). However there has been a quantum jump in the mobile infrastructure and it has risen significantly across all countries including the African countries.

Measurement of market access for Africa in world trade

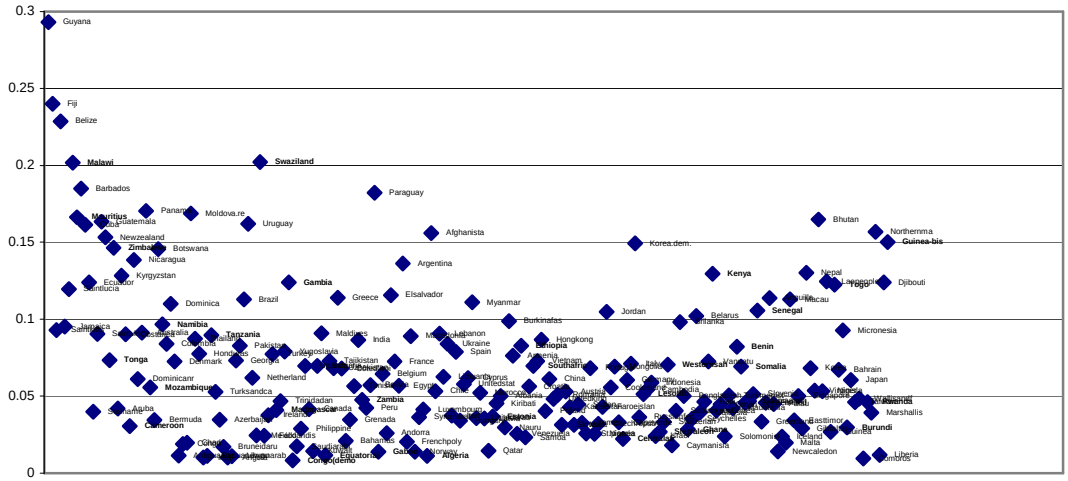
An important concern in the existing studies that estimate trade flows relates to the error in measuring market access. The problem of measurement error in market access is complex owing to different distribution of protection based on the breadth of included measures of protection. Figures 1 and 2 compare the distribution of applied protection by the countries in the sample when only ad valorem tariffs are included and when specific tariffs are also included. As is evident, the distribution of applied protection changes significantly depending upon the breadth of included measures of protection.

Figure 1: Distribution of applied protection on exports (Ad valorem tariffs only)



Source: MacMAP 2001

Figure 2: Distribution of applied protection including both ad valorem and ad valorem equivalent of specific tariffs



Source: MacMAP 2001

Table A.1 in the appendix presents the average duties faced on the exports by different continents. Europe enjoys the best access to foreign markets on an average. The African market access is however better than America, Asia and Pacific. Again, among African countries, there are wide disparities in market access. 21 African countries have a better access than the world average, with 11 countries facing a duty on exports of less than 2%: Algeria, Angola, Bostwana, Central Africa, Chad, Congo D.R., Equatorial Guinea, Gabon, Lesotho, Liberia and Libya. In fact, 32 countries have bad access to foreign markets as compared to the world average, with 13 countries facing an average duty on exports greater than 10%, and Malawi facing a stiff average of 23.1% tariff on its exports.

This contrasting picture on African access to foreign markets comes from two different effects. First, the structure of world protection is unequally distributed amongst sectors and across importers. Countries highly specialized in certain agricultural products, like meat, milk, sugar or some cereals or exporting to protectionist countries get penalized. This is what we call a composition effect. However, more preferential access to countries than rest of the world decreases the average duty on exports. This second effect is the true margin effect. If the composition effect is positive, even without preferences, a country benefits from a lower tariff than the world average. Positive true preference margin implies that the country benefits from preferences relative to the rest of the world and vice versa. Table 3 presents this decomposition for country groups and selected African countries (see Bouet et al 2007 for more details about the methodology behind this decomposition).

Table 3: Apparent margin and its decomposition for African countries 2004 (MAcMap HS6 database)

Country/Zone	Applied Duty	Apparent Margin	Composition Effect	True Margin
World	4.5			
Africa	4.2	0.3	0.6	-0.3
America	5.3	-0.8	-0.8	0.1
Asia	5.1	-0.6	0.5	-1.1

Europe	3.6	0.9	0.1	0.8
Pacific	10.6	-6.0	-5.3	-0.7
LDC	4.7	-0.1	-1.2	1.1
MIC	5.1	-0.6	0.1	-0.7
OECD	4.1	0.4	0.0	0.4
Chad	1.3	3.3	4.0	-0.8
Congo DR	1.2	3.3	4.5	-1.2
Malawi	23.1	-18.6	-23.1	4.5
Togo	14.9	-10.4	-10.8	0.5

Source: Author's calculations

Table 3 shows that for Africa as a whole, the true preference margin is negative. Europe benefits from the biggest true preference margin largely due to a complete free trade amongst these countries. Thus, if African countries benefit from a lower average duty faced on exports than the world, by 0.3%, this is due to a composition effect which is favorable (0.6%). Specialization in products (oil, gas, mineral products) which are not highly taxed throughout the world have a positive impact on market access in these countries. This average statistic hides significant heterogeneity across countries; exports from Malawi, Swaziland, Togo, Benin, Mauritius are penalized due to specialization in highly protected products while preferences compensate only partially (in absolute value true preference margins are less than the composition effect). On the other side, Congo DR, Chad, Libya, Lesotho have a positive composition effect.

3. Methodology

We adopt Fontagne, Pajot and Pasteels (2005) (here on FPP (2005)) model augmented for the role of infrastructure in determining trade costs. In FPP (2005) model, all goods are differentiated by the place of origin and each region produces only one good. The supply of each good is fixed. Consumers have identical and homothetic preferences represented by a CES utility function. Let c_{ij} be the consumption of good produced in country i by agents in country j. The utility functions of the agents in country j are denoted as U_j.

The agents in country j maximize U_j subject to the budget constraint, i.e.

