Economic Geography and Economic Development in Sub-Saharan Africa

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Abstract

The physical or absolute geography of Sub-Saharan Africa (SSA) is often blamed for its poor economic performance. A country's location however not only determines its absolute geography, it also pins down its relative position on the globe vis-à-vis other countries. This paper assesses the importance of relative geography, and access to foreign markets in particular, in explaining the substantial income differences between SSA countries. We base our empirical analysis on a new economic geography model. We first construct a measure of each SSA country's market access based on bilateral trade flows and then assess the relevance of market access for economic development. In doing so, we explicitly distinguish between the importance of access to other SSA markets and to the rest of world respectively. We find that market access, and notably intra-SSA market access, has a significant positive effect on GDP per capita. This indicates that improving SSA market access (e.g. by investing in intra-SSA infrastructure or through increased SSA integration) will have substantial positive effects on its future economic development.

Keywords: Sub Saharan Africa, economic development, economic geography, market access

JEL codes: O10, O19, O55, F1

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We thank Rob Alessie, Bernard Fingleton, Henri Overman, Joppe de Ree, Steve Redding, Giacomo Pasini, Marc Schramm and seminar participants in Cambridge, Glasgow, Rotterdam, Utrecht, Savannah (2007 North American Regional Science Conference), and Milan (2008 European Economic Association Conference) for useful comments and discussions.
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1. Introduction

Sub-Saharan Africa (SSA) is home to the world's poorest countries. Alongside factors as poor institutional quality, low (labour) productivity and low levels of human capital, the region's geographical disadvantages are often viewed as an important determinant of its dismal economic performance. It is well-established that a country's geography may directly affect economic development through its effect on disease burden, agricultural productivity, and the availability of natural resources (see Gallup et al., 1999; Collier and Gunning, 1999; Ndulu, 2007). Geography can also indirectly affect economic development through its influence on institutional quality (Rodrik et al., 2004; Gallup et al., 1999) or by determining a country's transport costs (Limao and Venables, 2001; Amjadi and Yeats, 1995). Recently, the new economic geography (NEG) literature (see Krugman, 1991; Fujita et al, 1999) has, however, highlighted another mechanism through which geography could affect a country's prosperity. A country's location not only determines its absolute (or 1st nature) geography; it also pins down its position on the globe vis-à-vis all other countries (its relative or 2nd nature geography). This determines the type and importance of a country's international relations that in turn can leave their mark on its economic development. The NEG literature in particular emphasizes the role of relative geography as the main determinant of a country's access to international markets that in turn has an important effect on the country's level of income[1].

Redding and Venables (2004) were among the first to establish empirically that market access indeed matters for economic development[2]. Based on the estimation results for a sample of 101 countries, they find for example that were Zimbabwe to be located in central Europe, the resulting improvement in its market access would ceteris paribus increase its GDP per capita by almost 80%. Similarly, halving the distance between Zimbabwe and all its trading partners would boost its GDP per capita by 27%, while direct access to the sea would increase it by 24%. Following Redding and Venables (2004), several studies have confirmed the positive effect of market access on economic development. These papers all focus on regional economic development. Knaap (2006) finds a strong positive effect of market access on income levels when looking at US states, and Breinlich (2006) finds the same for European regions. Also in case of developing countries, the positive effect of market access has been confirmed (see Deichmann, Lall, Redding and Venables, 2008 for a good overview).

[1] Market access may also have indirectly affect income levels through its positive effect on education or skill level (see Redding and Schott, 2004 and also Breinlich, 2006). We will come back to this in section 6.
[2] Redding and Venables (2004, p.77-78).

Amiti and Cameron (2007) show that wages are higher in Indonesian districts that enjoy better market access, and Hering and Poncet (2007) find similar evidence in case of Chinese cities. Moreover, Amiti and Javorcik (2008) find that market access positively affects the amount of FDI in Chinese provinces and Lall, Shalizi and Deichmann (2004) show that market access is an important determinant of firm level productivity in India. The only paper, we know of, focusing on the role of market access in SSA is Elbadawi, Mengistae and Zeufack (2006) that shows that differences in terms of *export performance* between firms in 10 SSA countries and firms in other developing countries (e.g. India, China, Malaysia or Peru) can partly be explained by SSA's poor market access. The importance of relative geography in shaping global and regional patterns of economic development has also not gone unnoticed in policy circles; it is even the main topic of the World Bank's 2009 World Development Report[3].

Despite the attention given to the role of relative geography, and market access in particular, in shaping the differences in economic development observed between countries and/or regions in both the developing and developed world, we are unaware of a study that clearly establishes its role in explaining the differences in *economic development* observed between SSA countries. The paper by Elbadawi et al. (2006) mentioned above looks at the role of market access on *export performance at the firm level*: it does not link export performance – or market access – to income per capita. The aim of this paper is to fill this gap and find provide evidence on the importance of market access for economic development across SSA.

SSA is only a marginal player on the world's export and import markets. Since 1970, the region's share in global trade (exports plus imports) has declined from about 4% to a mere 2% in 2005 (IMF, 2007). Through their detrimental effect on market access, high trade costs are generally viewed as one of the main causes for its poor trade performance (see Collier, 2002; Foroutan and Pritchett, 1993; Coe and Hoffmaister, 1999; Limao and Venables, 2001; Amjadi and Yeats, 1995 and Portugal-Perez and Wilson, 2008). Increasing SSA participation in world markets is viewed as very important to its future economic success (IMF, 2007; World Bank 2007). It will not only alleviate the constraint of small domestic market size faced by most African countries (Collier and Venables, 2007), it is also expected to increase overall SSA productivity through increased knowledge spillovers and learning by doing

[3]See *http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2009/0,,contentMDK:21547034~menuPK:4231158~pagePK:64167689~piPK:64167673~theSitePK:4231059,00.html* for an overview of the project.

resulting from being active in export markets (Van Biesebroeck, 2005; Bigsten and Söderbom, 2006). As a result, improving the region's market access by investing in infrastructure, increasing regional integration and providing preferential access to European and US markets is seen as a vital ingredient for improving the trade potential of SSA and its overall economic performance (IMF, 2007; World Bank, 2007; Collier and Venables, 2007; Buys et al., 2006).

Against this background the main contribution of our paper is to empirically establish the importance of SSA market access for its economic development. Following the empirical strategy introduced by Redding and Venables (2004) that is firmly based in the new economic geography (NEG) literature, we first construct each SSA country's market access over the period 1993-2003 making use of bilateral manufacturing trade data involving at least one SSA country. Making use of bilateral trade data to construct market access allows us to establish the importance of trade costs and market size respectively as determinants of each country's trade potential. Because SSA countries trade far more with the rest of the world (ROW) than with each other (see e.g. IMF, 2007) and have even been found to undertrade with each other (Limao and Venables, 2001)[4], we focus explicitly on the determinants of intra-SSA trade as well as SSA trade with the rest of the world (ROW). Our results show that poor infrastructure across the continent (see also Amjadi and Yeats (1995), Limao and Venables (2001) and Longo and Sekkat, 2004), the civil unrest experienced by many SSA countries, and the fact that those countries with direct access to the sea (and island nations in particular) are much more oriented towards the ROW, are part of the explanation for this 'ROW-bias' in SSA trade.

Next, having constructed the various measures of market access, we estimate the impact of market access on GDP per capita for our sample of 48 SSA countries. In particular we hereby distinguish between the relevance of SSA market access to other SSA markets and to markets in the ROW respectively. Also, a nice feature of our data set is that it allows for the use of panel data estimation techniques. We show that this is quite important when trying to establish the relevance of market access, as cross-section studies are likely to overstate the importance of market access. Overall, our main findings are that market access, and notably *intra-SSA* market access, has a significant positive effect on GDP per capita. Moreover, and in line with Redding and Schott (2003) and Breinlich (2006), we find evidence of an indirect effect of market access on economic development through its positive effect on human

[4] Although the latter is not undisputed, see e.g. Foroutan and Pritchett (1993) and Subramanian and Tamarisa (2003).

capital. Our results finally show that (policy induced) changes in for instance SSA infrastructure (see also Buys et al. 2006) can indeed have strong positive effects on improving market access and thereby on enhancing economic prosperity across SSA.

The paper is organized as follows. In the next section we briefly set out the new economic geography model underlying our empirical analysis, focusing on the specification of the wage equation and the trade equation that are the two equations we will estimate in section 4 and 5. Section 3 introduces our data set. In section 4, and as the first step of our estimation strategy, a trade equation is estimated using bilateral trade flows involving at least one SSA country. Next, and based on the trade estimation results, we construct our market access variables in section 5 and present our baseline results with respect to the impact of market access on GDP per capita for SSA. In section 6 we first provide various robustness checks, next analyze the relationship between human capital and market access in some more detail for SSA, and finally conduct some thought experiments to establish how various policy-measures and shocks affect economic development in SSA through their effect on market access. Section 7 concludes.

2. The NEG model: wage equation, trade costs and market access[5]

We start by briefly setting out the new economic geography (NEG) model that underlies our empirical framework. Assume the world consists of $i = 1,...,R$ countries, each being home to an agricultural and a manufacturing sector. As in virtually all NEG models, we focus on the manufacturing sector[6]. Moreover, and in line with e.g. Redding and Venables (2004), Breinlich (2006), Knaap (2006) and Head and Mayer (2006), we restrict our attention to the 'short-run' version of the model. This amounts to, as Redding and Venables (2004) p.59 put it *"taking the location of expenditure and production as given and asking the question what wages can manufacturing firms in each location afford to pay its workers"* (see also Brakman, Garretsen, and Schramm (2006) on this important assumption when taking NEG models to the data).

In the manufacturing sector, firms operate under internal increasing returns to scale, represented by a fixed input requirement c_iF and a marginal input requirement c_i. Each firm produces a different variety of the same good under monopolistic competition using the same

[5] See Fujita, Krugman, and Venables (1999), Puga (1999) or Head and Mayer (2004) for more detailed expositions on how the equilibrium wage equation and consequently market access can be derived from the various basic NEG models.

[6] The agricultural sector uses labor and land to produce a freely tradable good under perfect competition that acts as the numéraire good.

Cobb-Douglas technology combining two different inputs. The first is an internationally immobile factor (labor), with price w_i and input share β, the second is an internationally mobile factor with price v_i and input share γ, where $\gamma + \beta = 1$[7].

Manufacturing firms sell their products to all countries and this involves shipping them to foreign markets incurring trade costs in the process. These trade costs are assumed to be of the iceberg-kind and the same for each variety produced. In order to deliver a quantity $x_{ij}(z)$ of variety z produced in country i to country j, $x_{ij}(z)T_{ij}$ has to be shipped from country i. A proportion (T_{ij}-1) of output 'is paid' as trade costs (T_{ij} = 1 if trade is costless). Note that this relatively simple iceberg specification (introduced mainly for ease of modeling purposes, see Fingleton and McCann, 2007) does not specify in any way what trade costs are composed of[8]. Taking these trade costs into account gives the following profit function for each firm in country i,

$$\pi_i = \sum_j^R p_{ij}(z) x_{ij}(z) / T_{ij} - w_i^{\beta} v_i^{\gamma} c_i [F + \sum_j^R x_{ij}(z)] \tag{1}$$

where $p_{ij}(z)$ is the price of a variety produced in country i.

