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Supply-side constraints, capital goods imports, and the quality of Sub-Saharan African countries' exports

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Abstract: In the last decade, a large portion of capital goods imports of Sub-Saharan African countries is telecommunications equipment, and China is now the main source of equipment for 30 Sub-Saharan African countries. A connection between specific types of equipment imports and subsequent exports is found with elasticity estimates ranging from 0.2 to 1.2 per cent. Estimates show that controlling for price, the estimated quality of Sub-Saharan African countries' exports is lower than that of their peers. This means that if Sub-Saharan African export prices were to increase, their US market share would suffer despite the price advantage provided by the African Growth Opportunity Act.

Keywords: capital goods, product quality, Sub-Saharan Africa, African Growth Opportunity Act
JEL classification: F14, O24

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1 Introduction

The gross domestic product (GDP) per capita for Sub-Saharan African (SSA) countries in 1978–82 was US$885 while that for the East Asia and Pacific region was US$327 (World Bank 2013). After three decades, per capita GDP in 2008–12 for these two regions increased to US$953 and US$2,487, respectively.[1] These figures translate to a real per capita GDP growth of less than 10 per cent for the SSA region and close to 700 per cent growth for the East Asia and Pacific region in 30 years.[2]

Myriad factors contribute to the SSA region's low growth. Of particular interest to this paper is the region's poor infrastructure and lack of investment in capital equipment. Compared to other low-income countries, Africa's infrastructure deficit is largest in power generation capacity, paved roads, and fixed-line telephones (Yepes et al. 2008). Moreover, the prices of these infrastructure services are also higher in Africa than in other developing regions. For example, Foster (2008) documents electricity prices of US$0.02–0.46/kWh in the SSA region and US$0.05–0.10/kWh in other developing regions. Lowering the extent of the infrastructure deficit is an important target for African policy makers as there is evidence in the literature that economic outcomes improve with investments in infrastructure. Calderón (2009) estimates that, between 1990 and 2005, infrastructure accounts for close to 1 percentage point of per capita output growth in Africa. According to another estimate, Africa needs to spend close to US$75.5 billion per year to address this infrastructure deficit, with more than half in power generation (Foster 2008). This spending needs to include capital expenditures (US$38.1 billion) as well as operations and maintenance (US$37.4 billion). Using trade data, this paper's first task is to estimate the extent of infrastructure investments made from the imports of capital goods such as electric generators.

Besides poor infrastructure, SSA countries have limited production capabilities. Thus, it is also important to study what items have been imported over the years. This is because local production capacities, and thus export capabilities, can be expanded by capital goods imports sourced not only from industrialized countries such as the United States but also from emerging economies such as China.[3] For example, the import of textile spinning machines at period t might lead to increased local production and exports of textiles at period $t+s$. This paper's second task is to investigate this import–export link. To the best of my knowledge, this type of quantification has not been done before for the SSA region.[4] This is part of the broader literature dealing with the ability of SSA countries to join the global supply chains (e.g. Collier and Venables 2007; Subramanian and Matthijs 2007).

Imports of capital equipment by SSA countries may partly be in response to the granting of preferential market access by select trading partners. For example, the African Growth Opportunity Act (AGOA 2000) provides duty-free access to US imports of more than 6400 items from eligible SSA countries until 30 September 2015. Eligibility is tied to a country's progress

[1] These are the mean real values for the period for developing economies in the two regions (2005=100).

[2] Developing Latin America and the Caribbean (Middle East and North Africa) experienced 32 per cent (42 per cent) growth in the same period.

[3] It is possible that production using imported equipment and machinery will only supply local markets, but detailed production data are not available for these countries. Detailed trade data from SSA countries' trade partners are used to infer changes in SSA countries' production capacities.

[4] In fact, related literature mostly uses aggregate capital equipment imports and their linkage to aggregate exports. So far, no attempt has been made to disaggregate capital equipment imports into various types.

towards a more market-oriented economy, its efforts to fight corruption, and other criteria.[5] Prior literature has investigated the trade effects of AGOA.[6] However, beyond quantitative trade effects, it is also important to ask whether any changes can be observed in the quality of countries' exports. Because quantitative effects have been observed for apparel products, the third task of this paper is to estimate the quality of US apparel imports from SSA countries since the start of AGOA in 2000.

The three tasks outlined above should provide a clear picture of the types of capital equipment imported by SSA countries, whether these equipment imports have had any measurable effects on these countries' manufactured exports, and whether the quality of SSA countries' apparel exports has changed over time. The remainder of this paper is organized as follows: In Section 2, related literature is reviewed. Section 3 discusses the data used and documents the extent and type of capital augmentation via imports, and how country of origin and sector distribution of imported capital goods have evolved over time. In Section 4, the link between SSA countries' imports of capital goods and subsequent exports is explored. In particular, the hypothesis is that SSA countries' imports of sector-specific machineries lead to increased exports of products utilizing these machineries whereas imports of capital goods with broad uses (e.g. electricity generators or telecommunications equipment) lead to increased overall exports. The methodology and data used to estimate the quality of SSA countries' exports to the United States are presented in Section 5. The section also discusses the quality estimates obtained. Section 6 contains an extensive discussion of the main findings and concluding remarks appear in Section 7.

2 Related literature

Calderón (2009), in his study, uses physical indicators to estimate the volume of electric power, telecommunications, and transportation infrastructure in African countries from 1991 to 2005.[7] The author also measures the quality of available infrastructure.[8] Controlling for other country characteristics such as human capital endowment, trade openness, and governance, Calderón (2009) finds a positive association between real GDP per worker growth and the volume and quality of available infrastructure. In particular, 99 basis points of the productivity growth per year in African countries between 1991–95 and 2001–05 are due to infrastructure (89 basis points are due to an increase in the volume, whereas ten basis points are due to quality improvements). Infrastructure's contribution to output per capita growth is largest in Central African countries (1.08 percentage points), followed by Southern Africa (1.01 percentage points), North Africa (0.92 percentage points), and East Africa (0.94 percentage points), and smallest in West Africa (0.88 percentage points). In all cases, infrastructure's positive contribution to growth is mostly due to

[5] See Jones and Williams (2012) for a brief summary of the original AGOA and subsequent changes.