Max:

$$U_j = \left(\sum_i \beta_i^{1/\sigma} c_{ij}^{(\sigma-1)/\sigma} \right)^{\frac{\sigma}{\sigma-1}} \quad (1)$$

subject to the budget constraint:

$$\sum_i p_{ij} c_{ij} = y_j . \quad (2)$$

σ is the elasticity of substitution between all goods, β_i is a distribution parameter and p_{ij} is the price in j of the good produced in i. If p_i is the exporter's supply price then:

$$p_{ij} = p_i \tau_{ij} \tag{3}$$

τ_{ij} is greater than or equal to 1 and includes trade costs (transportation costs, tariffs, administrative costs, information costs etc) and is of iceberg type.

Finally the total income of country i is:

$$y_i = p_i Q_i \tag{4}$$

Let s_i be the share of country i in world income y^W

Maximizing (1) subject to the budget constraint in (2) gives the consumption of i in j:

$$c_{ij} = \frac{\beta_i y_j}{p_i \tau_{ij}} \left(\frac{p_i \tau_{ij}}{\Pi_j} \right)^{1-\sigma} \tag{5}$$

Π_j is a price index defined by:

$$\Pi_j = \left[\sum_j \left(\beta_j p_j \tau_{ji} \right)^{1-\sigma} \right]^{1/(1-\sigma)} \tag{6}$$

If all i quantities are normalized such that $p_i = 1$, then exports are defined by:

$$x_{ij} = \frac{\alpha_i Y_j}{\tau_{ij}} \left(\frac{\tau_{ij}}{\tilde{\Pi}_j} \right)^{1-\sigma} \tag{7}$$

Where,

$$\tilde{\Pi}_j = \left[\sum_i \alpha_i \tau_{ij}^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{8}$$

is a CES index of the trade costs in exports from country i to j. Substituting in (7) gives the gravity equation:

$$x_{ij} = \frac{1}{\tau_{ij}} \frac{y_i y_j}{y^W} \frac{\left(\frac{\tau_{ij}}{\tilde{\Pi}_j} \right)^{1-\sigma}}{\sum_k s_k \left(\frac{\tau_{ik}}{\tilde{\Pi}_k} \right)^{1-\sigma}} \tag{9}$$

Equation (9) implies that the exports from i to j are positively related to the supply capacity of i (i's income - y_i), the demand capacity of j (j's income - y_j) and negatively related to trade costs where trade costs include the trade costs borne by i in exporting to all other destinations. Thus, the trade costs include multilateral trade resistance terms as in Anderson and van Win Coop (2004) ($\tilde{\Pi}_j$ and $\tilde{\Pi}_k$ respectively).

Hence we include the distance of exporter from the rest of the world and the distance of importer from rest of the world as explanatory variables. Similarly, protection faced on exports to rest of the world (and the tariffs

imposed by the importer on imports from the rest of the world) are included as explanatory variables in the regressions.

The bilateral trade costs in the presence of infrastructure can be given as:

$$\tau_{ij} = (1+t_{ij})m(I_i)d_{ij}^{\rho} \quad (10)$$

In equation (10), t_{ij} is the bilateral import duty applied by country j on exports from i.[4] Transportation costs are assumed to increase with geographic distance between trading countries d_{ij} and vary negatively with the level of infrastructure. In the simplest formulation where infrastructure is included linearly, the function $m(I_i) = \frac{1}{I_i}$,transport costs are specified as

$$\tau_{ij} = \frac{(1+t_{ij})d_{ij}^{\rho}}{I_i} \quad (10a)$$

In the empirical formulation, extended measures of trade costs can be included, for example the countries being landlocked and sharing of a common border or language between trading partners. Following Mayer and Zignago (2005) and Combes, Lafourcade and Mayer (2005), bilateral trade costs can be defined as:

$$\tau_{ij} = (1+t_{ij})d_{ij}^{\rho}m(I_i)\exp\left\{\Phi Ll_i + \Gamma Ll_j - \Theta C_{ij} - \mathrm{K}La_{ij} - \Omega Co_{ij} - \Psi CCo_{ij}\right\} \quad (11)$$

The function $m(I_i)$ can take any form and if we let it to be data specific then the estimated gravity model is semi-parametric in nature. The basic specification of the gravity equation that we adopt is given below as:

$$\ln\left(X_{ij}\right) = \beta_0 + \beta_1 \ln\left(Y_i\right) + \beta_3 \ln\left(Y_j\right) + \gamma \ln(d_{ij}) + \rho \ln(t_{ij}) + \sum_i \theta_i \mu_{ij} + \delta A_{i/j} + \sum_s \theta_s T_{ij} + \sum_i^n \mu_i \ln(I_i) + \varepsilon_{ij} \quad (12)$$

where x_{ij} is the average value of annual exports from country *i* to country *j* (averaged over three years), Y_i is the real GDP of country *i*, T_{ij} is a vector containing the multilateral trade resistance terms for the importers and exporters. μ_{ij} is a vector of variables that capture the relationships that can matter for trade like sharing of a common border among others. The dummy A_i and A_j capture respectively whether the exporter or the importer in a bilateral trading pair falls in Africa.

Without any prior for the nature of linkage between trade and infrastructure, the semi parametric framework that we employ for estimating the impact of infrastructure on trade can be really meaningful. The parametric model if correctly specified provides precise inference and has the advantage of $\sqrt{n}$ convergence of the parameter vectors. However, if the model is mis-specified, then the parameter estimates and the associated inference is misleading. In the partial linear model, we assume that the conditional mean has a linear parametric component (the standard gravity model variables) and a non-parametric component (i.e. a function of the levels of infrastructure).