Turning to the demand side, consumers combine each firm's manufacturing variety in a CES-type utility function, with σ being the elasticity of substitution between each pair of product varieties. Given this CES-assumption, it follows directly that in equilibrium all manufacturing varieties produced in country i are demanded by country j in the same quantity (for this reason varieties are no longer explicitly indexed by (z)). Denoting country j's expenditure on manufacturing goods as E_j, country j's demand for each product variety produced in country i can be shown to be,

$$x_{ij} = p_{ij}^{-\sigma} E_j G_j^{(\sigma-1)} \tag{2}$$

where G_j is the price index for manufacturing varieties that follows from the assumed CES-structure of consumer demand for manufacturing varieties. It is defined over the prices, p_{ij}, of all goods produced in country $i = 1,...,R$ and sold in country j,

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[7] In Redding and Venables (2004) and Knaap (2006) each firm also uses a composite intermediate input (made up of all manufacturing varieties) in production, allowing them to also look at the relevance of so-called supplier access for income levels. Since our goal is to establish the relevance of market access we, in line with Breinlich (2006), skip intermediate inputs and thereby ignore supplier access [this also has the advantage that we avoid the severe multicollinearity problems when including both market and supplier access in the estimations, see Redding and Venables (2004) and Knaap (2006)]. In this respect our derivation and application of the wage equation is closer to Hanson (2005), see also Head and Mayer (2004, pp. 2622-2624).

[8] When estimating the effect of several trade cost related variables in section 4, we will need to specify a trade cost function.

$$G_j = \left[\sum_i^R n_i p_{ij}^{1-\sigma} \right]^{1/(1-\sigma)} \tag{3}$$

Maximization of profits (1) combined with demand as specified in (2) gives the well-known result in the NEG literature that firms in a particular country set the same f.o.b. price, p_i, depending only on the cost of production in location i, i.e. p_i is a constant markup over marginal costs:

$$p_i = w_i^{\beta} v_i^{\gamma} c_i \sigma / (\sigma - 1) \tag{4}$$

As a result, price differences between countries of a good produced in country i can only arise from differences in trade costs, i.e. $p_{ij} = p_i T_{ij}$.

Next, free entry and exit drive (maximized) profits to zero, pinpointing equilibrium output per firm at $\bar{x} = (\sigma - 1)F$. Combining equilibrium output with equilibrium price (4) and equilibrium demand (2), and noting that in equilibrium the price of the internationally (perfectly) mobile primary factor of production will be the same across countries ($v_i = v$ for all i), gives the equilibrium manufacturing wage:

$$w_i = A c_i^{-1/\beta} \left(\underbrace{\sum_j^R \overbrace{E_j G_j^{(\sigma-1)} T_{ij}^{(1-\sigma)}}^{MA_{ij}}}_{MA_i} \right)^{\frac{1}{\beta\sigma}} \tag{5}$$

where A is a constant that contains inter alia the substitution elasticity, σ, and the fixed costs of production, F).

Equation (5) is the wage equation that lies at the heart of virtually all empirical NEG studies (see e.g. Hanson, 2005; Redding and Venables, 2004; Knaap, 2006 and Amiti and Cameron, 2007). It predicts that the wage level a country is able to pay is a function of a country's level of technology, c_i, that determines marginal costs, and, most importantly for our present purposes, so-called real market access MA_i: a trade cost weighted sum of *all* countries' market capacities. Or put differently, country j's contribution to country i's market access, MA_{ij}, is country j's market capacity weighted by the level of trade costs involved when shipping goods from country i to country j, i.e. $MA_{ij} = E_j G_j^{\sigma-1} T_{ij}^{1-\sigma}$. Note that market access stresses an important role of relative geography: the closer (or better connected) a country is to world markets, the higher its market access. It is Equation (5) that constitutes the backbone of our empirical analysis into the relevance of market access for SSA economic development in section 5 and 6.

Basically two estimation strategies have been proposed to estimate the parameters of the wage equation (5). The first strategy follows Hanson (2005) and estimates the wage equation directly either using non-linear estimation techniques or by estimating a linearized version of the wage equation, see e.g. Hanson (2005), Brakman et al (2004) and Mion (2004). Here, and given that we have additional information on the *'strength'* of countries' economic interlinkages (i.e. trade), we opt for another strategy as first introduced by Redding and Venables (2004)[9]. This second strategy involves a two-step procedure where in the first step the information contained in (bilateral) trade data is used to provide estimates of the role of trade costs and market and supplier capacity in determining a country's market access. The connection between bilateral trade and market access follows directly from the NEG model. Aggregating the demand from consumers in country *j* for a good produced in country *i*, see (2), over all firms producing in country *i*, gives the following aggregate trade equation:

$$EX_{ij} = n_i p_i^{1-\sigma} \underbrace{E_j G_j^{(\sigma-1)} T_{ij}^{(1-\sigma)}}_{MA_{ij}} \qquad (6)$$

Equation (6) says that exports EX_{ij} from country *i* to country *j* depend on the 'supply capacity' of the exporting country, $n_i p_i^{1-\sigma}$ (the product of the number of firms and their price competitiveness), the market capacity of the importing country, $E_j G_j^{\sigma-1}$ (the product of its income multiplied by its price index, i.e. its real spending power), and the magnitude of bilateral trade costs T_{ij} between the two countries. As real market access is made up of these market capacities, weighted by bilateral trade costs, see (5) and (6), one can construct a measure of each country's market access using the estimated parameters of (6). This is exactly what we do in section 5, where we subsequently use this constructed market access variable in the 2nd step of the estimation procedure: estimating equation (5) to establish the effect of market access on income levels.

3. Data set[10]

The data on SSA manufacturing trade that we use in the first step of the estimation procedure, are collected from CEPII's *Trade and Production Database*[11], which contains information on bilateral manufacturing trade flows from 1976-2002. Within this dataset we focus on bilateral

[9] Other papers using this strategy include inter alia Knaap (2006), Breinlich (2006), Head and Mayer (2006), Hering and Poncet (2006).
[10] See Appendix A, for a full list of all the variables (including data sources) that we use in our analysis.
[11] http://www.cepii.fr/anglaisgraph/bdd/TradeProd.htm. An explanation of the dataset is given at http://www.cepii.fr/tradeprod/TradeProd_cepii.xls.

trade flows involving at least one SSA country (exporter or importer). Given poor data availability before 1993 (over this period SSA manufacturing import data are only given for 6 SSA countries[12]), we focus on the 10-year period 1993-2002. This leaves us with a data set containing information on bilateral manufacturing trade flows for 44 SSA countries both to and from other SSA countries and to and from 148 countries in the rest of the world (ROW). A nice feature of the data set is that it also contains information on some countries' internal trade, i.e. the amount that a country trades with itself (measured as total production minus total exports). After dropping missing observations, we are left with a total sample of 78748 observations (8574 intra-SSA, 70083 SSA-ROW and 91 internal trade observations).

As determinants of SSA trade that are related to *market and supplier capacity*, recall trade equation (6), we collected information on each country's GDP, % rural population, % workforce in agriculture and the incidence of civil war and/or conflict. As measures of *trade costs,* we use data on bilateral distances, internal distance, language similarity, sharing a common colonizer, having had a colony - colonizer relationship, being landlocked, being an island, sharing a common language, an index of infrastructural quality; and membership of an African regional or free trade agreement.

Table 1 provides a list of the SSA countries in our sample, also indicating (*) for which countries we do not have any information on bilateral manufacturing trade flows.

Table 1 : SSA countries

Angola	Côte d'Ivoire	Liberia	Senegal
Benin	Djibouti	Madagascar	Seychelles
Botswana*	Equatorial Guinea	Malawi	Sierra Leone
BurkinaFaso	Eritrea	Mali	Somalia
Burundi	Ethiopia	Mauritania	South Africa
Cameroon	Gabon	Mauritius	Sudan
Cape Verde	Gambia	Mozambique	Swaziland*
Central African Republic	Ghana	Namibia*	Tanzania
Chad	Guinea	Niger	Togo
Comoros	Guinea-Bissau	Nigeria	Uganda
Congo	Kenya	Rwanda	Zambia
Dem. Rep. of the Congo	Lesotho*	Sao Tome and Principe	Zimbabwe

Notes : * denotes not in the trade sample.

In the second stage of our analysis in section 5, we will complement the above data with data for 48 SSA countries on GDP per capita that we use as our proxy for wages[13] (see also

[12] South Africa, Kenya, Ethiopia, the Comoros, Malawi and Madagascar.

[13] Using GDP per worker instead invariably gives the same results but we loose an additional 8 observations in the process. This and the fact that Redding and Venables (2004) also use GDP per capita, made us decide to show the results using GDP per capita. Results using GDP per worker are available upon request.

Redding and Venables, 2004), human capital measures (most notably adult illiteracy), and a measure for economic density (working population density per km^2 of arable land). Also we have collected information on each country's status as an oil producer, its primary product exports (ores and metals) – both being measures of a country's degree of natural resource dependence – that we use in further robustness checks.

4. Step 1: Trade Estimation Results

The starting point of our empirical analysis[14] is the trade equation (6) as derived from the NEG model in section 2. Rewriting (6) in loglinear form and allowing for a year-specific intercept gives:

$$\ln EX_{ijt} = \alpha_0 + \alpha_t + \alpha_1 \ln Y_{it} + \alpha_2 \ln Y_{jt} + \alpha_3 \ln T_{ijt} + \varepsilon_{ijt} \qquad (7)$$

where Y denotes a country's GDP, and a subscript t is added to denote the year of observation. As has been mentioned before, the NEG-model does not specify trade costs T_{ijt} in any way (except that they are of the iceberg type). In the absence of actual trade cost data and following the modern empirical trade and economic geography literature (see e.g. Anderson and van Wincoop, 2004; Limao and Venables, 2001; Redding and Venables, 2004), we specify trade costs, T_{ijt}, to be a multiplicative[15] function of the following observable variables that are commonly used in the literature (see Appendix A for more details on each of the variables): bilateral distance (*D)*, sharing a common border (*B*), a common language (*CL*), or a common colonial heritage [distinguishing between sharing a common colonizer (*CC*) and having had a colony-colonizer relationship (*CR*)], being landlocked (*ll*), being an island (*isl*), an index measuring the quality of infrastructure (*inf*) and membership of the same African regional or free trade agreement (*RFTA*). In loglinear form this amounts to the following trade costs specification:

$$\begin{aligned} \ln T_{ijt} = {} & \chi_1 \ln D_{ijt} + \chi_2 \ln B_{ijt} + \chi_3 \ln CL_{ijt} + \chi_4 \ln CC_{ijt} + \chi_5 \ln CR_{ijt} \\ & + \chi_6 ll_{it} + \chi_7 ll_{jt} + \chi_8 isl_{it} + \chi_9 isl_{jt} + \chi_{10} inf_{it} + \chi_{11} inf_{jt} + \chi_{12} RFTA_{ijt} \end{aligned} \qquad (8)$$

Besides including GDP as the standard trade determinant related to countries' economic size, we also include the following additional variables in (7) that we think take account of some trade determinants that are to some extent typical of SSA. Given the fact that SSA has been the most conflict-ridden continent over the last few decades, we include two dummy variables

[14] We note that all results presented in the paper are robust to the exclusion of South Africa from the sample.