[6] Using 2000–06 trade data, Frazer and van Biesebroeck (2010) found that the AGOA led to large increases in US imports from SSA countries, especially in apparel. However, these countries did not experience any spillovers in the production of other products because of their limited capacity to produce most of the products on the AGOA list (Edwards and Lawrence 2010).

[7] Data are available for 36 African countries. Electricity-generating capacity (megawatts per 1000 workers) measures electric power infrastructure. Number of main telephone lines or mobile phones (per 1000 workers) measures telecommunications infrastructure. Total road network (in kilometres) divided by either arable land or surface area (in square kilometres) measures transportation infrastructure.

[8] Transmission and distribution losses as a percentage of electricity production measure the quality of electric power infrastructure. Waiting time (in years) for the installation of main telephone lines measures telecommunications infrastructure quality. Paved roads as a percentage of the total road network measures transportation quality.

increases in volume rather than quality improvements. Moreover, increases in telecommunications infrastructure are estimated to have the largest contribution to output per capita growth.

Extending Calderón's (2009) research, Calderón and Servén (2010), in their study, find that income inequality drops as available infrastructure increases. According to the authors, this finding is 'consistent with the view that infrastructure development enhances the ability of poor individuals and/or residents of backward areas to access additional productive opportunities' (Calderón and Servén 2010: i42–4) In particular, increases in the volume of infrastructure lead to a 2-basis-point drop in the Gini coefficient in SSA countries. Data for 89 countries show that, besides the amount of foreign capital goods, per capita income growth in the 1960–85 period increases with foreign-to-domestic capital goods usage (Lee 1995). This is because capital goods imported from developed countries are comparatively cheaper and, when combined with domestic capital goods, increase the efficiency of the country's capital stock. However, Lee's (1995) findings may be an artefact of 'the difference between equipment and non-equipment investment rather than the difference between imported and domestic capital goods' (Mazumdar 2001: 211). The study by Mazumdar (2001) improves on Lee's (1995) work by properly measuring imported and domestic equipment investment. For the most part, data for a panel of 30 least developed countries show that per capita income growth increases (decreases) with imported (domestic) equipment investment.

This paper is also related to the broad literature on technology diffusion (via imports of capital goods) across space and its implications on growth (for a review, see Keller 2004). For example, Eaton and Kortum (2001) study capital goods imports of 34 countries in 1985. First, they establish that capital equipment is highly traded. Second, they find that developing countries import most of their equipment. For example, almost all of Malawi's equipment absorption (gross production + imports – exports) is imports. Kenya has the lowest import share (60 per cent) among the five SSA countries in Eaton and Kortum's (2001) study. Third, colonial and cultural ties are found to be important determinants of imports of capital goods. The United Kingdom is the main source for Kenya, Malawi, and Nigeria, whereas France is the main source for Mauritius and Morocco. Lastly, the authors find that the relative price of capital equipment to consumption goods is higher in poorer countries, and this might be why the capital investment rate is lower in poorer countries. According to Eaton and Kortum (2001: 1198), these relative price differences 'account for over 25% of productivity differences between developing and developed countries'.

Caselli and Wilson (2004) study the determinants of nine types of capital goods imports using data for up to 38 countries for 1970–95. The authors find huge variation in the types of capital goods imported by these countries primarily due to whether the countries have complementary factors or appropriate institutions where these could be used efficiently. For example, computing equipment imports (compared to fabricating equipment imports) are positively associated with the average years of schooling. Caselli and Wilson (2004) also find suggestive evidence that productivity differences across countries may partly be attributed to the composition of their capital goods imports. Similar evidence is found at the micro level. Using a panel of 340 manufacturing firms in Botswana in 1985–2010, Habiyaremye (2013), in his study, finds a positive correlation between firms' imports of machinery and equipment and productivity growth, and the effect on productivity is not concurrent but appears with a lag of up to two years.

Recently, several papers have introduced the quality dimension in analysing trade patterns. Using unit values (value/quantity) at the product level, a positive correlation is observed between unit values and exporter per capita income (e.g. Schott 2004). If unit values are a good proxy for quality, then this suggests that higher income countries export products of higher quality. Product level (ten-digit Harmonized System (HS) code) unit values of US imports from 60 of the largest countries are used by Hallak (2006) to construct the quality index of country i's exports to importer

k. Import regressions at the sectoral level (three-digit Standard International Trade Classification (SITC) Revision 2) show positive coefficients for the interaction between exporter quality and importer income for a large number of sectors. Thus, imports increase with export quality. This finding holds even after controlling for export prices. Khandelwal (2010) provides an alternative approach to estimating product quality, which this paper uses. As described in detail in Section 5, quality indices are estimated at the industry level (five-digit SITC Revision 3) for a cross-section of exporters to the United States from 1996 to 2006. Products are of high quality if exporters do not lose market share as prices rise. These indices can be used to compare product quality across exporters for any period *t*, or product quality changes over time for any exporter *i*.

This paper extends the literature described in this section as follows: First, SSA countries' capital augmentation via imports at the most detailed level possible is documented. Second, the export effect of industry-specific capital goods imports is also investigated at the most detailed level possible. In both cases, extant literature as reviewed here only use total capital goods imports; most focus on the determinants of capital goods imports and their effects on productivity, and very few studies focus on SSA countries. Third, this paper provides initial (if not first) estimates of the quality of African countries' apparel exports to the United States, and how they compare to other apparel exporters to the US market.

3 Capital augmentation via imports

3.1 Data

Trade data are available at the six-digit HS code level from the United Nations' (2013) Commodity Trade Statistics (UN Comtrade) database.[9] Each six-digit HS code will be referred to as a product in this section. At this level of disaggregation it is possible to track whether imported capital goods have broad (e.g. steam turbines) or industry-specific (e.g. textile spinning machines) applications. The evolution of the type and scale (at the finest level possible) of SSA countries' capital goods imports will be determined to assess these countries' investments in capital goods and changes (if any) in their export capabilities. The evolution of the country of origin of these imports will also be determined.

Because countries have more incentive to track imports (e.g. for duty collection) than to track exports, import data are typically preferred over export data when studying bilateral trade. However, SSA countries provide less information than other countries. Therefore, other countries' exports to SSA countries have been used here. Export data from 1996 to 2011 from the 35 largest capital goods exporters have been collected. These countries account for at least 95 per cent of worldwide exports of capital goods each year.[10] Capital goods are identified using the UN's Broad Economic Categories (BEC) classification scheme that allocates six-digit HS codes according to their main end-use. Using the HS–BEC concordance provided by the UN Statistics Division, 905 six-digit HS codes are identified as capital goods, with 278 codes classified as parts and accessories (BEC 42); the remaining 627 codes are final goods (BEC 41), accounting for more than half of SSA countries' capital goods imports each year.