The partial linear model is thus specified as:

$$\ln\left(X_{ij}\right)=\beta_0+\beta_1\ln\left(Y_i\right)+\beta_3\ln\left(Y_j\right)+\gamma\ln(d_{ij})+\rho\ln(t_{ij})+\sum_i\ \theta_i\mu_{ij}+\delta A_{i/j}+\sum_s\theta_s T_{ij}+\sum_i^n\mu_i\ln(I_i)+m(I_i)+\varepsilon_{ij} \quad (13)$$

Where $\varepsilon_{ij}\ \square\ iid(0,\sigma^2)$ and $I_i=(I_{i1},I_{i2})'$. The two infrastructure variables that we use in the partial linear model are (1) mobile density (I_{i1}) and (2) road density (I_{i2}). The definition of other variables is same as in equation (12). Note that the specification in equation (13) nests the specification in equation (12). By first order Taylor series expansion around some value $(\tilde{I}_1,\tilde{I}_2)$ we get

$$m(I_{i1},I_{i2})=m(\tilde{I}_1,\tilde{I}_2)+m_1^{(1)}(\tilde{I}_1,\tilde{I}_2)(I_{i1}-\tilde{I}_1)+m_2^{(1)}(\tilde{I}_1,\tilde{I}_2)(I_{i2}-\tilde{I}_2)+o(\left|I_i-\tilde{I}_i\right|$$

where $m_j^{(1)}(\tilde{I}_1,\tilde{I}_2)$ is the first derivative of $m(.)$ with respect to the j^{th} argument. $\tilde{I}_i=(\tilde{I}_1,\tilde{I}_2)'$ and $o(.)$ includes terms that are negligible compared to the leading terms.

Note that $m_j^{(1)}(\tilde{I}_1,\tilde{I}_2)$ is the marginal effect of the j^{th} infrastructure on average annual exports of any country i, where the effect has been averaged across all trading partners of that particular country. By construction, this marginal effect depends on both infrastructure variables.[5]

The flexible form in the partial linear model also allows us to investigate the existence of complementarity among infrastructure variables in a meaningful way. If we observe that $\hat{m}_j^{(1)}(I_1,\tilde{I}_2)\geq\hat{m}_j^{(1)}(I_1,\overline{I}_2)$ where $\tilde{I}_2\geq\overline{I}_2$ for all values of I_1 and all pairs $(\tilde{I}_2,\overline{I}_2)$ then this would imply that I_2 complements I_1 globally.

[5] Roughly, if the plots of $\hat{m}_j^{(1)}$ against the different infrastructure values is close to horizontal line for all j, then it is expected that the true data generating process is a linear parametric model. More formally, statistical testing of linearity versus a partial linear model can be done using a Generalized Likelihood Ratio test as given by Fan et al (2001)

However, it is possible that the above condition is satisfied for a subset of values of I_1 and when $(\tilde{I}_2, \overline{I}_2) \in W \subset R^2$. In this case, we have local complementarity which is more plausible. Thus, it is possible that when the road density is too low, then increasing road density may not increase the marginal impact of mobiles on trade but beyond a critical level, increases in road density positively affect the marginal impact of mobile density.[6]

Apart from estimating partial linear model as in (13), we also estimate other forms of equation (12) to account for zero trade flows. Some studies employ a Tobit estimator to examine bilateral zeros (for example Subramanian and Tamirisa 2001). In the Heckman specification we treat zero trade to imply that the countries that have a positive trade comprise a selected sample and we apply the Heckman selection. The sample selection model allows accounting for the unobserved selection criterion that leads to positive trade in the current time period. The Heckit estimator, combines Probit analysis of zero trade flows with OLS analysis of trade volumes. Francois and Manchin (2006) employ the same method to control for sample selection but their framework does not include an exclusion variable for likelihood of trade.

Most variables that affect whether two countries trade or not are also likely to affect the strength of their trading relationship (for example geographical distance). It is thus challenging to select variables that are highly correlated with country's propensity to export and not correlated with the actual levels of exports. We use the historical frequency of positive trade between the two countries as the exclusion variable. The premise is that higher the frequency of positive trade in the past, greater is the likelihood of two countries having a non-zero trade flow in the current period. The first stage of the Heckman regressions shows that historical frequency of positive trade is a very strong predictor of the likelihood of non-zero current trade. Since our trade flow variable for the current time period is an average over three years (and not a data for a single year), the relationship between historical frequency and likelihood of current trade is likely to be more systematic. Subsequently, variants of equations 12 are estimated on a truncated sample which includes only the low income exporter countries and low income importer countries respectively.

4. Results and interpretations

Table 4: Log linear Gravity model estimation results for 2001 and 2004

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[6] Specifying the partial linear model as $P_{ij} = S_{ij}^{'}\beta + m(Z_i) + \varepsilon_{ij}$, we can estimate the parameters and the non-parametric component of this model. One of the established models for obtaining the asymptotitc properties of β was given by Robinson (1988) where $m(Z_i)$ is treated as a nuisance parameter and thus not of significance to an empirical researcher. In this paper we use the profile least squares based estimator to obtain the estimates of $m(.)$ and $m^1(.)$ respectively. Note that the estimate of marginal impact of interest to us is the vector $\hat{m}^1(Z_i, \hat{\beta})$. The confidence bound for $\hat{m}(Z_i, \hat{\beta})$ and $\hat{m}^1(Z_i, \hat{\beta})$ have been obtained based on Carroll et al (1997).

Log linear specification	**Full sample (Africa - exporter) - 2001**	**Low income exporter sample (Africa-exporter)-2001**	**Full sample accounting for infrastructure -2001**	**Full sample (Africa - exporter) - 2004**	**Full sample (Africa - exporter) -2004 accounting for infrastructure**
Log GDP importer	0.96***	0.88***	0.96***	0.90***	0.90***
	(78.09)	(27.56)	(78.37)	(39.55)	(40.17)
Log GDP exporter	1.10***	1.05***	1.08***	1.18***	1.15***
	(97.16)	(26.39)	(83.08)	(61.96)	(57.19)
Log of bilateral distance	-1.49***	-1.24***	-1.49***	-1.49***	-1.49***
	(-40.93)	(-10.64)	(-40.83)	(-24.72)	(-24.95)
Distance of exporter from the world	0.81***	1.65***	1.27***	1.29***	2.02***
	(6.61)	(2.63)	(8.04)	(6.58)	(8.81)
Distance of the importer from the world	0.59***	-1.45	0.58***	-0.13	-0.17
	(4.75)	(-1.58)	(4.68)	(-0.64)	(-0.84)
Log bilateral tariff	0.06	0.51***	0.03	-0.32***	-0.38***
	(1.20)	(4.49)	(0.72)	(-3.50)	(-4.12)
Log relative import protection	0.05	-0.12	0.03	0.07	0.07
	(1.45)	(-1.36)	(1.05)	(1.35)	(1.25)
Log relative export protection	-0.12***	-0.46***	-0.10**	0.31***	0.36***
	(-2.77)	(-4.47)	(-2.10)	(4.06)	(4.64)
Log of NTB in the importing country	-0.04**	-0.06	-0.05**	-0.03	-0.04
	(-2.14)	(-1.09)	(-2.20)	(-0.82)	(-1.14)
μ variables[7]					
Africa exporter	**-0.35*** **	**0.12**	**-0.09**	**-0.27** **	**0.02**
	(-5.08)	**(0.74)**	**(-1.15)**	**(-2.29)**	**(0.20)**
Air			0.01		-0.10***
			(0.44)		(-3.00)
Mobile			0.02		0.12***
			(1.07)		(3.10)
Road			0.17***		0.16***
			(4.37)		(4.42)
R-squared	0.73	0.54	0.74	0.67	0.68
N	6208	1029	6208	3086	3086