[15] This is the usual choice in the gravity literature (see e.g. Limao and Venables, 2001; Subramanian and Tamarisa, 2003). See Hummels (2001) for a critique on this, arguing in favor of an additive specification instead.

that indicate whether a country experienced outbreaks of civil unrest (see Rupert, 2004) in a specific year: civil conflict (*cconfl)* or civil war *(cwar)*; where civil war indicates more intense fighting than civil conflict. Next, we include the share of people living in rural areas (*%rural)*. Manufacturing activity is usually located in or near urban centers; higher urbanization increases a country's capacity to im- and export these goods. Also, Ancharaz (2003) shows that higher urbanization shares increase the likelihood of trade policy reform, and moreover, see Sahn and Stifel (2003), the welfare level of the urban population is generally higher than that of the rural population in SSA, resulting in higher demand for imported manufacturing products. Finally, we also include dummies for intra-SSA and internal trade (α_{ssa}, α_{own}) respectively, so that the trade specification that we estimate in the 1st step of our analysis is:

$$\begin{aligned}\ln EX_{ijt} &= \alpha_0 + \alpha_{SSA} + \alpha_{own} + \alpha_t + \alpha_1 \ln Y_{it} + \alpha_2 \ln Y_{jt} + \ln T_{ijt} + \alpha_4 \%rural_{it} \\ &+ \alpha_5 \%rural_{jt} + \alpha_6 cconfl_{it} + \alpha_7 cconfl_{jt} + \alpha_8 cwar_{it} + \alpha_9 cwar_{jt} + \varepsilon_{ijt}\end{aligned} \quad (9)$$

with $\ln T_{ijt}$ as in (8).

Some related studies do not have to choose the specific variables that capture a country's market capacity by opting instead for the inclusion of *importer and exporter fixed effects* when estimating the trade equation, see e.g. Breinlich (2006) and Knaap (2006). We, however, decided to explicitly specify the country-specific determinants of trade (see also Elbadawi et al., 2004; and §7 in Redding and Venables, 2004) for the following three reasons. First, as explained in Bosker and Garretsen (2007), these importer and exporter fixed effects also capture all trade cost related variables that are country-specific. The constructed market access term only includes the importer fixed effects (see Redding and Venables, 2004), and as a result it ignores the exporter-specific trade costs. Second, as pointed out by Redding and Venables (2004, p.75), using importer and exporter fixed effects does not allow one *"to quantify the effects on per capita income of particular country characteristics (for example, landlocked or infrastructure), since all such effects are contained in the dummies"* (Redding and Venables, 2004, p. 75). As a result, recommendations regarding the effect of country-specific policies (see section 6.3) aimed at e.g. lowering trade costs, are impossible to make. Third, as bilateral trade data are missing for 4 SSA countries (see Table 1), we would not be able to estimate the importer and exporter effect for these four countries. As a result these countries would also not be considered when constructing the various market access variables. When using country-specific characteristics instead, this can be avoided: we can use the estimated parameters from the first step in combination with these four countries' characteristics to construct the market access contributions for each of these countries even in the absence of these countries' bilateral trade data (of course given that we do have data on these country characteristics).

The actual estimation of (9) is, however, not without problems. In particular, the presence of zero trade flows complicates matters. As shown in Bosker (2008), about half of the observed bilateral SSA manufacturing trade flows are zeroes[16]. To deal with these zero observations one can choose between several estimation strategies that each have their (dis)advantages *(see also footnote 19)*. Referring to Bosker (2008) for a detailed exposition of the pro's and con's of (and the results using) different estimation strategies, here we use a Heckman 2-step estimation strategy (see also Helpman et al., 2007) to estimate the parameters of (9). Doing so we do not have to impose exogenous sample selection, i.e. that there is no unobserved variable related to both the probability to trade and the amount of trade, as e.g. discarding the zero observations and applying OLS on the non-zeroes only does. Nor, do we have to assume a priori that the exact same model explains both the probability to trade and the amount of trade, as using Tobit or estimating (9) in its non-linear form (6) using either NLS or pseudo-Poisson techniques would imply[17].

The Heckman 2-step procedure amounts to first estimating, using probit, how each of the variables affects the probability to trade. Next, in the second stage, the effect of each variable on the amount of trade is estimated, including the inverse Mills ratio (that is constructed using the results from the first step) to control for endogenous selection bias that would plague the results when simply discarding the non-zero observations (see for instance ch.17 in Wooldridge, 2003). However, using the Heckman 2-step procedure is also not free of assumptions[18]: the results when using this 2-step procedure are more convincing when one uses an exclusion restriction, i.e. having at least one variable that determines the probability to trade but *not* the amount of trade (see p.589 Wooldridge, 2003). To this end, we decided to

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[16]This number of zeroes in *bilateral trade flows* does not mean that the manufacturing sector is unimportant in SSA countries: on average about 30% of SSA GDP is generated in the manufacturing sector (compared to 20% in agriculture), and manufacturing exports and imports constitute a respective 37% and 68% of total SSA exports and imports [source: World Development Indicators 2008]. Moreover developing the (exporting) manufacturing sector is viewed by many as crucial to the region's chances on future economic success (IMF, 2007; World Bank, 2007).

[17] Also, given that the NEG model in section 2 in principle implies that each country trades at least something with each other country, using the NEG trade equation in explaining both the zero and the non-zero trade flows ascribes the zero observations to the error term only (relying on arguments of measurement error or reporting errors, see Santos Silva and Tenreyro, 2006, p.643).

[18] At this point we also note that our baseline results regarding the relevance of market access (i.e. its significance) are not affected when constructing market access based on estimating the trade equation (9) assuming exogenous sample selection instead and using OLS on the non-zero trade observations. The magnitude of the effect tends to be somewhat larger. See Appendix B, for the results of estimating (9) using OLS on the non-zero trade sample and for the baseline results on the relevance of market access when using market access constructed using those estimates.

use the *percentage of the labor force employed in agriculture*. We assume that this variable (after correcting for the other included variables!) does not affect the amount of trade but only the probability to trade. The reasoning for using this variable, and again referring to Bosker (2008) for a much more detailed exposition of both the econometric validity[19] and economic validity of our choice, is that it has been shown by inter alia Temple and Wößmann (2006) and Poirson (2001) that a lower share of the labor force employed in agriculture increases aggregate total factor productivity. When looked upon as a proxy of the economy's aggregate productivity, the fact that the percentage of the labor force in agriculture only affects the probability that a SSA economy exports or imports manufacturing goods, can be viewed as being consistent with trade theories of the Melitz (2003) type emphasizing productivity as a major determinant of the probability to trade (see also e.g. Hallak, 2006 and Helpman et al., 2007 for a similar line of reasoning).

Table 2 shows the estimation results, where the marginal effects give the overall effects of each of the included variables on the amount of trade (after taking the 1st stage into account) and the results for 0/1 trade refer to the 1st stage probit estimations. To explicitly allow for a different effect of a particular variable on intra-SSA and SSA trade with the rest of the world, we have interacted several variables with a dummy-variable taking the value of 1 when considering intra-SSA trade. In Table 2, adding "*ssa*" after a certain variable denotes that variable interacted with this intra-SSA trade dummy. Significance of an *"ssa"*-variable indicates a different effect of that particular variable on intra-SSA trade than on SSA trade with the ROW. Also, as argued in Bosker and Garretsen (2007), we allow distance to have a different effect when considering internal trade, hereby explicitly estimating the possibly different effect of distance on internal trade instead of simply postulating a difference (as in Redding and Venables, 2004) or assuming no difference (as in e.g. Breinlich (2006) and Knaap, 2006).

The main insights from the results reported in Table 2 are as follows[20]. First the outcomes for the *non-trade cost related* variables. Importer and exporter GDP both have the expected positive sign. More interesting, the trade-stimulating effect of an increase in GDP is much lower when considering intra-SSA trade, suggesting that as SSA countries get richer the focus of their manufacturing trade activity shifts away from other SSA countries in favor of

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[19] The econometric validity hinges on the significance of the Mills ratio in Table 2 and on noting the fact that % labor force in agriculture is not significant in an OLS regression using the non-zero trade flows only (see Table A2 in Appendix B).

[20] Although reported, the results of the first stage probit estimation are not explicitly discussed here. See Bosker, 2008 for a more detailed discussion of these results.

countries in the ROW. Civil unrest negatively affects trade, and the more so the more violent it becomes (compare the parameters of the civil war dummies to those of the civil conflict dummies). Also as expected, a higher degree of urbanization results in more exports and imports of manufacturing goods. The effect on manufacturing exports is however much larger than on imports. Given that manufacturing in SSA is mostly located in urban areas and (unskilled) labor-intensive, an explanation for this last finding is that a higher level of urbanization suppresses wages due to the larger supply of unskilled labor. This lowers firms' production costs making it easier for them to be competitive on world markets[21].

Table 2 : The Trade Equation Estimates

dependent variable			ln trade		
Estimation method			Heckman - 2step		
time period			1993-2002		
Variable	marginal effects	0/1 - trade	variable	marginal effects	0/1 - trade
ln distance	-1.478	-0.395	island exp	0.555	0.166
ln internal distance	0.869*	0.430	island exp ssa	-2.177	-0.690
ln distance ssa	-0.033**	-0.140	island imp	0.393	0.228
ln GDP imp	1.385	0.464	island imp ssa	-1.504	-0.748
ln GDP imp ssa	-0.427	-0.060	ln infrastructure exp	0.459	0.126
ln GDP exp	1.531	0.436	ln infrastructure exp ssa	1.053	0.277
ln GDP exp ssa	-0.250	-0.031	ln infrastructure imp	0.168	-0.013**
colony – colonizer	2.470	1.702	ln infrastructure imp ssa	0.833	0.223
common colonizer	1.094	0.309	RTA or FTA	-0.471**	0.013**
common colonizer ssa	-0.079**	-0.011**	RTA or FTA ssa	1.489	0.085**
Contiguity	-1.241	-0.272**	civil conflict imp	-0.538	-0.196
Contiguity ssa	2.645	0.821	civil conflict exp	-0.599	-0.062
common off language	0.858	0.289	civil war imp	-0.905	-0.322
common off language ssa	-0.553	-0.164	civil war exp	-1.447	-0.368
landlocked exp	-0.226	-0.229	% rural population imp	-0.343	-0.030**
landlocked exp ssa	-0.765	-0.066**	% rural population exp	-2.985	-0.651
landlocked imp	-0.294	0.039*	% in agriculture imp	-	-0.159
landlocked imp ssa	0.334	-0.006**	% in agriculture exp	-	-0.119
dummy ssa trade	13.021	3.371	dummy internal trade	2.413**	4.982
nr observations			74492		
Mills ratio [p-value]			2.930 [0.000]		

Notes : ** (*) denotes **NOT** significant at the 5% (1%) respectively.