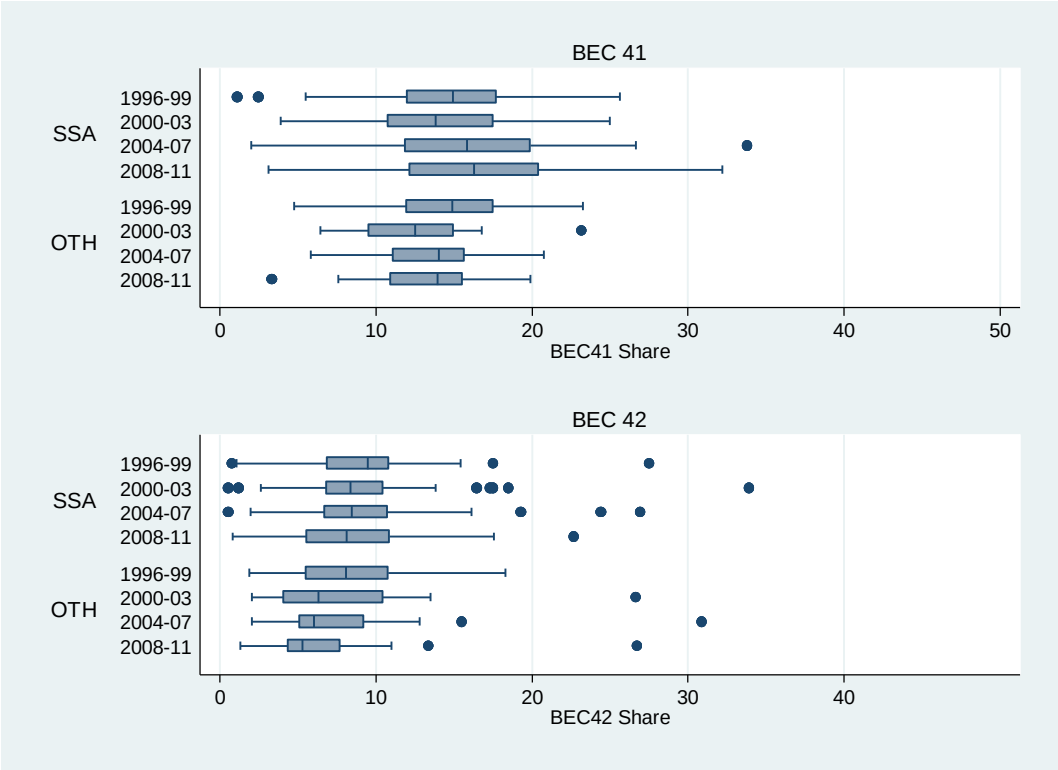
[9] HS codes and definitions for 1996 are used.

[10] Analysis excludes Taiwan (which could be a major source of some types of capital goods) as Taiwanese data are not covered by the UN owing to its one-China policy.

3.2 Analysis

The median share of capital goods (BEC 41 and BEC 42) is about 22.3–24.8 per cent of the total imports of SSA countries and about 19.2–22.5 per cent of the total imports of non-SSA low-income countries.[11] Figure 1 summarizes the distribution of shares for BEC 41 and BEC 42 imports across countries. For the most part, countries import a larger amount of finished capital goods (BEC 41) than parts and accessories of capital goods (BEC 42). But there are several exceptions where parts and accessories comprise at least 20 per cent of total imports. The maximum values in 2008–11 for Lesotho is a parts and accessories share of 23 per cent compared to a 15 per cent share for finished capital goods. The same is true for China, with a parts and accessories share of 26.8 per cent compared to a 15 per cent share for finished capital goods.

Figure 1: Capital goods as per cent of importers' all goods imports



Notes: Imports from the top 35 capital goods exporters are used here. SSA is Sub-Saharan African countries and OTH includes non-SSA low-income countries using the World Bank's classification scheme in 1996. BEC 41 includes capital goods (excluding parts and accessories) and BEC 42 includes parts and accessories of capital goods under the UN's Broad Economic Categories (BEC) classification scheme. For each country, mean values for each period are used to construct the share distributions.

Source: Author's calculations using data from the UN Comtrade database (United Nations 2013).

For the most part, the source of imported capital goods has become less concentrated over time. The median source concentration index is seen to decline from about 2600 to 1400 for SSA

[11] The World Bank's 1996 classification scheme is used throughout. Cape Verde and Sudan are not included as data are missing for these countries. The comparison group used is all non-SSA low-income countries as only 7 of the 45 SSA countries analysed are classified as middle-income countries in 1996. The comparison group includes 24 low-income countries.

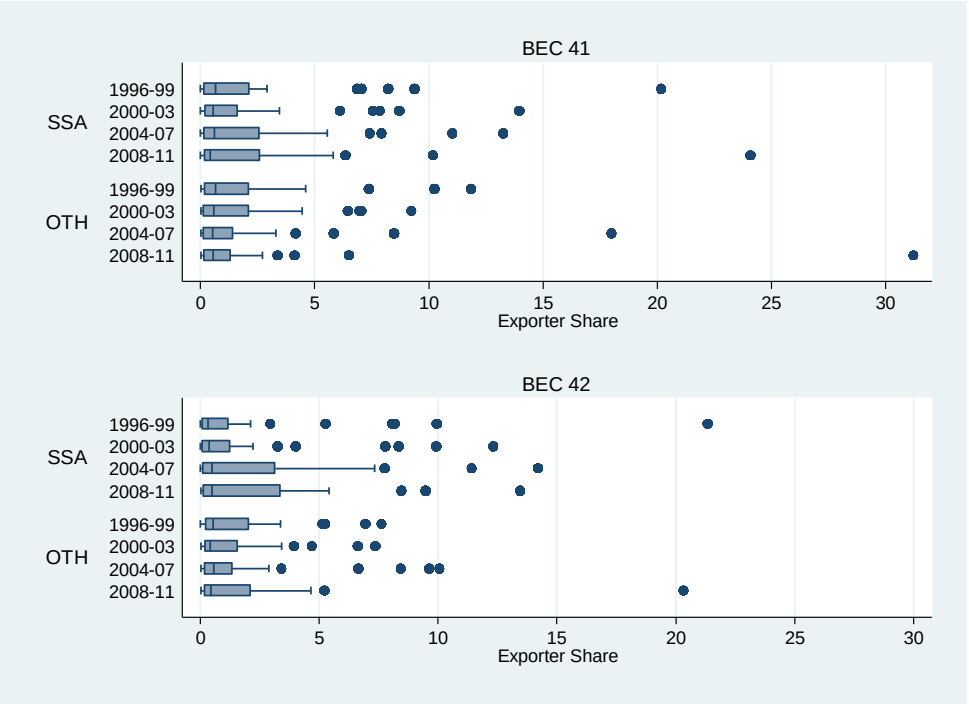
countries and from 2000 to 1600 for other low-income countries.[12] Among SSA countries, Somalia's and Lesotho's finished capital goods sources are the most concentrated, with 76.3 and 42.8 per cent, respectively, sourced from China alone in the 2008–11 period. As data show, Liberia imports 43.2 per cent of its finished capital goods from South Korea in the same period.