Table 5: Tobit model: Gravity model estimation for 2001 and 2004

Tobit specification	**Full sample (with Africa as an exporter - 2001**	**Full sample (with Africa as an exporter accounting for infrastructure -2001**	**Full sample (with Africa as an exporter - 2004**	**Full sample (with Africa as an exporter accounting for infrastructure -2004**
Log GDP importer	1.22***	1.22***	0.96***	0.96***
	(71.32)	(71.66)	(38.31)	(38.86)
Log GDP exporter	1.43***	1.32***	1.25***	1.21***
	(90.22)	(69.91)	(55.60)	(52.80)
Bilateral distance	-1.88***	-1.85***	-1.55	-1.54***
	(-36.64)	(-36.14)	(-23.72)	(-23.78)
Distance of exporter from the world	0.49***	1.22***	1.15***	1.87***
	(3.02)	(5.81)	(5.12)	(7.22)
Distance of the importer from the world	0.59***	0.53***	-0.29	-1.33*
	(3.73)	(3.41)	(-1.41)	(-1.62)
Log bilateral tariff	0.26***	0.21***	-0.24***	-0.31***
	(4.01)	(3.25)	(-2.56)	(-3.23)
Log relative import protection	0.12**	0.10**	0.02	0.02
	(2.58)	(2.14)	(0.38)	(0.33)
Log relative export protection	-0.34***	-0.29***	0.31	0.38***
	(-6.73)	(-5.58)	(4.16)	(4.83)

[7] The μ variables include whether the trading partners share a common border, common language and whether the exporter or the importer is a landlocked country.

Log of NTB	-0.08***	-0.09***	-0.07*	-0.08**
	(-2.90)	(-2.98)	(-1.81)	(-2.09)
μ variables				
Africa exporter	-0.33***	0.21**	-0.21**	0.08
	(-4.33)	(2.22)	(-2.06)	(0.65)
Air		-0.18***		-0.13***
		(-6.06)		(-3.96)
Mobile		0.25***		0.14***
		(9.06)		(3.69)
Road		0.20***		0.17***
		(4.70)		(4.84)
N	7422	7422	3161	3161

Table 6: Heckman Selection model: Gravity model estimation for 2001 and 2004

	Full sample (with Africa as an exporter	Full sample (with Africa as an exporter accounting for infrastructure	Full sample (with Africa as an exporter -2004	Full sample (with Africa as an exporter accounting for infrastructure -2004
Log GDP importer	0.89***	0.89***	0.86***	0.86***
	(63.56)	(63.74)	(36.69)	(36.92)
Log GDP exporter	1.01***	1.01***	1.14***	1.12***
	(72.69)	(66.34)	(54.11)	(51.88)
Bilateral distance	-1.38***	-1.38***	-1.44***	-1.43***
	(-34.91)	(-35.94)	(-24.58)	(-23.46)
Distance of exporter from the world	0.85***	1.20***	1.35***	2.24***
	(6.75)	(7.55)	(6.45)	(7.94)
Distance of the importer from the world	0.55***	0.55***	-0.11	-0.16
	(4.61)	(4.63)	(-0.59)	(-0.86)
Log bilateral tariff	0.03	0.01	-0.32***	-0.35***
	(0.62)	(0.34)	(-4.66)	(-3.93)
Log import protection	0.03	0.02	0.08	0.07
	(1.09)	(0.84)	(1.36)	(1.21)
Log export protection	-0.09**	-0.07*	0.30***	0.34***
	(-2.25)	(-1.82)	(4.26)	(4.60)
Log of NTB	-0.04**	-0.04**	-0.05	-0.06*
	(-2.05)	(-2.07)	(-1.49)	(-1.74)
μ variables				
Africa exporter	**-0.35*** **	**-0.16** **	**-0.29*** **	**-0.03**
	(-5.82)	**(-2.24)**	**(-2.98)**	**(-0.30)**
Air		0.06**		-0.10***
		(2.42)		(-3.10)
Mobile		-0.02		0.09**
		(-1.24)		(2.28)
Road		0.15***		0.25***
		(4.01)		(3.76)
N	7399	7399	3239	3239

Tables 4, 5 and 6 present the results from log linear OLS and the Tobit and Heckman specification of the gravity model for 2001 and 2004. For brevity, the results of the regressions on the low income exporter sample are not presented for both 2001 and 2004 for the Tobit and Heckman specification. The status of Africa as an under-trader in the global sample and not as an under-trader in the low income sample holds true in all these specifications. The first stage of the Heckman sample selection model is presented in table A.4 in the appendix.

Besides implications for Africa, table 4,5 and 6 also present some interesting results on the impact of trade protection. The result for both 2001 and 2004 show that not only the levels of protection in the importing country (the bilateral tariff) i.e. protection in an absolute sense matters but also the protection in the relative sense. Thus, the

coefficient on the variable relative protection on imports from the rest of the world and the relative protection on exports to the rest of the world (from the exporting country) are often significant determinants of trade flows. The absolute effect of bilateral tariff is thus a cumulative effect of three coefficients, once absolutely and twice as part of the relative protection variables. Test for significance show that the net effect of the variable bilateral tariff is negative and statistically significant Moreover, even though the ad valorem equivalents of non-tariff barriers are not available at bilateral levels, the negative impact of such barriers is evident in most specifications.