Next, the effect of the different trade cost variables on SSA manufacturing trade. Starting with the results regarding the *bilateral trade cost* variables, we find the standard result that distance negatively affects the amount of trade between countries. More interesting, and in line with Foroutan and Pritchett (1993) but contrary to Limao and Venables (2001), we do not find evidence that the penalty on distance is higher for intra-SSA trade. Also, the results

[21] Also, productivity (and hence international competitiveness) tends to be higher in urban areas due to positive spillovers or externalities associated with agglomeration economies (see Rosenthal and Strange, 2004).

clearly show the advantage of explicitly allowing for a different effect of distance on internal trade: the distance penalty is about 60% lower for internal trade compared to bilateral trade. For intra-SSA trade we find a clear positive effect of sharing a common border on trade flows (see e.g. Limao and Venables, 2001; Subramanian and Tamirisa, 2003 and Foroutan and Pritchett, 1993). For SSA-ROW trade we, however, find (surprisingly) a negative effect. When we take into consideration that the only SSA countries that border non-SSA countries are those bordering North African countries, this simply indicates that these SSA countries trade less with their North African neighbors than with non-African countries (see also IMF, 2007). Sharing a colonial history has a strong positive effect on the amount of trade. Especially SSA trade with its former colonizer(s) is much higher than trade with other countries in the world. Having a common colonizer also boosts bilateral trade and we find no indication that the effect is different for intra-SSA trade compared to trade with the ROW. Sharing a common language stimulates both intra-SSA and SSA-ROW trade (see also Foroutan and Pritchett, 1993) and Coe and Hoffmaister, 1999). The trade facilitating effect of language similarity is much larger for trade with the rest of the world however (the common border and common colonizer variable may already be capturing some of the language effect in case of intra-SSA trade). A bilateral trade cost variable that is of particular interest is the variable capturing the effect of being a member of the same African regional or free trade agreement (RFTA). Intra-SSA trade in manufactures substantially benefits from having an RFTA, providing evidence in favor of those who argue for increased African integration (one of the explicit goals of e.g. the African Union). The finding that having an RFTA does not significantly affect SSA-ROW trade is not surprisingly since the only non-SSA countries being part of an all-African RFTA are some of the North African countries (see the earlier-discussed results regarding the common border variable).

Our results regarding the three *country-specific trade cost* variables, i.e. being landlocked, being an island, and the quality of a country's infrastructure also show some interesting differences when comparing their impact on intra-SSA and SSA-ROW trade respectively. We find that being landlocked depresses both SSA imports and exports of manufacturing goods to the ROW, corroborating the findings in Coe and Hoffmaister (1999). When looking at intra-SSA trade, being landlocked affects intra-SSA exports even more negatively; on the contrary, being landlocked slightly increases the amount imported from other SSA countries. This difference is quite interesting, as it indicates that landlocked countries in SSA are more dependent on imported manufacturing goods from other SSA countries compared to the SSA countries that do have direct access to the sea. Being an island nation increases trade with the ROW, confirming findings by e.g. Limao and Venables (2001). Intra-SSA is much lower for these same island nations. Apparently, the island nations of SSA (Mauritius, Comoros, Cape Verde and Sao Tome and Principe) are oriented away from the African mainland when it comes to trade. These findings suggest that SSA countries are much more oriented towards the ROW than towards other SSA countries: island nations trade much less with the African mainland and countries with direct access to the sea import more manufacturing goods from the ROW than from other SSA countries (see also the results on the GDP variables).

The final trade cost related variable that we consider is the quality of a country's infrastructure that is arguably the most interesting variable from a policy perspective given the large amounts of funds currently allocated by donors to (co-)finance infrastructure improvements in SSA ($7.7 billion by members of The Infrastructure Consortium for Africa alone[22]). In line with the results in Limao and Venables (2001), and Buys et al. (2006) we find that improved quality of infrastructure has large positive effects on the amount of trade. Even more interestingly, improving the quality of infrastructure has a much larger positive effect on intra-SSA trade than on SSA trade with the ROW. These findings show that the current focus on improving SSA infrastructure (see e.g. the aim of the Sub-Saharan African Transport Policy Program[23] and The Infrastructure Consortium for Africa[17]) is warranted.

5. Step 2: Constructing Market Access and Baseline Results

5.1 Constructing market access from the trade estimations

Having estimated the effects of both the trade-cost related and the market capacity related variables on the amount of trade, we are now in a position to construct market access for each of the 48 SSA countries in our sample. More specifically, we use the estimated coefficients shown in Table 2 and the relationship between the trade equation in (6) and market access in (5) to construct market access as follows, distinguishing explicitly between the respective contribution of internal market access, SSA market access and ROW market access to a country's total market access:

$$MA_{it} = MA_{it}^{own} + MA_{it}^{SSA} + MA_{it}^{ROW} \qquad (10)$$

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22 See http://www.icafrica.org/fileadmin/documents/AR2006/ICA_Annual_Report_-_Volume_1_-_FINAL_March_2007.pdf.

23 For more info see: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTAFRREGTOPTRA/EXTAFRSUBSAHTRA/0,,menuPK:1513942~pagePK:64168427~piPK:64168435~theSitePK:1513930,00.html?

where $MA_{it}^{SSA} = \sum_{j \in SSA, j \neq i}^{R} MA_{ijt}^{SSA}$, $MA_{it}^{ROW} = \sum_{j \notin SSA}^{R} MA_{ijt}^{ROW}$ and $MA_{it}^{own} = MA_{iit}$. And these three components of a country's total market access are constructed using:

$$\begin{aligned}
MA_{iit}^{own} &= e^{\hat{\alpha}_{own}} \left(Y_{jt}\right)^{\hat{\alpha}_2} \left(\%rural_{jt}\right)^{\hat{\alpha}_5} \left(D_{iit}\right)^{\hat{\chi}_1 + \hat{\chi}_1^{own}} \\
&\quad e^{(\hat{\chi}_6 + \hat{\chi}_7) ll_{it} + (\hat{\chi}_8 + \hat{\chi}_9) isl_{it} + (\hat{\chi}_{10} + \hat{\chi}_{11}) inf_{it} + (\hat{\alpha}_6 + \hat{\alpha}_7) cconfl_{it} + (\hat{\alpha}_8 + \hat{\alpha}_9) cwar_{it}} \\
MA_{ijt}^{row} &= \left(Y_{jt}\right)^{\hat{\alpha}_2} \left(\%rural_{jt}\right)^{\hat{\alpha}_5} \left(D_{ijt}\right)^{\hat{\chi}_1} e^{\hat{\chi}_2 B_{ijt} + \hat{\chi}_3 CL_{ijt} + \hat{\chi}_4 CC_{ijt} + \hat{\chi}_5 CR_{ijt} + \hat{\chi}_{12} RFTA_{ijt}} \\
&\quad e^{\hat{\chi}_6 ll_{it} + \hat{\chi}_7 ll_{jt} + \hat{\chi}_8 isl_{it} + \hat{\chi}_9 isl_{jt} + \hat{\chi}_{10} inf_{it} + \hat{\chi}_{11} inf_{jt} + \hat{\alpha}_6 cconfl_{it} + \hat{\alpha}_7 cconfl_{jt} + \hat{\alpha}_8 cwar_{it} + \hat{\alpha}_9 cwar_{jt}} \\
MA_{ijt}^{row} &= e^{\hat{\alpha}_{ssa}} \left(Y_{jt}\right)^{\hat{\alpha}_2^{ssa}} \left(\%rural_{jt}\right)^{\hat{\alpha}_5} \left(D_{ijt}\right)^{\hat{\chi}_1^{ssa}} e^{\hat{\chi}_2^{ssa} B_{ijt} + \hat{\chi}_3^{ssa} CL_{ijt} + \hat{\chi}_4^{ssa} CC_{ijt} + \hat{\chi}_{12}^{ssa} RFTA_{ijt}} \\
&\quad e^{\hat{\chi}_6^{ssa} ll_{it} + \hat{\chi}_7^{ssa} ll_{jt} + \hat{\chi}_8^{ssa} isl_{it} + \hat{\chi}_9^{ssa} isl_{jt} + \hat{\chi}_{10}^{ssa} inf_{it} + \hat{\chi}_{11}^{ssa} inf_{jt} + \hat{\alpha}_6 cconfl_{it} + \hat{\alpha}_7 cconfl_{jt} + \hat{\alpha}_8 cwar_{it} + \hat{\alpha}_9 cwar_{jt}}
\end{aligned} \tag{11}$$

where $\hat{\alpha}_k^{ssa}$ and $\hat{\chi}_k^{ssa}$ capture the estimated effect of a variable on intra-SSA trade (i.e. the coefficient on a variable plus the coefficient on that variable interacted with the intra-SSA dummy).

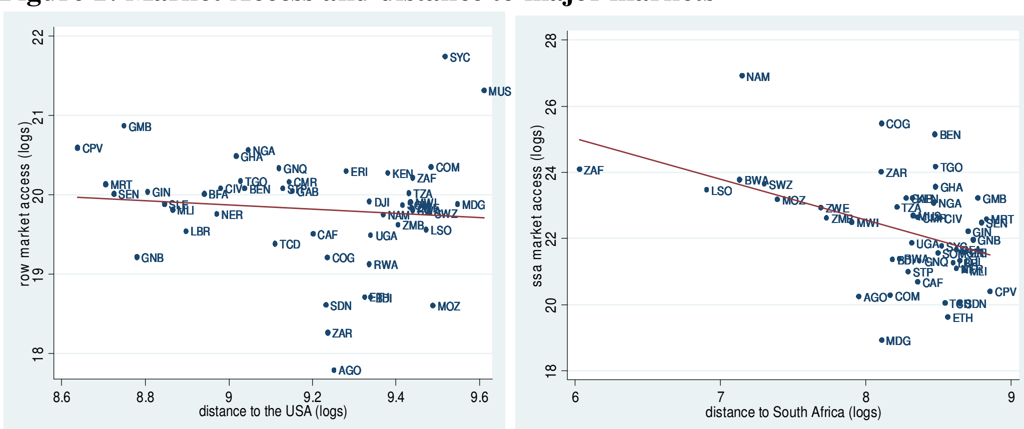
Using (10) and (11), we construct total market access (MA), SSA market access (SSA-MA), ROW market access (ROW-MA) and own market access (own-MA) for each of the 48 SSA countries in each year during our sample period 1993-2002. Table 3 shows average (log) total market access along with the share of each of its subcomponents, and the average SSA GDP per capita for each of the years in our sample.