Data also show a steady increase in China's market share. China's median rank as capital goods source improves to second place from eleventh place, with a median share close to 20 per cent for SSA countries in 2008–11, up from less than a 2 per cent share in 1996–99.[13] This mostly comes at the expense of French exporters: It is observed that France's median share among SSA countries drops to 10.6 per cent in 2008–11 from 22.5 per cent in 1996–99. Exporters from Germany, the United States, and the United Kingdom also experience a drop in their median market shares, but by less than 5 percentage points. Unlike observations made by Eaton and Kortum (2001), colonial and cultural ties no longer explain capital goods sourcing by SSA countries. Figure 2 illustrates the distribution of the median shares of the top capital goods exporters for the two major types of capital goods. The maximum points in 1996–99 for SSA countries are for France, with a median share of 20.2 and 21.3 per cent for BEC 41 and BEC 42, respectively. China's median share is largest in 2008–11 at 24.1 per cent for BEC 41 (France's median share drops to 10.2 per cent), but France continues to have the largest median share at 13.5 per cent for BEC 42. For non-SSA low-income countries, Japan has the largest median share at 11.5 per cent for BEC 41, whereas the United States has the largest median share at 7.6 per cent for BEC 42 in 1996–99. By 2008–11, for both types of capital goods, China's median shares are largest at 31.2 per cent for BEC 41 and 20.3 per cent for BEC 42.

[12] The source concentration index is based on the Hirschman–Herfindahl index which is the sum of the squared source country's shares. Higher index values indicate more concentration, with 10,000 indicating only one country as import source.

[13] For non-SSA low-income countries, China's median market share in 2008–11 is 29.1 per cent, up from less than a 4 per cent share in 1996–99.

Figure 2: Exporter share as per cent of importers' capital goods imports from all sources



Notes: For each exporting country, their median shares across all SSA and non-SSA low-income importing countries are used to construct the share distributions.

Source: Author's calculations using data from the UN Comtrade database (United Nations 2013).

Given this paper's objective, subsequent analyses focus on finished capital goods (BEC 41). Tables 1a and 1b summarize the top capital goods source for each of the 45 SSA countries for two periods: 1996–99 and 2008–11, with each source country's market share.[14] The tables also include the number one item imported from the source and the share of this item in the country's total capital goods import from the source. Table 1a shows that France is the top source of capital equipment in 1996–99 in half of the SSA countries, with shares ranging from 18.1 (Seychelles) to 82.8 (Comoros) per cent. By 2008–11, China is seen to have become the top source for 30 of the 45 SSA countries, with available data (see Table 1b). China's share is largest in Somalia at 76.3 per cent and lowest in Guinea at 17.4 per cent. Transmission with reception apparatus for radio, television, and so on is noted to be the top import for a large number of countries until 2007. This product item is replaced by telecommunications equipment in half of the SSA countries in 2008–11. Telecommunications equipment consists of more than a third of Lesotho's, Somalia's, and Swaziland's capital goods imports from China.[15] As data show, until 2007 the United States is the top source of Equatorial Guinea's capital goods, with more than half of the country's imported capital goods from the United States in 1996–99 consisting of equipment for offshore drilling. China replaces the United States as a top source in 2008–11, and its top export item to Equatorial Guinea is telecommunications equipment.

[14] Similar tables for 2000–03 and 2004–07 are available upon request.

[15] This is based on 1996 HS 851780, which includes part of 2007 HS 851762 (which includes switching and routing apparatus) and HS 851769 (other).

Table 1a: Shares of the top BEC 41 sources and capital goods imports of the Sub-Saharan African countries in 1996–99