Further, tables 4, 5 and 6 provide consistent evidence that trade related infrastructure is a significant determinant of trade flows and accounting for infrastructure (in all the specifications), consistently reduces the size of the African export dummy. Thus, infrastructure (or its correlates for example institutions) can be considered to be among the factors that account for at least part of under-trading by Africa. This follows from levels of trade related infrastructure being on an average lower in Africa than the rest of the world and the fact that trade facilitating infrastructure affect trade flows significantly.

5. Role of infrastructure in African trade

Having established that infrastructure is a potential factor for Africa's under-trading, we estimate their impacts on trade using a partial linear specification (as given in equation 13) of the gravity model that allows for all possible interactions across the types of infrastructure. We consider two infrastructure variables— road and mobile density as interactions between them are easiest to conceive. Figure 4 and 5 show the impact of increment in mobile and road density on trade for the countries in the sample with pooled data for 2001 and 2004. The data on infrastructure for 2001 correspond to average of 1998 and 1999 while for 2004 they correspond to the average of 2001 and 2002.

While mobiles density has increased drastically in all countries between 1998 and 2002, only small changes in road density (as a fraction of land area or of population) have occurred between these two periods. Thus, when marginal impacts of mobile are estimated for 2001 and 2004 separately, the impacts are significantly higher in 2004. We interpret this result as possibly capturing the role of network effects. Network effects imply that starting from a higher base, the same percentage increase in mobile density is much more effective since there already exists a large set of mobile users.

Figure 3: Marginal impact of mobile on trade

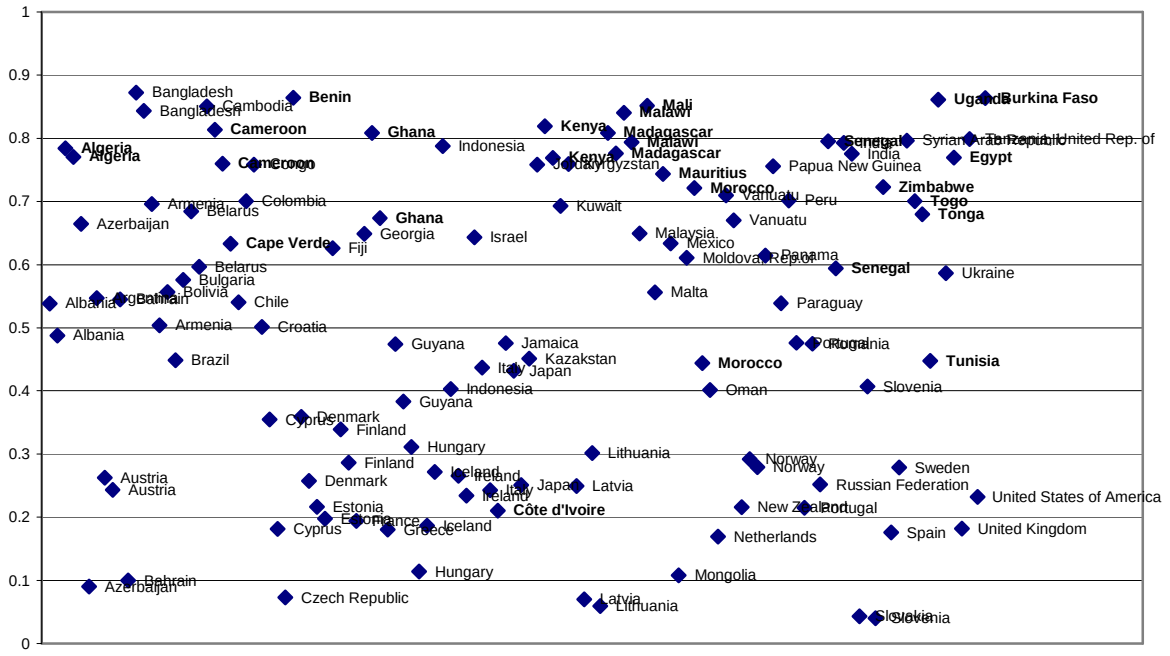
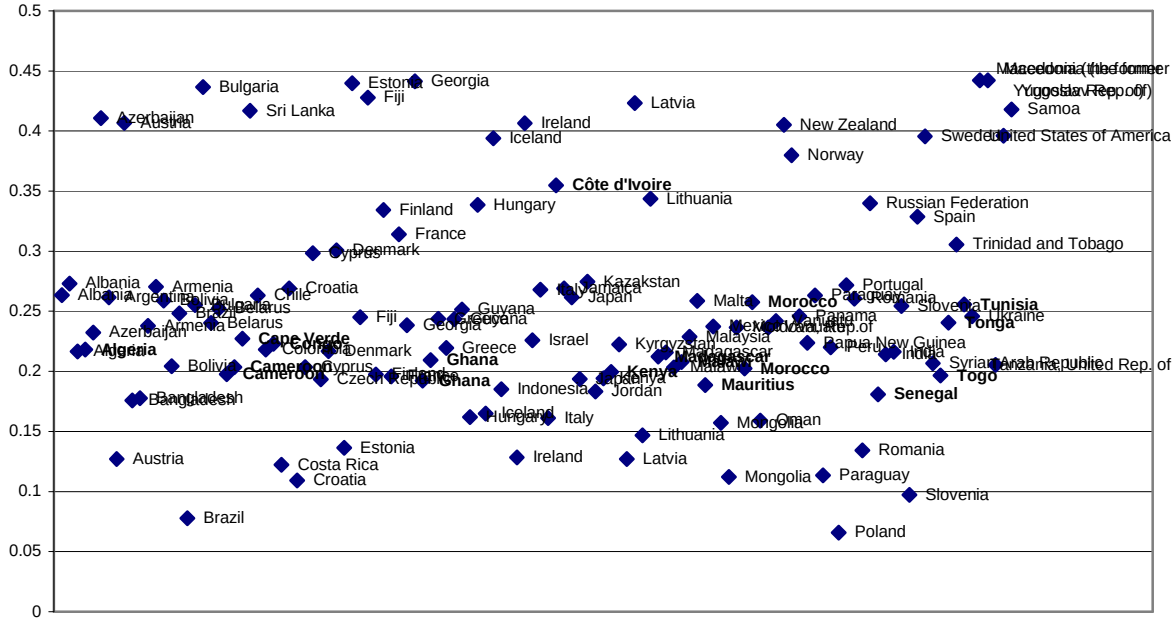


Figure 4: Marginal impact of road on trade



Figures 3 and 4 present the estimated marginal impacts of mobile and road on trade flows. The marginal impacts are averaged across all bilateral trading pairs. The set of countries for which the scatter plots present the marginal impacts are only those where the impacts are statistically significant at 1% level. Expanding the confidence intervals will capture more countries with significant marginal impacts including in Africa.