Table 3 : Market Access (shares) and GDP per capita over time

year	ln avg MA	% row	% ssa	% own	GDP per capita
1993	24.23	8.9	69.7	21.4	2342
1994	24.24	9.0	70.2	20.7	2334
1995	24.33	9.3	69.9	20.9	2353
1996	24.12	9.3	69.0	21.7	2394
1997	24.03	10.2	67.6	22.2	2462
1998	24.04	8.9	68.4	22.7	2534
1999	24.11	9.6	67.6	22.8	2567
2000	24.12	12.1	62.5	25.3	2633
2001	24.49	11.3	63.4	25.3	2559
2002	24.48	11.4	63.3	25.4	2661
% change 1993-2002	28.61	2.5	-6.5	4.0	13.64
average yearly % change	1.40	0.3	-0.7	0.4	1.30

Average market access has improved at an annual rate of 1.4%, slightly higher than the average annual growth rate of GDP per capita. Looking at the three subcomponents of market access shows that SSA market access dominates total market access, and this reflects in part the high penalty on distance in SSA trade and the positive border effect (see Table 2). The share of SSA trade has, however, decreased from around 70% in 1993 to about 63% in 2002. ROW and own market access have both been gaining in importance in total market access. The fact that the ROW's share in market access has been on the rise partly reflects that the ROW experienced (on average) higher GDP growth than SSA. Combined with the higher coefficient on ROW GDP (see Table 2), this has increased ROW market access faster than SSA market access. The increase in own market access can also be ascribed to the higher coefficient on GDP in own market access compared to that in SSA market access, but also to the much smaller penalty on internal distance (see Table 2) plays a role here.

Figure 1: Market Access and distance to major markets



Notes: the raw correlation between log distance to the USA and log ROW market access is (p-values in brackets): -0.09 (0.05) and that between log distance to South Africa and log SSA market access is –0.42 (0.00).

Figure 1 illustrates in some more detail the role of distance to major markets as a determinant of market access. The left panel plots for each SSA country its ROW-market access against the distance to the United States, and the right panel plots for each country its SSA-market access against the distance to South Africa[24]. It shows that in both cases market access is lower for those countries at greater distance from the United States and South Africa respectively. This effect is, however, much more pronounced when considering SSA market access and the distance to South Africa, which is in part due to the fact that besides the USA also Europe (and increasingly also Asia) constitutes a large market for SSA products. Figure 1 also shows that some of SSA countries with the worst access to markets in the ROW are landlocked (e.g. Chad, the Central African Republic, Rwanda), whereas the island nations (e.g. Seychelles, Mauritius, Comoros and Cape Verde) tend to have the best access to non-

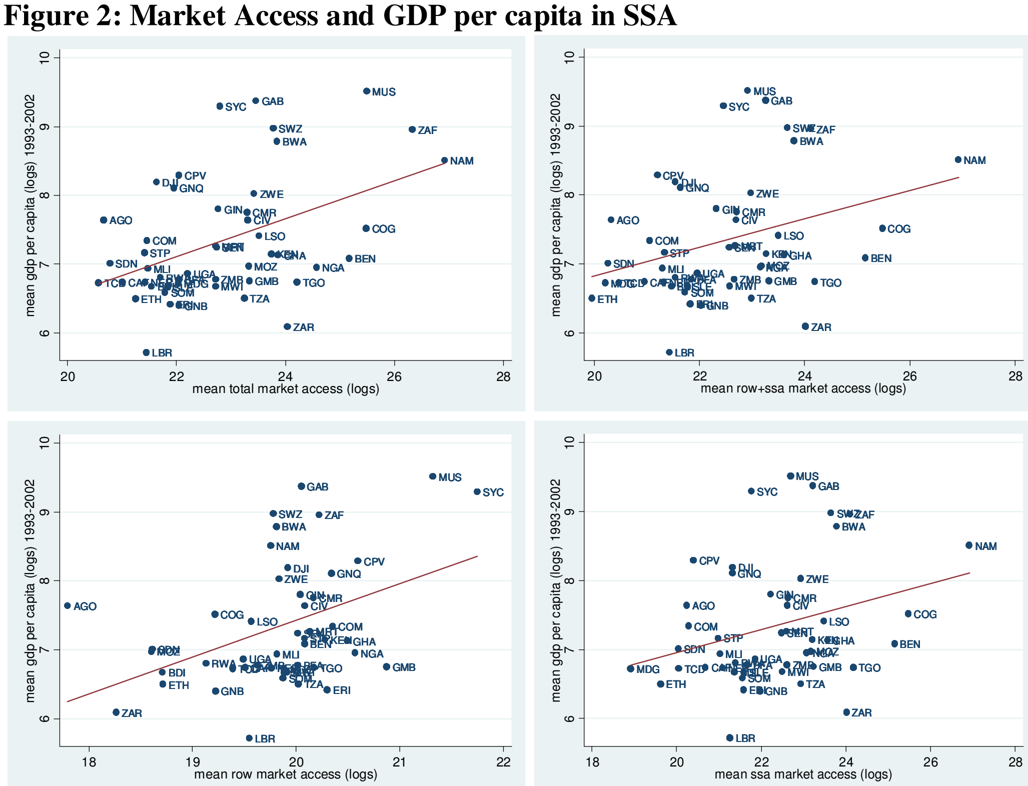
[24] Besides countries close to South Africa also those countries close to Africa's second largest economy, Nigeria, tend to have higher SSA market access. Scatter plot available upon request.

SSA markets. When considering SSA market access, these same island nations are doing much worse. The landlocked countries are again among the countries with the worst SSA market access. Finally we note that those countries experiencing civil conflict or, worse still, civil war, e.g. Sudan, the Democratic Republic of Congo, Ethiopia, or Angola, tend to be among the countries with the lowest SSA as well as ROW market access.

5.2 The relevance of market access for GDP per capita in SSA: baseline results

Now that we have constructed the various measures of market access for all 48 SSA countries in our sample, we can assess the effect of market access on GDP per capita. Before we turn to the actual estimation of the wage equation (5), Figure 2 plots *mean* market access (TOTAL, ROW+SSA[25], ROW, and SSA market access) for the period 1993-2002 against *mean* GDP per capita over that same period.

Figure 2: Market Access and GDP per capita in SSA



Notes: the raw correlations of each of the market access variants are (p-values in parentheses): total: 0.44 (0.00); row + ssa: 0.31 (0.00); row: 0.38 (0.00); ssa: 0.28 (0.00).

[25] Note that this is basically *"Foreign Market Access"* as used in e.g. Redding and Venables (2004) or Breinlich (2006) as it excludes access to a country's own market.

Figure 2 shows a clear positive relationship between GDP per capita and market access. Also, SSA-market access seems somewhat less important compared to ROW market access (see the reported correlations below Figure 1).

Taking logs on both sides of the wage equation (5) from the NEG model in section 2, we arrive at the log-linear relationship between market access and wages that we will estimate using panel data techniques:

$$\ln w_{it} = \beta_0 + \beta_1 \ln MA_{it} + \eta_{it} \qquad (12)$$

In line with Redding and Venables (2004, p.63) and Breinlich (2006), we proxy wages (the price of the immobile factor of production) by GDP per capita [see also footnote 14]. The error term η_{it} includes c_i a country's the level of technological efficiency. Again following Redding and Venables (2004), we start by assuming that these cross-country differences in technology are captured by an idiosyncratic error term (implicitly only allowing for other variables determining technological efficiency that are *un*correlated with our market access measure), and estimate (12) using pooled OLS. The results are shown in the first four columns of Table 4[26].

Table 4 : Market access and GDP per capita – first estimation results

dep: log GDP per capita	ols	ols	ols	ols	ols	ols	ols	ols
log tot ma	0.258	-	-	-	0.063	-	-	-
robust	0.000	-	-	-	0.005	-	-	-
bootstrapped	0.000	-	-	-	0.010	-	-	-
log ssa+row ma	-	0.186	-	-	-	0.031	-	-
robust	-	0.000	-	-	-	0.050	-	-
bootstrapped	-	0.000	-	-	-	0.073	-	-
log row ma	-	-	0.461	-	-	-	0.032	-
robust	-	-	0.000	-	-	-	0.321	-
bootstrapped	-	-	0.000	-	-	-	0.373	-
log ssa ma	-	-	-	0.153	-	-	-	0.031
robust	-	-	-	0.000	-	-	-	0.036
bootstrapped	-	-	-	0.000	-	-	-	0.049
p-value country FE	no	no	no	no	0.000	0.000	0.000	0.000
p-value time FE	no	no	no	no	0.000	0.000	0.001	0.000
nr observations	477	477	477	477	477	477	477	477
R2	0.190	0.094	0.147	0.077	0.966	0.965	0.951	0.965

Notes : p-values below coefficients. Bootstrapped p-values on the basis of 200 replications. Results for the constant and the time- and country fixed effects are not shown to save space.

[26] Following Breinlich (2006), Knaap (2006) and Redding and Venables (2004), we show both robust and bootstrapped standard errors for all our estimation results. The bootstrapped standard errors take explicit account of the fact that our measures of market access are all generated regressors, see Redding and Venables (2004, p. 64) for more details.

The estimated market access coefficient is positive and significant for each of the four measures of market access, indicating a positive effect of market access on GDP per capita across SSA. An increase of total market access by 1% would increase GDP per capita by 0.25%. Also, when considering only foreign market access (ROW+SSA market access excludes own market access), we find a positive (but somewhat smaller) effect of market access. When considering only SSA or only ROW market access, we find an interesting difference. The estimated coefficient on ROW market access is much higher that that on SSA market access, and also ROW market access on its own explains about twice as much of the SSA-variance in GDP per capita than SSA market access does. This suggests that it is above all improved market access to non-SSA countries that will boost economic development in SSA, thereby seemingly vindicating those studies that proclaim that intra-SSA economic linkages are too weak and under-developed to be of importance to SSA countries.

The estimation results in the first 4 columns of Table 4 are, however, only valid under the earlier-mentioned assumption of idiosyncratic differences in country's technological efficiency that are uncorrelated with market access. As this assumption is likely to be violated, we subsequently make use of the panel data nature of our data set. We include country fixed effects to capture country-specific variables affecting a country's technological efficiency that do not vary over time. Most notably we hereby control for the effect of absolute (or 1st nature) geography (climate, soil quality, etc) that is, as we discussed in the introduction, often blamed for Africa's poor development. But it arguably also controls for a country's institutional quality[27] (see Breinlich, 2006). By also including time (year) fixed effects, we take account of shocks that are affecting all countries similarly, such as the availability of technological innovations made in developed countries (the introduction of mobile phones, which have rapidly spread all over SSA, is a prime example). The last 4 columns of Table 4 show the results of these fixed effects estimations.

As can be seen from Table 4, the inclusion of fixed effects is quite important: the effect of total market access on GDP per capita is still positive and significant but the size of the market access coefficient is much lower: a 1% increase in a country's total market access, now 'only' increases GDP per capita with 0.06%. In addition, when we split total market access in ROW+SSA-MA, ROW-MA and SSA-MA, we now observe that the coefficient on SSA market access is *not* different from that on ROW market access. Even more strikingly,

[27] Of course, institutional quality may change over time, but given our relatively short time span of 10 years and the fact that institutional change is general a very slow process, we are quite confident that we are capturing institutional quality to a large extent by allowing for country fixed effects.

when considering ROW market access only, it no longer has a significant impact on GDP per capita, whereas SSA market access still does have a significant effect. The significance of ROW+SSA-MA and also that of total MA seems to be largely due to market access to other SSA countries. Also note that both the country and time fixed effects are significant.