Country	Top BEC 41 source		Top product item from source	
	Source country	Share (%)	Item	Share (%)
Angola	United States of America	26.0	Floating, submersible drilling, or production platforms	8.3
Benin	France	49.0	Telephonic or telegraphic switching apparatus	3.4
Botswana	NA	—	—	—
Burkina Faso	France	72.4	Transmit–receive apparatus for radio, TV, etc.	4.2
Burundi	France	31.3	Transmit–receive apparatus for radio, TV, etc.	16.9
Cameroon	France	48.4	Transmit–receive apparatus for radio, TV, etc.	2.2
Central African Republic	France	55.4	Transmit–receive apparatus for radio, TV, etc.	4.3
Chad	France	78.1	Instruments, appliances for medical use, etc., science n.e.s.	6.7
Comoros	France	82.8	Instruments, appliances for medical use, etc., science n.e.s.	3.0
Congo	France	61.7	Floating, submersible drilling or production platforms	43.5
Democratic Republic of the Congo	Belgium	47.3	Units of automatic data processing machines	4.8
Equatorial Guinea	United States of America	33.7	Floating, submersible drilling, or production platforms	60.2
Eritrea	Italy	30.4	Mobile lifting frames on tyres, straddle carriers	27.6
Ethiopia	Italy	17.2	Shuttle-less looms for weaving fabric >30 cm wide	21.2
Gabon	France	60.1	Air or gas compressors, hoods	4.6
Gambia	United Kingdom	36.0	Automatic data processing machines	6.8
Ghana	United Kingdom	28.1	Instruments, apparatus, and models for demonstration	5.2
Guinea	France	44.0	Engines, diesel, except motor vehicle/marine	7.4
Guinea-Bissau	France	27.1	Medical, dental, surgical and veterinary furniture n.e.s.	23.5
Ivory Coast	France	45.8	Transmit–receive apparatus for radio, TV, etc.	5.3
Kenya	United Kingdom	23.4	Wheeled tractors n.e.s.	4.6
Lesotho	NA	—	—	
Liberia	Spain	20.0	Instruments, appliances for medical use, etc., science n.e.s.	75.5
Madagascar	France	60.0	Telephonic or telegraphic switching apparatus	5.2
Malawi	United Kingdom	25.5	Cameras for special use, underwater, aerial, etc.	20.4
Mali	France	55.8	Generating sets, diesel, output >375 kVA	3.7
Mauritania	France	45.0	Transmission apparatus for radio, telephone, and TV	4.3
Mauritius	France	23.8	Turbines n.e.s., of 0>40 mW	7.8
Mozambique	France	19.3	Apparatus for electro-plating, electrolysis, etc.	35.2
Namibia	NA	—	—	—
Niger	France	52.3	Auxiliary plant for steam-/vapour-generating boilers	3.9
Nigeria	United Kingdom	18.0	Generating sets, diesel, output <75 kVA	3.8
Rwanda	United States of America	19.9	Radar apparatus	56.5
São Tomé and Príncipe	United Kingdom	48.0	Machines for public works, building, etc. n.e.s.	46.7
Senegal	France	58.8	Transmit–receive apparatus for radio, TV, etc.	4.3

Seychelles	France	18.1	Cans, iron/steel, capacity <50 l closed by crimp/solder	22.8
Sierra Leone	United Kingdom	50.6	Wheeled tractors n.e.s.	5.4
Somalia	United Kingdom	42.9	Machines to crush or grind stone, ores and minerals	62.1
South Africa	NA	—	—	—
Swaziland	NA	—	—	—
Togo	France	58.2	Transmit–receive apparatus for radio, TV, etc.	5.7
Uganda	United Kingdom	28.6	I/O units within storage units	6.1
United Republic of Tanzania	United Kingdom	19.6	Machinery for preparing or making tobacco	7.8
Zambia	United Kingdom	31.6	Mine conveyors/elevators, continuous action	10.3
Zimbabwe	United Kingdom	20.7	Wheeled tractors n.e.s.	10.6

Note: BEC=Broad Economic Categories; n.e.s.=not elsewhere specified.

Source: Author's calculations using data from the UN Comtrade database (United Nations 2013).

Table 1b: Shares of the top BEC 41 sources and top capital goods imports of the Sub-Saharan African countries in 2008–11

Country	Top BEC 41 source		Top product item from source	
	Source country	Share (%)	Item	Share (%)
Angola	China	24.1	Generating sets, with spark ignition engines	9.6
Benin	France	33.1	Digital process units	7.0
Botswana	China	37.1	Electrical apparatus for line telephony, telegraphy	4.0
Burkina Faso	France	34.9	Electrical apparatus for line telephony, telegraphy	3.0
Burundi	China	39.6	Electrical apparatus for line telephony, telegraphy	36.8
Cameroon	France	30.9	Electrical apparatus for line telephony, telegraphy	4.1
Central African Republic	France	29.4	Machines to crush or grind stone, ores, and minerals	5.9
Chad	China	34.8	Boring or sinking machinery n.e.s., not self-propelled	7.5
Comoros	China	32.6	Dredgers	77.3
Congo	France	23.4	Generating sets, diesel, output <75 kVA	3.2
Democratic Republic of the Congo	China	26.5	Electrical apparatus for line telephony, telegraphy	13.0
Equatorial Guinea	China	24.3	Electrical apparatus for line telephony, telegraphy	9.2
Eritrea	China	35.4	Non-medical X-ray equipment	30.9
Ethiopia	China	54.0	Electrical apparatus for line telephony, telegraphy	28.6
Gabon	France	38.5	Floating, submersible drilling, or production platforms	26.8
Gambia	United Kingdom	19.3	Instruments, appliances for medical use, etc., science n.e.s.	29.4
Ghana	China	23.7	Electrical apparatus for line telephony, telegraphy	7.0
Guinea	China	17.4	Transmit–receive apparatus for radio, TV, etc.	7.9
Guinea-Bissau	China	21.6	Electrical apparatus for line telephony, telegraphy	20.7
Ivory Coast	France	33.1	Electrical apparatus for line telephony, telegraphy	5.5
Kenya	China	25.6	Transmit–receive apparatus for radio, TV, etc.	9.3
Lesotho	China	42.8	Electrical apparatus for line telephony, telegraphy	36.6
Liberia	Republic of Korea	43.2	Floating docks, special function vessels n.e.s.	99.9

Madagascar	China	28.1	Transmit–receive apparatus for radio, TV, etc.	8.6
Malawi	China	26.1	Transmit–receive apparatus for radio, TV, etc.	25.6
Mali	France	34.0	Electrical apparatus for line telephony, telegraphy	6.1
Mauritania	France	20.1	Electrical apparatus for line telephony, telegraphy	4.1
Mauritius	France	17.7	Electrical apparatus for line telephony, telegraphy	3.8
Mozambique	China	28.7	Electrical apparatus for line telephony, telegraphy	8.0
Namibia	China	24.1	Non-medical X-ray equipment	24.0
Niger	China	43.2	Boring or sinking machinery n.e.s., self-propelled	28.1
Nigeria	China	27.5	Generating sets, with spark ignition engines	11.8
Rwanda	China	20.9	Non-medical X-ray equipment	17.1
São Tomé and Príncipe	France	21.1	Electrical apparatus for line telephony, telegraphy	24.1
Senegal	France	25.6	Electrical apparatus for line telephony, telegraphy	6.8
Seychelles	India	10.8	Floating docks, special function vessels n.e.s.	96.6
Sierra Leone	China	22.2	Apparatus for carrier-current line systems	26.6
Somalia	China	76.3	Electrical apparatus for line telephony, telegraphy	43.1
South Africa	China	18.8	Portable digital data processing machines	11.0
Swaziland	China	23.5	Electrical apparatus for line telephony, telegraphy	35.8
Togo	China	33.2	Video recording/reproduction apparatus, not magnetic tape	16.2
Uganda	China	21.2	Transmit–receive apparatus for radio, TV, etc.	22.6
United Republic of Tanzania	China	30.0	Electrical apparatus for line telephony, telegraphy	7.0
Zambia	China	37.7	Electrical apparatus for line telephony, telegraphy	11.8
Zimbabwe	China	47.9	Electrical apparatus for line telephony, telegraphy	26.7

Note: BEC=Broad Economic Categories; n.e.s.= not elsewhere specified.