Few important points emerge from these marginal impacts. First, the marginal impacts of greater phone connectivity are the highest among low income and low middle income countries in Africa. African countries being

concentrated in that income distribution have some of the highest estimated marginal impacts of phones on trade. In countries like Benin and Mali, one percent increase in the phone density increases trade by greater than 0.8%. Similarly, statistically significant and quantitatively important impacts on trade are estimated for several African countries also in case of road density. The highest estimated marginal impact of road for African countries is 0.35% in case of Côte d'Ivoire. The lowest marginal impact of roads on trade in Africa is for Senegal but is still quantitatively important at 0.18%.

How do these estimated marginal impacts vary with country characteristics? Table 7 presents the average of the estimated marginal impacts across several country group characteristics. It includes the average for the world excluding Africa and for Africa separately. The average estimated marginal impact of road in Africa is fairly constant across all groupings. Among low income countries, the impacts are higher in Africa than elsewhere. The impacts vary significantly also with the composition of exports. The impact of greater phone density is unambiguously higher greater is the share of high technology exports or service exports in Africa.

Table 7: Marginal impacts and country characteristics

Characteristics	Average marginal impact of road by category		Average marginal impact of phone by category	
	Excluding Africa (rest of the world)	Africa only	Excluding Africa (rest of the world)	Africa only
All exporting countries	0.27	0.21	0.43	0.73
Landlocked exporter	0.28	0.20	0.36	0.81
Not landlocked exporter	0.27	0.22	0.44	0.70
Low income exporter	0.18	0.21	0.67	0.75
Middle income exporter	0.27	0.22	0.48	0.69
High income exporter	0.29	-	0.30	-
Share of high tech exports (greater than 25%)	0.28	0.21	0.47	0.76
Share of high tech exports (less than 25%)	0.25	0.21	0.47	0.71
Ratio of service to merchandise exports (greater than median)	0.26	0.20	0.55	0.76
Ratio of service to merchandise exports (less than median)	0.26	0.22	0.45	0.70
Levels of other infrastructure and institutions (not incorporated in the model) – High : greater than median , low: smaller than median				
High aircraft departure	0.28	0.22	0.38	0.71
Low aircraft departure	*0.26*	*0.21*	*0.50*	*0.74*
High electricity	0.28	0.22	0.35	0.71
Low electricity	*0.25*	*0.19*	*0.56*	*0.77*
High icrge index (high index for institutional quality)	0.29	0.23	0.34	0.70
Low icrge index (low index for institutional quality)	*0.23*	*0.20*	*0.52*	*0.75*
High internet usage	0.28	0.21	0.30	0.67
Low internet usage	*0.25*	*0.20*	*0.57*	*0.80*
High density of mainline phones	0.27	0.22	0.30	0.65
Low density of mainline phones	*0.24*	*0.21*	*0.58*	*0.80*
High documents requirements	0.23	0.22	0.46	0.74
Low document requirements	*0.30*	*0.21*	*0.34*	*0.66*
High time to export	0.24	0.20	0.49	0.80
Low time to export	*0.30*	*0.22*	*0.35*	*0.65*
High exports cost	0.25	0.21	0.44	0.79
Low exports cost	0.28	0.22	0.41	0.65

Source: Author's calculations based on estimations

The generalizable trend in the impact of infrastructure is as follows. With lower availability of other infrastructure viz. air, electricity or mainline phones, there is greater estimated impact of phone density though such

a straightforward relationship does not exist in case of road density. Based on the cost of doing trade from the World Bank, in table 7, we classify the countries as low costs of trade (in terms of documents requirements, time to export and costs to export) and high costs of trade respectively. Importantly, in countries both in Africa and elsewhere, wherever the existing costs of trade are higher, the marginal impacts of phone connectivity are higher. This is true both within Africa and in rest of the world. Indeed., part of greater costs to trade or time taken to trade are by themselves is a consequence of lower levels of infrastructure.

Given the specification of the partial linear gravity model, the marginal impact of either of the two infrastructure depends upon the level of the other infrastructure as discussed above. The plot of estimated marginal impacts in figures 3 and 4 for either road or mobile depends on the other infrastructure (for example marginal impact of mobile depends both upon the density of mobiles as well as roads). Establishing complementarities across types of infrastructure is equivalent to addressing the following question: Independent of the country considered, is the marginal impact of one infrastructure on average level of exports significantly higher when the level of other infrastructure is higher.

Thus, for complementarity between phone and road connectivity, this counterfactual exercise requires assigning same level of road density to all countries in the sample and obtaining marginal impacts of mobile for different mobile densities. Let us call this mobile density plot (conditional on a given level of road density) . A change in the level of road density may lead to a potential shift in the mobile density plot. As explained in the previous section, local or global complementarity can be observed depending on the resultant shift.