The inclusion of these two fixed effects may still not provide us with accurate estimates of the effect of market access however. They only control for time-invariant country-specific or country-invariant time-specific variables. It is possible that a country's technological efficiency is also determined by time- <u>ànd</u> country-varying variables that are correlated with market access. If this is the case, we would still obtain biased estimates of the coefficient on market access, even when allowing for country- and year fixed effects. Following Breinlich (2006), we therefore also include two variables, namely the adult illiteracy rate as a measure for a country's human capital[28], and the working population density per km^2 of arable land[29], that both have been shown to affect a country's productivity level and to be correlated with market access (see e.g. Ciccone and Hall (1996), Ciccone (2002), Redding and Schott (2003) and Breinlich, 2006).

Table 5 Adding Human Capital and Employment Density: Baseline Results

					BASELINE			
dep: log GDP per capita	ols	ols	ols	ols	ols	ols	ols	ols
log tot ma	0.160	-	-	-	0.076	-	-	-
robust	0.000	-	-	-	0.001	-	-	-
bootstrapped	0.000	-	-	-	0.004	-	-	-
log ssa+row ma	-	0.088	-	-	-	0.053	-	-
robust	-	0.000	-	-	-	0.004	-	-
bootstrapped	-	0.000	-	-	-	0.007	-	-
log row ma	-	-	0.352	-	-	-	0.083	-
robust	-	-	0.000	-	-	-	0.038	-
bootstrapped	-	-	0.000	-	-	-	0.043	-
log ssa ma	-	-	-	0.072	-	-	-	0.050
robust	-	-	-	0.000	-	-	-	0.003
bootstrapped	-	-	-	0.000	-	-	-	0.005
adult illiteracy	-0.018	-0.022	-0.022	-0.022	-0.021	-0.019	-0.017	-0.018
robust	0.000	0.000	0.000	0.000	0.048	0.074	0.111	0.084
bootstrapped	0.000	0.000	0.000	0.000	0.073	0.105	0.167	0.133
log working pop / km2 arable land	0.108	0.091	0.047	0.089	0.294	0.300	0.320	0.304
robust	0.004	0.011	0.206	0.013	0.050	0.044	0.032	0.042
bootstrapped	0.004	0.000	0.331	0.029	0.063	0.079	0.058	0.046
p-value country FE	no	no	no	no	0.000	0.000	0.000	0.000
p-value time FE	no	no	no	no	0.320	0.395	0.419	0.385
nr observations	369	369	369	369	369	369	369	369
R2	0.401	0.356	0.412	0.352	0.966	0.965	0.965	0.966

Notes : p-values below coefficients. Bootstrapped p-values on the basis of 200 replications.

[28] In section 6.2, we focus in more detail on the relationship between human capital, market access and income.

[29] We use arable land, instead of total land because large parts of almost each SSA country are quite hostile to human settlement (e.g. the Sahara and Kalahari desert and the jungles in central Africa).

Table 5 shows the corresponding estimation results when we add these two control variables (with and without fixed effects) [30]. Compared to Table 4, the inclusion of human capital and working population density leads to the following changes. Without fixed effects, we observe that the coefficients on market access are much lower than in Table 4, confirming findings by Breinlich (2006), Hering and Poncet (2006) and Amiti and Cameron (2007) who also find that controlling for human capital and density leads to lower estimates for market access. When the county- and time- fixed effects are included, the size of the estimated market access coefficients drops even further (which is in line with the results shown in Table 4). This drop is again the largest for ROW market access, again indicating that the positive effect of ROW market access would be much overstated when not controlling for these effects (as for example a cross-section analysis would do). Note also that the time dummies are no longer significant which suggests that the time effects are picked up by our two (time-varying) controls.

With regard to the different impact of each of the components of total market access, we find that all three components are significant and positively contributing to GDP per capita. ROW market access still has a larger impact on GDP per capita, although the difference with SSA market access is much smaller than in the first four columns of Table 4 or Table 5. Given the fact that SSA market access' contribution to total MA is much larger than that of ROW market access (see Table 3), the coefficient on ROW+SSA market access is about the same as that on SSA market access. Overall, a 1% increase in total market access increases GDP per capita by 0.08%, and when focussing only on SSA, ROW or foreign (SSA+ROW) market access the effect of a 1% increase in the corresponding market access term increases GDP per capita by 0.05% in case of SSA and SSA+ROW market access and by 0.08% in case of ROW market access.

6. Additional Results: Robustness Checks, Human Capital and Policy Shocks

6.1 Robustness of the results

The last four columns of Table 5 constitute our baseline results. One could still raise several issues that would invalidate these results. First, even though we have corrected for fixed time and country effects and have added two additional control variables, there is the issue of endogeneity. The assumption under which our baseline results are valid is that, after

[30] Also controlling for natural resource dependence (by including a dummy for oil exporting countries and/or the percentage of ores and metals in merchandise trade) leaves the results on market access unaffected. Including these proxies for natural resource dependence does however significantly reduce the number of observations so that we decided to report the results without these two proxies in the paper. Results are available upon request.

controlling for fixed effects and our two included controls, the remaining error term is uncorrelated with our measures of market access. One way in which this may be violated is when the error term still contains other variables influencing a country's GDP per capita that are correlated with market access. Another way is reverse causality: when market access not only influences GDP per capita but GDP per capita in turn also influences marker access, the error term would by construction be correlated with market access and thus give biased estimates of the effect of our measures of market access.

To control for both possible sources of endogeneity[31], we employ an instrumental variable approach by using the distance to the USA and South Africa as instruments (see Figure 1) for our measures of market access[32]. The first four columns of Table 6 show that our results remain unaffected (also note that our instruments pass both the overidentification and instrument relevance tests): all variants of market access still positively and significantly affect GDP per capita. Note however that the instruments are time-invariant, which precludes the use of country-fixed effects. Comparing our results to the first four columns of Table 5 (that also excludes country-fixed effects) thus provides the best insight into the effect of controlling for endogeneity by using our instruments. We observe that the coefficient on SSA market access (and also that on total and ROW+SSA market access, that are largely made up of SSA market access, see Table 3) is much larger, whereas the coefficient on ROW market access is much lower. The results on human capital and density are largely unaffected.

Given the choice of instruments, the inability to control for fixed country effects constitutes a drawback of the IV-estimates. Columns 5-8 of Table 6 hence show the results when one includes each market access measure lagged one period (the human capital and density measure are also lagged one period). This arguably controls for one of the three main reasons of possible endogeneity problems when estimating the NEG wage equation that usually receives most attention, i.e. reverse causality, while still allowing for the inclusion of country-fixed effects. Comparing these results to the last four columns in Table 5 shows that reverse causality does not seem to be a major issue, and, most importantly, we still find a positive effect of each of the market access variables on SSA's GDP per capita.

[31] It also controls for the third way by which endogeneity issues may be raised, i.e. measurement error.

[32] Distance to major markets is often used as an instrument in empirical studies in NEG, see e.g. Redding and Venables (2004) and Breinlich (2006). When considering total or SSA+ROW market access we use both distances as instruments, when considering SSA or ROW market access by itself, we use only distance to South Africa in case of SSA and only distance to the USA in case of ROW market access.

Table 6 Robustness of the results – IV, lagged MA, and 1st differences (FD)

dep: log GDP per capita	IV	IV	IV	IV	ols lagged	ols lagged	ols lagged	ols lagged	FD	FD	FD	FD
log tot ma	0.427	-	-	-	0.077	-	-	-	0.033	-	-	-
robust	0.000	-	-	-	0.003	-	-	-	0.011	-	-	-
bootstrapped	-	-	-	-	0.005	-	-	-	0.013	-	-	-
log ssa+row ma	-	0.392	-	-	-	0.053	-	-	-	0.027	-	-
robust	-	0.000	-	-	-	0.013	-	-	-	0.024	-	-
bootstrapped	-	-	-	-	-	0.010	-	-	-	0.024	-	-
log row ma	-	-	0.232	-	-	-	0.102	-	-	-	0.035	-
robust	-	-	0.059	-	-	-	0.013	-	-	-	0.214	-
bootstrapped	-	-	-	-	-	-	0.022	-	-	-	0.241	-
log ssa ma	-	-	-	0.376	-	-	-	0.048	-	-	-	0.025
robust	-	-	-	0.000	-	-	-	0.014	-	-	-	0.024
bootstrapped	-	-	-	-	-	-	-	0.024	-	-	-	0.031
adult illiteracy	-0.007	-0.012	-0.023	-0.012	-0.025	-0.023	-0.022	-0.022	-0.008	-0.008	-0.006	-0.007
robust	0.035	0.000	0.000	0.006	0.029	0.044	0.054	0.051	0.676	0.681	0.746	0.695
bootstrapped	-	-	-	-	0.040	0.069	0.085	0.054	0.674	0.688	0.732	0.703
log working pop / km2 arable land	0.175	0.173	0.054	0.180	0.258	0.264	0.286	0.268	0.066	0.060	0.051	0.060
robust	0.000	0.000	0.147	0.000	0.068	0.061	0.044	0.059	0.727	0.751	0.787	0.751
bootstrapped	-	-	-	-	0.095	0.106	0.043	0.076	0.748	0.774	0.796	0.774
p-value country FE	no	no	no	no	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
p-value time FE	0.838	0.927	0.999	0.937	0.849	0.891	0.828	0.894	0.345	0.356	0.407	0.352
nr observations	369	369	369	369	369	369	369	369	328	328	328	328
R2	0.990	0.988	0.992	0.9871	0.961	0.960	0.960	0.960	0.082	0.076	0.070	0.076
F-statistic	41.45	35.38	66.33	57.63	-	-	-	-	-	-	-	-
p-value F-test	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	-
p-value overID-test	0.845	0.631	-	-	-	-	-	-	-	-	-	-

Notes : p-values below coefficients. Bootstrapped p-values on the basis of 200 replications.

Our final robustness check again concerns the way we dealt with the unobserved country-specific variables that are correlated with our measures of market access. In our baseline results we capture these by including country-fixed effects. Another standard way of doing this is by estimating (12) in first differences. Compared to the fixed effect estimation, first differencing requires less strict assumptions regarding the exogeneity of lagged error terms (fixed effect requires strict exogeneity, i.e. any lagged error is uncorrelated with the included explanatory variables, whereas first differencing requires this for the first lag of the error process only). The last four columns show the results of estimating the wage equation (12) in first differences. The effect of market access, although slightly lower than when using fixed effects, is still significant and positive. The only substantial difference lies in the fact that ROW-market access is no longer significant (see also Table 4).