Source: Author's calculations using data from the UN Comtrade database (United Nations 2013).

Tables 1a and 1b also provide rough estimates of the extent of production capacity augmentation in SSA countries in specific sectors. For example, close to half of Congo's capital equipment imports from France in 1996–99 comprise equipment for offshore drilling. Also, about 21.2 per cent of Ethiopia's capital goods imports from Italy in 1996–99 are looms for weaving fabrics whereas close to 10 per cent of Tanzania's imported capital goods from the United Kingdom are machinery for preparing or making tobacco (Table 1a). Half of Burkina Faso's capital goods imports in 2004–07 originate from France, 6.1 per cent of which are machines to mill and work cereals or dried legumes (not shown).

Instead of focusing on the top import source and the top imported item from this source, in the next section, overall capital goods augmentation by SSA countries is analysed. To the extent possible, capital goods are classified into those with broad uses (general purpose) and those that are industry-specific. The import of capital goods with broad uses (e.g. hydraulic turbines) can expand countries' electricity-generating capacities, so production and export effects might be across a broad range of commodities rather than on select commodities. Industry-specific equipment imports can expand production capacities of SSA countries in these industries. For example, importing knitting machinery could expand textile and apparel production capabilities of SSA countries, so their textile and apparel exports might increase in the future. Whether or not such a link exists is studied in the next section.

4 Import–export link

4.1 General-purpose versus sector-specific capital goods imports

To identify each product's broad or specific end-use, a concordance from the US Bureau of Census is used.[16] Between 1996 and 2011, SSA countries import US$267 billion worth of finished capital goods, with more than half in the last period alone (Table 2). Imports more than double (in nominal terms) in two of the three four-year periods. General-purpose capital goods account for 42.1 per cent of finished capital goods imports, with telecommunications equipment having the largest share (17.6 per cent) in SSA countries' imports of capital goods in 1996–2011. For the same period, telecommunications equipment is only 9.0 per cent of non-SSA low-income countries' capital goods imports. The differential of 9 percentage points in shares is evidence of SSA countries starting to address their deficiencies in telecommunication services. SSA countries' telecommunications equipment imports total US$23.6 billion in 2008–11, up from US$1.5 billion in 1996–99. Thus, these contribute to an increase in the (mean) number of main telephone lines per 1000 workers (from 10 in 1991–95 to 93 main telephone lines and mobile phones per 1000 workers in 2001–05) and to improvements in the quality of telecommunication services in Africa (Calderón 2009).

Table 2: Sub-Saharan African countries' imports of capital equipment by end-use in 1996–2011

	1996–2011	1996–99	2000–03	2004–07	2008–11
Capital goods imports (in billion US$)	269.0	16.7	38.2	83.7	130.4
Growth rate (in per cent)	—	—	128.2	119.2	55.8
Shares (in per cent)					
General–purpose goods	42.1	30.4	40.0	43.2	43.4
Electric and non-electric generating equipment	7.7	7.8	6.1	6.7	8.9
Computers, peripherals, and semi-conductors	7.3	6.5	10.0	7.4	6.7
Telecommunications equipment	17.6	9.2	16.0	19.3	18.1
Business machinery and equipment, except computers and related products	1.0	1.8	1.1	1.1	0.9
Scientific, hospital, and medical machinery	4.0	4.0	4.5	4.0	3.8
Transport equipment and spacecraft, except automotive	4.4	1.1	2.2	4.7	5.2
Sector-specific goods	37.9	46.9	36.9	37.9	37.1
Oil drilling, mining, and construction machinery	13.0	15.7	11.5	14.4	12.2
Industrial and service machinery	23.2	29.2	23.8	22.0	23.1
Agriculture machinery, equipment	1.6	2.0	1.6	1.5	1.7
Others	20.0	22.7	23.1	18.9	19.5

Source: Author's calculations using data from the UN Comtrade database (United Nations 2013) and US Bureau of Census' HS–End-Use Concordance.

Electric and non-electric generating equipment imports have a 7.7 per cent share for the entire 1996–2011 period. As is evident in Table 2, the relative importance of this type of capital goods in SSA countries' import basket increases from a low 6.1 per cent in 2000–03 to 8.9 per cent in the latest period. In nominal terms, electric and non-electric generating equipment imports are

[16] Denyse Ford of the US Bureau of Census shared concordances between ten-digit HS codes and five-digit end-use codes. However, only concordances since 2006 are available. Since the data used are based on the 1996 six-digit HS codes, the correspondence between 1996 six-digit HS and 2007 six-digit HS codes is first established, then the correspondence between 2007 six-digit HS and Census' five-digit end-use codes is established. It is important to note that since Census' HS–end-use concordance uses ten-digit HS codes, it is possible that a six-digit HS code is matched with several five-digit end-use codes. If the correspondence between six-digit HS and five-digit end-use codes is not one-to-one, then three-digit or two-digit end-use codes are used instead. This correspondence is available from the author upon request.

observed to increase from US$2.3 billion in 2000–03 to US$11.6 billion in 2008–11. This increase, however, is insufficient to close the continent's large deficit in power generation, which stands at 289 (178) megawatts per million population when low (lower-middle) income African countries are compared to countries with similar income levels (Foster 2008).