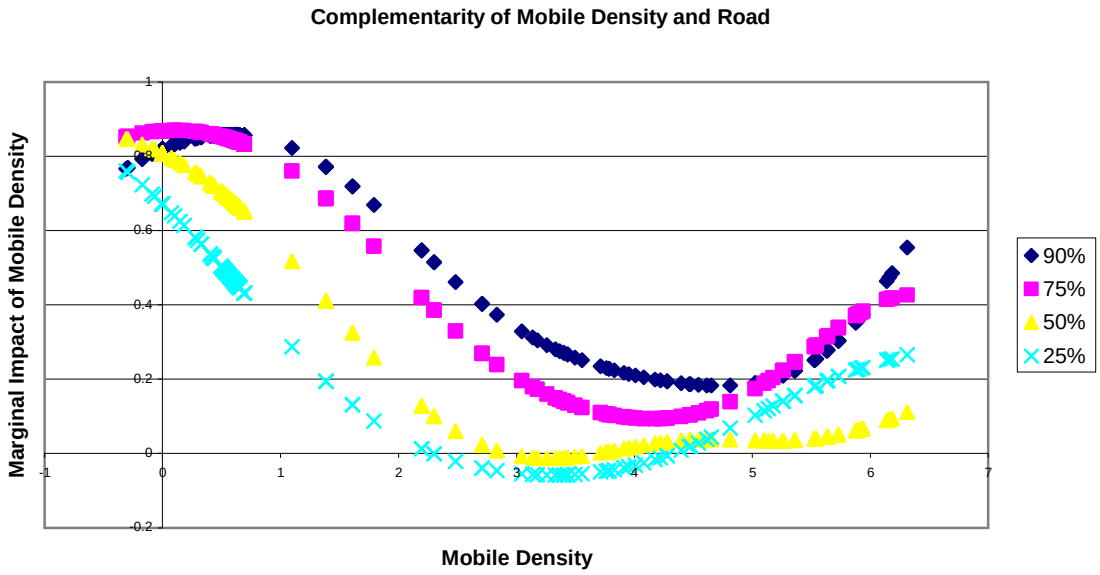
Complementarities in infrastructure

Figure 5 presents the results of a counterfactual exercise in which all countries in the sample are made to have the same road density. We consider four levels of road densities i.e. are 25^{th} , 50^{th}, 75^{th} , and 90^{th} percentile obtained from the empirical distribution of observed road density. In the figure, different lines are associated with these four different levels of road density. As expected, we witness local complementarity i.e that is when the log of mobile density is between 1 and 4.5 we observe an upward shift in the mobile density plot. Complementarity is not observed in lower and upper extreme values for mobile density.

When the mobile density is too low then it is expected that increasing road density will not affect the marginal impact of mobile density due to the absence of a critical level of mobile density. When the mobile density is very high then the potential of mobile penetration is already realized and thus increase in road density does not seem to affect this marginal impact. This idea of thresholds in impact of infrastructure has increasingly been recognized through use of threshold regressions in estimating the augmented production functions (for example see Hurlin 2006). Our results support the idea of thresholds albeit in terms of impact on trade and estimated in a way that allows for an unrestricted number of thresholds compared with the threshold regressions framework.

Even though it is natural to expect possibilities of such complementarities, a relationship like this has formally not been established in the trade literature. Note that this relationship does not correspond to a positive relationship between road density and marginal impacts of mobile. Since countries trade in different products and have different levels of determinants of trade, a monotonic relationship is difficult to predict across a cross-section of exporting countries. Hence, this complementarity implies that the gains from investment in infrastructure (in terms of its impact on trade) for any country is higher, higher is the level of infrastructure that it is complementary to.

Figure 5: Infrastructure complementarities



7. Conclusions and policy implications

The assessment of market access for Africa shows that on an average Africa enjoys good access to foreign markets. However, there are significant variations within Africa with some really low income countries like Malawi facing relatively worse market access. Trade preferences can improve market access by lowering the duties faced on African exports. Based on the types of products on which preferences are granted and the countries that grant preference to Africa, the current true preference margin for Africa is in fact negative. Thus, greater market access will help African exports but again the effects are likely to be disparate across countries.

The evidence, however, points that even if preferences can help raise the level of exports, there exists a basis for the belief that Africa will continue to trade less than it ideally should. The low quality of trade-related infrastructure in Africa implies that interventions that improve the level and quality of infrastructure can yield high returns. However, the impact of infrastructure on trade exhibits significant complementarities. Thus, policy interventions that develop infrastructure in a piece meal fashion are likely to yield much lower returns than when they develop infrastructure comprehensively.

These results on significant impacts of infrastructure on trade have important policy implications especially in light of the "aid for trade" policy agenda that has surfaced in the Doha round. Essentially, the principle behind aid for trade agenda is realization of the fact that observed low trading by countries with already good market access (in Africa or elsewhere but mainly low income countries) implies that market access is not the only reason for declining trade performance of certain countries. The result that infrastructure has important and significant effect on trade basically supports this premise behind the aid for trade agenda.

In several African countries where there already exists a good market access, enhancing preferential access is likely to yield insignificant gains. In many of the same countries (for example Uganda), the high impacts of infrastructure imply that the gains in terms of enhanced trade might accrue through improvements in domestic factors most noticeably in trade related infrastructure.