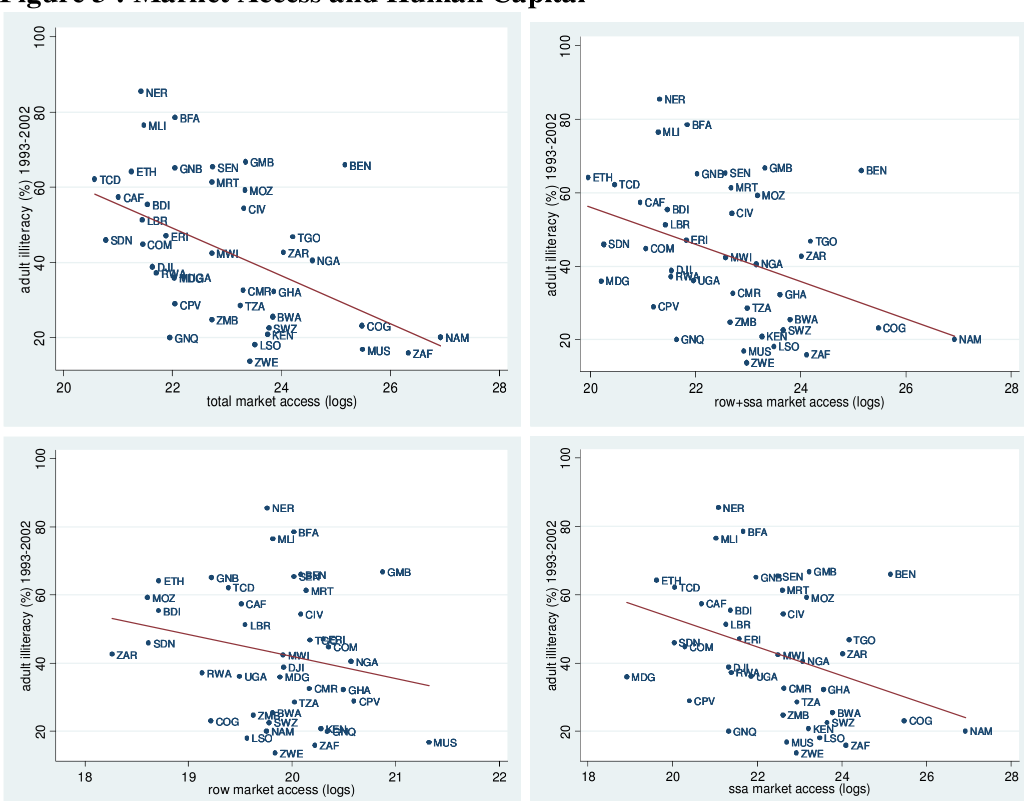
Overall, the positive effect of SSA-MA that we find is most robust, indicating that current efforts to improve SSA-MA in particular, such as the Trans-Africa highway network that is being developed by among others the United Nations Economic Commission for

Africa, the African Development Bank and the African Union (see also e.g. Buys, et al., 2006), are likely to contribute positively to economic development in the SSA region.

6.2 *Human capital and market access*

Besides the direct effect of a country's market access, Redding and Schott (2003) argue that it may also have an indirect effect through the accumulation of human capital. They show theoretically that if manufacturing is relatively skill and trade cost intensive, countries with better access to international markets will experience increased incentives to invest in the education of their workforce. They also provide empirical evidence to back up their claim using a sample of 106 countries. Breinlich (2006) finds similar empirical evidence of a positive effect of market access on human capital when considering European regions.

Figure 3 : Market Access and Human Capital



Notes: the raw correlations of each of the market access variants with the adult illiteracy rate are (p-values in brackets): total: -0.46 (0.00); row + ssa: -0.35 (0.00); row: -0.19 (0.00); ssa: -0.33 (0.00).

Our baseline results in Table 5 showed that controlling for human capital still leaves a positive and significant direct effect of market access on GDP per capita. In this subsection we are concerned with a possible indirect effect of market access on income levels through its effect on human capital. Figure 3 shows that we also find a strong positive correlation between market access and human capital (as measured by the adult illiteracy rate) when considering our sample of 48 SSA countries. Interestingly, the correlation with ROW market access is somewhat weaker than with SSA (and also ROW+SSA and total) market access.

Table 7 provides estimation results to assess the relevance of market access for human capital. It shows the results of regressing a logistic transformation of adult illiteracy (following Redding and Schott (2003) this makes sure that illiteracy is bounded between 0 and 1) on each of our four measures of market access while controlling for the positive effect of income per capita on human capital. The results confirm the positive relationship between total market access and human capital levels (remember that our dependent variable is adult *il*literacy), even after controlling for income levels. Strikingly, we do not find evidence of such a positive relationship when considering only ROW market access. The significant positive effect of total (and ROW+SSA) market access seems to be entirely driven by the cross-country variation in SSA market access.

Table 7 : Human capital and Market Access

dep: adult illiteracy	ols	ols	ols	ols
log tot ma	-0.143	-	-	-
robust	0.000	-	-	-
bootstrapped	0.000	-	-	-
log ssa+row ma	-	-0.110	-	-
robust	-	0.000	-	-
bootstrapped	-	0.000	-	-
log row ma	-	-	0.048	-
robust	-	-	0.307	-
bootstrapped	-	-	0.324	-
log ssa ma	-	-	-	-0.091
robust	-	-	-	0.000
bootstrapped	-	-	-	0.000
log GDP per capita	-0.488	-0.549	-0.630	-0.559
robust	0.000	0.000	0.000	0.000
bootstrapped	0.000	0.000	0.000	0.000
nr observations	369	369	369	369
R2	0.389	0.373	0.342	0.369

Notes : p-values below coefficients. Bootstrapped p-values on the basis of 200 replications.

To check whether these results regarding human capital depend on our measure of human capital, we also collected data on three different measure of human capital, namely youth (= under 25) illiteracy, the gross secondary enrolment rate and the primary completion rate. As can be seen in column 2 of Table 8, the coverage of the last two variables is, however, much poorer than both illiteracy variables.

Table 8 Other Human Capital variables

human capital variable	correlation with adult illiteracy	nr. observations	effect of total MA	total MA effect in baseline	HC effect in baseline
adult illiteracy	1	369	-0.143 (0.00)	0.076 (0.00)	-0.021 (0.05)
youth illiteracy	0.97 (0.00)	369	-0.197 (0.00)	0.064 (0.00)	0.016 (0.10)
gross 2nd enrolment	-0.67 (0.00)	277	0.289 (0.00)	0.055 (0.02)	0.002 (0.12)
primary completion rate	-0.82 (0.00)	242	0.196 (0.00)	0.105 (0.01)	-0.001 (0.58)

Notes: p-values in brackets.

Together with the fact that adult illiteracy is highly correlated with the other three measures of human capital (see column 1 of Table 8), this is the main reason for us to include adult illiteracy in our baseline estimates of the wage equation in the previous section. When regressing a logistic transformation of any of the other three human capital measures, column 4 of Table 8 also shows that we always find a positive effect of market access on human capital. In addition, as shown in the last two column of Table 8, when substituting either of the other three human capital measures for adult illiteracy in our baseline regression (see Table 5), we always find a positive effect of market access, whereas the human capital variable is not always significant any more.

6.3 Policy experiments

Our results clearly show the importance for the SSA countries of improving their market access, both with the rest of the world as well as (or even more importantly so) with other SSA countries. Besides this, our estimation results also help to gain insight into the relative effect of different policies or shocks aimed at improving a country's market access. As has already been discussed in section 4 (see also Redding and Venables (2004), section 7), the inclusion of country-specific variables in the trade equation, (9), allows us to perform policy experiments for both country-specific (e.g. infrastructure improvements, or efforts to end civil conflict) and country-pair specific variables (e.g. entering a regional or free trade agreement). The extent to which these policy measures improve a country's market access can first be inferred from the 1st step of our analysis, the estimation of the trade equation. Next, the effect of the resulting improvement in market access on GDP per capita easily follows from the estimated coefficient of market access shown in our baseline estimation results (Table 5). Table 9 and Figure 4 show the results of six such "policy" experiments. Four experiments focus on conflict-ridden Sudan and two on landlocked Ethiopia.

Table 9: Policy experiments

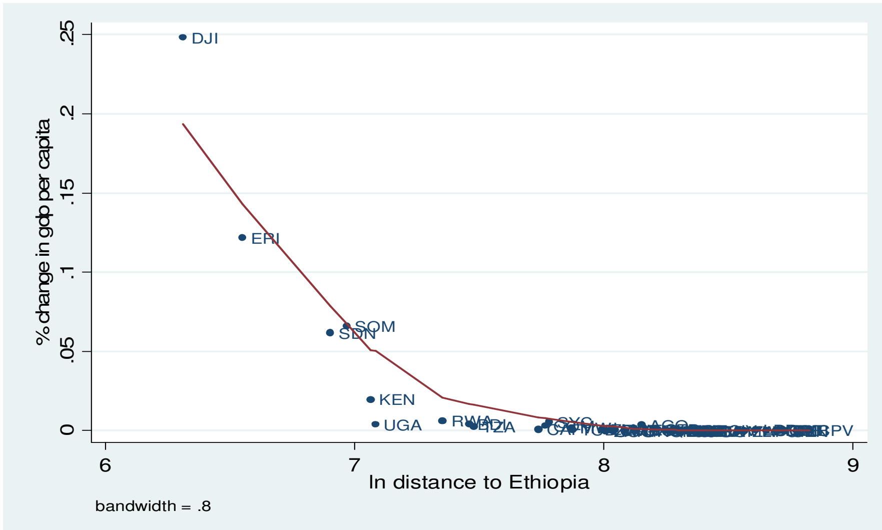
policy measure:	+ 1 s.d. infrastructure	end to civil war	all distances halved	RFTA with South Africa	no longer landlocked
country:	Sudan	Sudan	Sudan	Sudan	Ethiopia
		% increase in market access			
total	64.0	144.7	85.2	5.6	40.9
ROW+SSA	81.1	144.7	104.3	8.9	80.9
ROW	27.1	144.7	102.4	0.0	22.6
SSA	89.4	144.7	104.7	10.6	99.1
		resulting % increase in GDP per capita			
total MA	4.9	11.0	6.5	0.4	3.1
ROW+SSA-MA	4.3	7.7	5.6	0.5	4.3
ROW-MA	2.3	12.0	8.5	0.0	1.9
SSA-MA	4.4	7.2	5.2	0.5	4.9

First the results for Sudan: ending the civil war (Darfur) in that country would increase its market access the most[33] and raises its GDP per capita by around 10% depending on the measure of market access (and subsequent estimate of its effect on GDP per capita). This shows the devastating impact of civil unrest on SSA's economic development in general. Hypothetically halving Sudan's distance to all its trading partners also increases market access substantially and would increase GDP per capita by about 6.5%. Of particular interest are the effects of investments in infrastructure and the establishment of regional free trade agreements. The results show that improving Sudan's infrastructure by one standard deviation (resulting in a quality of infrastructure comparable to Namibia) would raise GDP per capita by about 5%, whereas forming a bilateral RFTA with South Africa would only raise its GDP per capita by 0.4%. The reason for this difference is that improvements in infrastructure affect all trading partners alike, whereas the establishment of a bilateral RFTA only affects one trading partner. This gives a clear policy recommendation: policies aimed at improving a country's ability to trade will have a much higher pay-off when they aim at general improvements that affect as many of that country's trading partners as possible.