Sector-specific capital goods imports have a 37.9 per cent share, with machineries used in oil drilling, mining, and construction comprising 13 per cent of SSA countries' total finished capital goods imports; industrial and service machineries account for close to a quarter of these countries' finished capital goods imports; and agricultural machinery and equipment have a 1.6 per cent share for the entire 1996–2011 period. About a fifth of capital goods imports are not classifiable into general-purpose use or sector-specific use either because HS–end-use matching is not feasible or HS–end-use matching is at the two-digit level (too broad) rather than at the five- or three-digit level.[17] Table 3 contains the breakdown of sector-specific capital goods imports. For the entire period, excavating machinery has the largest share, followed by materials handling equipment (e.g. conveyors or cranes) and drilling and oilfield equipment. Food and tobacco machinery and textile and sewing machines have close to a 3 per cent share each in the late 1990s; in the latest period, food and tobacco machinery has a 2 per cent share whereas textile and sewing machinery has a less than 1 per cent share. These shares translate to US$2.5 billion and US$648.4 million augmentation of capital equipment in these sectors, respectively, compared to the US$9.7 billion imports of excavating machinery used in oil extraction, mining, or construction in 2008–11. Together, these suggest the continued dominance of oil and mining sectors in the region and limited capital augmentation in other sectors. In fact, the relative importance of equipment used in food and tobacco, textile, sewing, machines, wood, glass, plastic, and pulp and paper production has declined over time.

Table 3: Sector-specific imports of finished capital goods in 1996–2011 (in per cent)

	Sub-Saharan African countries				
	1996–2011	1996–99	2000–03	2004–07	2008–11
Oil drilling, mining, and construction machinery (total)	13.0	15.7	11.5	14.4	12.2
Drilling and oilfield equipment	3.3	7.5	4.0	4.8	1.6
Specialized mining	1.0	0.5	0.7	0.9	1.2
Excavating machinery	6.7	5.5	5.5	6.5	7.4
Non-farm tractors and parts	0.3	0.6	0.3	0.3	0.3
Oil drilling, mining, and construction machinery, others	1.7	1.7	1.1	2.0	1.7
Industrial and service machinery (total)	23.2	29.2	23.8	22.0	23.1
Industrial engines	0.6	0.7	0.6	0.4	0.6
Food and tobacco machinery	1.9	2.7	1.7	1.7	1.9
Metal working machine tools	1.3	1.3	1.5	1.3	1.2
Textile and sewing machines	0.9	2.8	1.8	0.9	0.5
Wood, glass, and plastic machinery	0.6	0.9	0.7	0.6	0.4
Pulp and paper machinery	1.8	2.0	2.0	2.0	1.5
Measuring, testing, control instruments	1.8	1.9	1.9	1.7	1.7
Materials handling equipment	4.6	5.2	3.5	4.2	5.0
Industrial machines, others	2.0	2.4	1.9	1.7	2.1
Photo, service industry machinery	2.4	3.3	2.7	2.3	2.3
Industrial and service machinery n.e.s.	5.5	6.1	5.5	5.1	5.7

Note: n.e.s.=not elsewhere specified.

Source: Author's calculations using data from the UN Comtrade database (United Nations 2013) and US Bureau of Census' HS–End-Use Concordance.

[17] See footnote 16 for details.

Unlike in the study by Caselli and Wilson (2004), the focus here is not the determinants of imports of machinery and their effects on overall productivity.[18] Rather, emphasis is on the link between countries' imports of machineries and their subsequent exports of products utilizing these machineries.

4.2 Regression model

Country *i*'s period *t* exports (*exp*) are regressed against lagged capital goods imports (*imp*), population, per capita income, and a competitiveness indicator.[19] Country *i*'s exports are expected to increase with capital goods imports, population, and per capita income. Imports of capital goods augment production capacity (and thus, exports), and larger and richer countries have the capacity to produce (and thus, export) more items. Six measures of competitiveness from the World Economic Forum (WEF 2013) are used. The scores range from 1 to 7 (with 7 being best). Each competitiveness indicator is added one at a time as they are highly correlated to each other. Three competitiveness sub-indices are considered: basic requirements, efficiency enhancers, and innovation and business sophistication. One pillar from each sub-index is used: infrastructure, goods market efficiency, and business sophistication. One of the advantages of the WEF indices is that they capture various dimensions of competitiveness. For example, basic requirements include institutions, infrastructure, macroeconomic stability, and health and primary education. The infrastructure index alone includes the quality of roads, electric supply, and seven other dimensions. The comprehensiveness of the WEF indices is what makes their use appealing.[20] Exports are expected to increase with each competitiveness indicator. Because these indicators are available for a large number of countries only starting in 2008, estimation is based on a cross-section of 128 countries using the following trade gravity model (basic specification):[21]

$$lexp_t = \alpha + \beta_1 limp_{t-1} + \beta_2 lpop_{t-1} + \beta_3 lgdppc_{t-1} + \beta_4 comp_{t-1} + \varepsilon_t \qquad (1)$$

where exports (imports) are summed over the 2008–11 (2004–07) period for each country. To mitigate endogeneity problems, the regressors are measured with a lag. Two measures of capital goods imports are used: general-purpose equipment (i.e. equipment for generating electricity and telecommunications equipment) and equipment matched to their industry-specific use. Average population and per capita income are obtained for 2004–07 and the competitiveness indicator

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[18] Eaton and Kortum (2001) note several barriers to trade in capital equipment. These barriers can be natural or self-inflicted. For example, tariffs, non-tariff barriers, adapting equipment to foreign countries, the existence of labour to work the machines, and so on. Data from 2012 show that select SSA countries still charge high tariff rates on electrical and non-electrical machinery imports when compared to developed countries like the United States. For electrical machinery, Ethiopia and Gambia charge the highest (average) rates at 17.4 per cent. For non-electrical machinery, 12.3 per cent is the highest (average) tariff rate charged by Cameroon, the Central African Republic, Chad, Congo, and Gabon. For reference, the corresponding rates for the United States are 1.2 and 1.7 per cent, and for China, 8.0 and 8.3 per cent, respectively (WTO 2014).

[19] Note that country *i*'s exports are its trading partners' reported imports from country *i*. See Section 3.1 for a brief discussion of the advantages of using import instead of export data.

[20] Although this might also be deemed a weakness, as variations in the indices can be hard to interpret.

[21] The trade gravity equation is used widely in empirical investigations of bilateral trade flows. In its most basic form, it includes trading partners' gross products, population (or per capita gross products), and physical distance from each other. Other controls, such as infrastructure quality, that increase or impede trade are also included in the model. Anderson (2011), Cheng and Wall (2005), Leamer and Levinsohn (1995), and Deardorff (1984) review some contributions using the model. In this paper, Equation (1) is estimated for countries' worldwide (not bilateral) exports and total imports of capital goods from all 35 top exporters of capital goods.