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Appendix

Partner	Global	Agricultural	Industry	Primary (not agr.)
Algeria	1.4%	12.7%	1.6%	1.1%
Angola	1.5%	6.4%	0.9%	1.5%
Benin	13.2%	23.7%	8.6%	4.7%
Botswana	1.9%	53.5%	0.9%	5.5%
Burkinafaso	11.0%	30.4%	5.8%	8.7%
Burundi	6.0%	11.2%	2.7%	3.3%
Cameroon	4.2%	10.7%	4.3%	1.3%
Capeverde	2.5%	3.8%	1.8%	7.3%
Centralafrica	1.6%	8.3%	1.4%	1.0%
Chad	1.3%	16.9%	2.0%	1.0%
Comoros	2.0%	2.4%	1.7%	2.5%
Congo	2.9%	39.7%	2.7%	1.9%
Congo (democratic)	1.2%	17.3%	0.7%	1.1%
Côted'ivoire	5.7%	6.2%	5.7%	1.8%
Djibouti	11.0%	13.0%	9.8%	10.8%
Egypt	5.4%	21.5%	3.9%	1.4%
Equatorial Guinea	1.4%	2.2%	1.2%	1.4%
Eritrea	6.6%	14.6%	4.3%	2.4%
Ethiopia	9.1%	10.4%	3.6%	18.4%
Gabon	1.9%	24.6%	2.7%	1.4%
Gambia	11.7%	16.9%	6.5%	11.7%
Ghana	4.8%	5.1%	4.8%	3.1%
Guinea	2.0%	6.7%	2.7%	0.7%
Guinea-bissau	14.1%	22.9%	8.6%	1.6%
Kenya	12.5%	14.6%	10.6%	6.4%
Lesotho	1.3%	9.2%	1.3%	2.5%
Liberia	1.5%	10.6%	1.5%	1.5%
Libya	1.3%	11.9%	3.4%	0.9%
Madagascar	3.5%	4.8%	2.4%	2.6%
Malawi	23.1%	27.4%	8.5%	6.1%
Mali	4.5%	9.0%	4.2%	3.3%
Mauritania	5.3%	9.7%	5.0%	0.7%
Mauritius	13.0%	40.7%	4.0%	3.2%
Morocco	5.0%	9.8%	4.0%	1.6%
Mozambique	5.1%	22.5%	1.8%	3.9%
Namibia	9.2%	20.9%	3.9%	1.8%
Niger	4.8%	17.8%	2.7%	0.5%
Nigeria	2.4%	4.5%	2.4%	2.4%
Rwanda	6.7%	17.6%	6.7%	2.4%
Sao tome and Principe	3.7%	2.9%	4.2%	2.2%
Senegal	10.1%	11.1%	10.4%	6.0%
Seychelles	5.3%	5.8%	4.7%	2.8%
Sierra leone	2.1%	5.1%	1.6%	3.7%
Somalia	10.8%	13.3%	7.1%	6.1%
South africa	5.4%	17.6%	4.6%	1.5%
Sudan	4.4%	16.5%	5.0%	1.5%
Swaziland	19.0%	54.4%	8.8%	2.9%
Tanzania	9.5%	18.9%	4.9%	2.1%
Togo	14.9%	17.1%	15.6%	3.3%
Tunisia	5.2%	19.4%	4.2%	0.9%
Uganda	8.6%	10.1%	6.7%	1.7%
Western sahara	12.0%	12.7%	11.7%	13.1%
Zambia	6.6%	24.5%	3.9%	3.0%
Zimbabwe	11.3%	23.7%	5.0%	4.8%
World	4.5%	16.0%	3.7%	1.5%
LDC	4.7%	15.3%	4.3%	2.0%
MIC	5.1%	20.0%	4.6%	1.5%
OECD	4.1%	14.0%	3.3%	1.3%
Africa	4.2%	15.2%	3.9%	1.6%
America	5.3%	18.5%	3.7%	1.2%
Asia	5.1%	19.3%	4.9%	1.6%
Europe	3.6%	12.1%	2.9%	1.2%
Pacific	10.6%	32.1%	4.3%	2.5%

Table A.1: Average duties faced on exports (source: MacMapHS6-2004 and author's calculation)

Table A.2: Summary of the data in the low income exporter sample

Variable	Mean (2001)	Std. Dev. (2001)	Mean for African exporters 2001	Std deviation for African	Mean (2004)	Std. Dev. (2004)	Mean for African exporters 2004	Std deviation for African

				exporters 2001				exporters 2004
Log Distance	8.77	0.72	8.70	0.71	8.84	0.80	8.74	0.71
Contiguity	0.01	0.13	0.01	0.13	0.02	0.15	0.02	0.14
Common Language official	0.17	0.38	0.24	0.43	0.16	0.37	0.18	0.38
Common language (ethnic)	0.14	0.35	0.19	0.39	0.15	0.36	0.16	0.37
Landlocked	0.38	0.47	0.35	0.47	0.19	0.39	0.33	0.47
Bilateral tariff	0.20	0.30	0.16	0.29	0.14	0.22	0.15	0.28
Export protection	0.08	0.04	0.06	0.04	0.06	0.04	0.07	0.05
Import protection	0.10	0.10	0.10	0.09	0.09	0.06	0.09	0.06
NTB protection (data for 2004)	0.07	0.01	0.07	0.07	0.06	0.05	0.06	0.07
Log(GDP) Exporter	21.89	1.59	21.60	1.30	23.04	1.77	21.89	1.04
Log(GDP) Importer	23.26	2.33	23.11	2.42	22.91	1.75	23.30	2.06
Log(Total Exports)	2.64	3.6	2.43	3.19	3.31	4.29	2.53	3.42

Table A.3: Summary of the infrastructure variables in the low income exporter sample

Variable	Mean (2001) for non-African countries	Std. Dev. (2001) for non-African countries	Mean for African exporters 2001	Std deviation for African exporters 2001	Mean (2004) for non-African countries	Std. Dev. (2004) for non-African countries	Mean for African exporters 2004	Std deviation for African exporters 2004
Aircraft departures per capita	0.001	0.004	0.0006	0.001	0.005	0.04	0.0007	0.001
Road length per unit of population	0.003	0.004	0.002	0.001	0.003	0.004	0.002	0.001
Road length per unit of land area	0.25	0.36	0.13	0.13	0.25	0.37	0.14	0.14
Percent of road paved	30.86	27.04	20.56	17.22	49.70	32.44	17.60	11.79
Mobile per thousand people	0.49	1.07	0.91	1.33	213.05	266.21	13.85	11.19
Main line per thousand people	12.74	15.19	7.24	6.76	27.03	101.35	9.92	9.21

Table A.4: Heckman first stage regressions 2001 and 2004

Dependent variable (Likelihood of trade =0 if no positive trade and =1 if evidence of non-zero trade)	**Full sample without infrastructure 2001**	**Full sample with infrastructure 2001**	**Full sample without infrastructure 2004**	**Full sample with infrastructure 2004**
Log GDP importer	0.29***	0.31***		
	(11.79)	(12.35)		
Log GDP exporter	0.33***	0.32***		
	(14.59)	(11.59)		
Bilateral distance	-0.28***	-0.32***		
	(-4.50)	(-4.99)		
Distance of exporter from the world	-0.52***	-0.32		
	(-3.27)	(-1.56)		
Distance of the importer from the world	-0.28*	-0.24		
	(-1.87)	(-1.60)		

Log bilateral tariff	0.14**	0.14**
	(2.38)	(2.39)
Log import protection	0.14***	0.14***
	(2.77)	(2.83)
Log export protection	-0.22***	-0.24***
	(-5.74)	(-5.47)
Log of NTB	-0.05*	-0.05**
	(-1.78)	(-2.04)
μ variables		
Africa exporter	**-0.03**	**0.24*** **
	(-0.62)	**(3.01)**
Historical frequency of positive trade	**2.37*** **	**2.29*** **
	(23.11)	**(22.28)**
Air		-0.04
		(-1.60)
Road		0.18***
		(4.06)
Mobile		0.08***
		(3.45)
N		1451