An example of such an 'all-trade-partners-affecting' experiment is the one shown for Ethiopia in Table 9. When Eritrea officially became independent in 1993, Ethiopia lost its direct access to the sea. Table 9 shows that if this had not taken place Ethiopia's market access would ceteris paribus have remained much better, resulting in an improvement of its GDP per capita of about 3 to 4%.

[33] Note that the % increase in total market access is the same as for each of its subcomponents as we do not allow the coefficient on civil war to be different when considering intra-SSA trade or SSA trade with the ROW when estimating the trade equation (see Table 2).

Figure 4: The spatial reach of a 10% positive GDP shock in Ethiopia



The final experiment that we conducted is not so much concerned with improving a country's market access by trade cost reducing policies, but instead it focuses on the spatial reach of a one-time positive exogenous shock in Ethiopia's GDP of 10%. This improves other countries' market access through the increased demand from Ethiopia for their products, and the more so, the lower their trade costs with Ethiopia. Figure 4 shows the resulting increase in GDP per capita in other countries plotted against their distance to Ethiopia. Given the estimated penalty on distance in SSA the positive spatial spillover effect of Ethiopia's GDP shock quickly peters out. Ethiopia's nearby neighbors (Djibouti, Eritrea, Somalia and Sudan), and partly also reflecting the positive border effect in Table 2, benefit the most from the increased demand from Ethiopia and experience an increase in their GDP per capita in the range of 0.1% to 0.25%[34].

7. Conclusions

The role of geography in explaining Sub-Saharan Africa's poor economic performance is often confined to its *absolute geography*, focussing on e.g. its hostile disease environment or poor climate. This paper focuses on a different role of geography and establishes the importance of *relative geography* for economic development in Sub-Saharan Africa (SSA). Using an empirical strategy grounded upon a new economic geography model, our paper is

[34] The overall effect is small compared to some of the trade cost experiments, this is again due to the fact that for all the affected countries, Ethiopia constitutes only one of many trading partners (and mostly also a relatively unimportant one).

among the first to test for the importance of market access and thereby of economic geography in explaining the observed differences in economic development between SSA countries. Building on the framework introduced by Redding and Venables (2004), we first construct measures of market access for each SSA country where we rely on trade data to reveal the relative importance of trade costs and market size in determining each country's market access. In doing so, we explicitly allow for a different impact of trade costs on intra-SSA trade and SSA trade with the rest of the world (ROW), and subsequently decompose each country's total market access into market access to other SSA countries and into market access to the ROW respectively.

Using the thus constructed measures of market access, we estimate the impact of market access on GDP per capita, again distinguishing explicitly between the relevance of intra-SSA and ROW market access. Based on our sample of 48 SSA countries over the period 1993-2002, we find that market access invariably positively affects income per capita. We furthermore show that this finding is robust to controlling for other variables affecting economic development (most notably human capital), controlling for unobserved heterogeneity by allowing for country (and year) specific fixed effects, and to instrumenting market access by distance to major markets.

Arguably even more interesting is the finding that, among our market access measures, *intra-SSA* market access has a relatively large (and moreover the most robust) impact on economic development. Our findings indicate that the current efforts to improve SSA infrastructure by e.g. the Sub-Saharan African Transport Policy Program or The Infrastructure Consortium for Africa, or the aim of the African Union to increase intra-SSA integration will improve SSA access to markets and be successful in stimulating economic development. This is further strengthened by our finding of a possible additional indirect effect of market access on income levels through improvements in human capital (as argued Redding and Schott, 2003).

Above all, see also Henderson, Shalizi and Henderson (2001), our results are a reminder that distance or relative geography matters for economic development. Despite room for (policy-induced) improvements in market access, the (economic) remoteness of Sub-Saharan Africa remains a main deterrent to its economic development

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Appendix A. Data definitions and sources

GDP (also per capita and per worker)
Gross Domestic Product (also per capita and per worker), from Penn World Tables 6.2, if not available (for Angola, Haiti, French Polynesia, New Caledonia, Azerbaijan, Armenia, Belarus in selected years) from World Bank Development Indicators 2003 or World Bank Africa Database 2006.

Distance: Great circle distance between main cities, from CEPII.

Internal distance
This often-used specification of D_{ii} reflects the average distance from the centre of a circular disk with $area_i$ to any point on the disk (assuming these points are uniformly distributed on the disk). It is calculated on the basis of a country's area: $D_{ii} = 2/3\left(area_i / \pi\right)^{1/2}$.

Contiguity: Dummy variable indicating if two countries share a common border, from CEPII.

Common official language
Dummy variable indicating if two countries share a common official language, from CEPII

Common colonizer
Dummy variable indicating if two countries have been colonized by the same colonizer, from CEPII.

Colony – Colonizer relationship
Dummy variable indicating if two countries have ever had a colony-colonizer relationship, from CEPII.

Landlocked: Dummy variable indicating if a country has no direct access to the sea.

Island: Dummy variable indicating if a country is an island.

Infrastructure index
Following Limao and Venables (2001), the index is constructed as the unweighted average of four variables (each normalized to have a mean of 0 and standard deviation 1 over the whole sample period as well as in each year). As Limao and Venables (2001) I ignore missing values, making the implicit assumption that the four variables are perfect substitutes to a transport services production function. The four components are:

- ***Roads:*** Km road per km2, from World Bank Development Indicators 2003, World Bank Africa Database 2006 and Canning (1998).

- ***Paved roads:*** Km paved road per km2, from World Bank Development Indicators 2003, World Bank Africa Database 2006 and Canning (1998).
- ***Railways:*** Km railways per km2, from Canning (1998).
- ***Telephone main lines:*** Telephone main lines per 1000 inhabitants, from World Bank Development Indicators 2003, World Bank Africa Database 2006 and Canning (1998).

African regional or free trade agreement

Dummy variable indicating if two countries are both a member of one of the following African regional or free trade agreements: ECOWAS, ECCAS, COMESA, SADCC, UEMOA, CEMAC (or UDEAC), EAC, IGAD or CENSAD.

Civil conflict

Dummy variables indicating if a country experienced the use of armed force between two parties, of which at least one is the government of a state that resulted in at least 25 and at most 999 battle-related deaths, from the International Peace Research Institute, Oslo.

Civil war

Dummy variables indicating if a country experienced the use of armed force between two parties, of which at least one is the government of a state that resulted in at least 1000 battle-related deaths, from the International Peace Research Institute, Oslo.

% rural population

Share of the population living in rural areas, from World Bank Development Indicators 2003 and World Bank Africa Database 2006.

% labor force in agriculture

Average proportion of the total labor force recorded as working in agriculture, hunting, forestry, and fishing (ISIC major division 1) over the period 1993-2002. Labor force comprises all people who meet the International Labour Organization's definition of the economically active population, from World Bank Development Indicators 2003 and World Bank Africa Database 2006.

Adult illiteracy

The percentage of the population that is 25 years and older that cannot read or write, from World Bank Development Indicators 2003 and World Bank Africa Database 2006.

Youth illiteracy

The percentage of the population under 25 that cannot read or write, from World Bank Development Indicators 2003 and World Bank Africa Database 2006.

Gross secondary enrolment

Gross enrolment ratio is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers, from World Bank Development Indicators 2003 and World Bank Africa Database 2006.

Primary completion rate

Primary completion rate is the percentage of students completing the last year of primary school. It is calculated by taking the total number of students in the last grade of primary school, minus the number of repeaters in that grade, divided by the total number of children of official graduation age, from World Bank Development Indicators 2003 and World Bank Africa Database 2006.

Working population per km2 of arable land

Data on the working population and the km2 of arable land are separately taken from the World Bank Development Indicators 2003 and the World Bank Africa Database 2006.

Oil exporter

Dummy variable indicating whether or not a country is exporting oil. From the World Bank Africa Database 2006.

Exports of ores and metals

Exports of ores and metals as a percentage of total merchandise trade. From the World Bank Africa Database 2006.

Appendix B.

Table A1 : The Trade Equation Estimates – OLS on the non-zeroes
(valid under the assumption of exogenous sample selection)

dependent variable		ln trade	
estimation method		OLS	
time period		1993-2002	
Variable	coefficient	variable	coefficient
ln distance	-0.778	island exp	0.354
ln internal distance	0.728	island exp ssa	-1.244
ln distance ssa	-0.050**	island imp	0.060**
ln GDP imp	0.752	island imp ssa	-0.393
ln GDP imp ssa	-0.370	ln infrastructure exp	0.314
ln GDP exp	0.936	ln infrastructure exp ssa	0.649
ln GDP exp ssa	-0.224	ln infrastructure imp	0.177
colony – colonizer	2.106	ln infrastructure imp ssa	0.492
common colonizer	0.634	RTA or FTA	-0.601
common colonizer ssa	-0.201*	RTA or FTA ssa	1.358
Contiguity	-1.057	civil conflict imp	-0.291
Contiguity ssa	1.959	civil conflict exp	-0.521
common off language	0.558	civil war imp	-0.457
common off language ssa	-0.326	civil war exp	-0.978
landlocked exp	0.025**	% rural population imp	-0.061**
landlocked exp ssa	-0.699	% rural population exp	-1.976
landlocked imp	-0.436	% in agriculture imp	0.008**
landlocked imp ssa	0.335	% in agriculture exp	0.022**
dummy ssa trade	10.981	dummy internal trade	2.842
nr observations		34615	

Notes : ** (*) denotes **<u>NOT</u>** significant at the 5% (1%) respectively.

Table A2 Baseline Results - Market Access constructed with the coefficients in Table A1

	BASELINE			
dep: log GDP per capita	OLS	OLS	OLS	OLS
log tot ma	0.134	-	-	-
robust	0.000	-	-	-
bootstrapped	0.001	-	-	-
log ssa+row ma	-	0.080	-	-
robust	-	0.008	-	-
bootstrapped	-	0.015	-	-
log row ma	-	-	0.114	-
robust	-	-	0.035	-
bootstrapped	-	-	0.046	-
log ssa ma	-	-	-	0.073
robust	-	-	-	0.009
bootstrapped	-	-	-	0.012
adult illiteracy	-0.020	-0.017	-0.017	-0.017
robust	0.053	0.097	0.116	0.106
bootstrapped	0.074	0.104	0.192	0.146
log working pop / km2 arable land	0.312	0.313	0.328	0.313
robust	0.038	0.037	0.029	0.037
bootstrapped	0.062	0.063	0.048	0.055
p-value country FE	0.000	0.000	0.000	0.000
p-value time FE	0.283	0.382	0.444	0.383
nr observations	369	369	369	369
R2	0.967	0.965	0.965	0.965

Notes : p-values below coefficients. Bootstrapped p-values on the basis of 200 replications.