(*comp*) is measured in 2008. With the exception of the competitiveness indicator, the natural log of all variables is used in the estimation of Equation (1).

Equation (1) is estimated for country *i*'s total worldwide exports at period *t* matched against all equipment imports and imports of electricity generators and telecommunications equipment at period *t*–1, and for each of the 12 industries where imports of industry-specific machinery are matched to countries' exports of products made using these machines. The latter is done only for those with a clear match. Appendix Table A1 contains the HS codes of machinery in a particular end-use category and the HS codes of exported items using these machines. Altogether 55 six-digit HS capital goods can be matched to 12 two-digit HS export items. Country *i*'s period *t* exports of item *j* are regressed against lagged capital goods imports relevant to item *j*, and the other factors discussed earlier.

As a robustness check, a three-period pseudo-panel version of Equation (1) is also estimated, but, instead of the competitiveness indicators from the WEF, economic freedom indices from the Heritage Foundation (2011) are used. Four economic freedom indices capture certain dimensions of the WEF's basic requirements indices: fiscal freedom, government spending, property rights, and freedom from corruption. Five indices relate to some dimensions of the WEF's efficiency enhancers: business freedom, trade freedom, investment freedom, financial freedom, and monetary freedom.[22] Unfortunately, no representative index is available to capture the WEF's business sophistication and innovation indices. The indices range from 10 to 100, with higher values indicating more economic freedom. Here, 2000–03 (2004–07 and 2008–12) export data are matched with 1996–99 (2000–03 and 2004–07) capital imports and data for the other controls. Additionally, country-specific fixed effects are included to capture any country-specific time-invariant factors associated with countries' export levels (e.g. distance from markets) and two period dummies (with 1996–99 as the base) are also included to account for any time-specific effects that affect export levels of all countries in the same way.

4.3 Analysis of results

Table 4 contains elasticity estimates (export response to capital goods imports) for all countries and for the low-income sub-sample. The specifications using the six WEF competitiveness indices provide qualitatively similar estimates, so only three estimates are provided. Specification (1) includes infrastructure, Specification (2) includes goods market efficiency, and Specification (3) business sophistication. For comparison, specification (4) includes the overall economic freedom index for 2008–11. The results for all economic freedom indices are qualitatively similar to the results for the overall index, and so are not reported here because of limited space. Regardless of specification, the results indicate that imports of capital goods (all equipment) are statistically significant at the 1 per cent level for the full sample. Controlling for other factors, overall exports increase by about 0.5 per cent for a 1 per cent increase in capital goods imports. For the low-income sample, the elasticity estimates are lower and significant only at the 10 per cent level. Among general-purpose equipment, variations in countries' imports of electricity generators and telecommunications equipment explain variations in subsequent exports only for the full sample. Variations in imports among low-income countries are not large enough to explain variations in

[22] Efficiency enhancers include higher education and training, goods market efficiency, labour market efficiency, financial market sophistication, technological readiness, and market size.

their export levels. In the full sample, elasticity estimates are larger for electricity generators than for telecommunications equipment.[23]

Table 4: Elasticity estimates (export response to capital goods imports)

	Cross-section				Pseudo-panel
Manufactured item	(1)	(2)	(3)	(4)	(5)
All countries					
All equipment	0.514***	0.543***	0.500***	0.520***	0.217**
Electricity generators	0.331***	0.318***	0.329***	0.257***	0.108*
Telecommunications equipment	0.181**	0.143	0.151*	0.181**	0.010
Meat, fish, and other items	1.198***	1.179***	1.221***	1.094***	-0.101
Sugars and sugar confectionery	0.247***	0.241***	0.241***	0.293***	0.027
Cocoa and cocoa preparations	0.573***	0.561***	0.578***	0.416***	-0.021
Cereal, flour, and other items	0.822***	0.782***	0.822***	0.523***	-0.039
Vegetables, fruits, and nuts	0.272***	0.269***	0.275***	0.257***	-0.001
Beverages, spirits, and vinegar	0.568	0.562	0.580	0.285	-0.061
Tobacco	0.348***	0.341***	0.352***	0.336***	0.039
Wood and other items	0.234***	0.219***	0.223***	0.252***	0.040
Paper and paperboard	0.848***	0.815***	0.864***	0.616***	-0.008
Books, newspapers, and others	1.102***	1.064***	1.096***	0.699***	0.017
Footwear	0.454***	0.445***	0.462***	0.353***	-0.017
Textile and textile articles	1.151***	1.107***	1.147***	1.144***	0.017*
Number of countries	128	128	128	150	154
Number of observations	128	128	128	150	456
Low-income countries					
All equipment	0.439*	0.428	0.394*	0.540***	0.351*
Electricity generators	0.175	0.149	0.163	0.221	0.150
Telecommunications equipment	0.190	0.200	0.203	0.335**	0.061
Meat, fish, and other items	1.233***	1.304***	1.352***	1.142***	-0.124
Sugars and sugar confectionery	0.326	0.299	0.309	0.461***	0.091
Cocoa and cocoa preparations	0.532*	0.530	0.583*	0.495*	-0.098
Cereal, flour, and other items	0.502	0.512	0.507	0.364	-0.085
Vegetables, fruits, and nuts	0.194	0.218	0.222	0.275**	0.010
Beverages, spirits, and vinegar	1.045*	1.051*	1.024*	0.827**	-0.357***
Tobacco	0.362**	0.333**	0.366**	0.357***	-0.018
Wood and other items	0.257**	0.219**	0.238**	0.313***	0.094
Paper and paperboard	0.192	0.234	0.224	0.339	-0.005
Books, newspapers, and others	0.942***	0.995***	1.008***	0.710***	-0.014
Footwear	0.340***	0.341***	0.328***	0.347***	-0.035
Textile and textile articles	1.222***	1.208***	1.233***	1.307***	0.038
Number of countries	40	40	40	52	53
Number of observations	40	40	40	52	157

Notes: Estimated models include population, per capita income, and a competitiveness or economic freedom index. Specifications (1)–(4) use 2008–11 export data, where (1) includes infrastructure, (2) goods market efficiency, (3) business sophistication, and (4) overall economic freedom index. Specification (5) is a three-period pseudo-panel version of (4) and includes two period indicators, with 1996–99 as the base period. ***, **, and * denote significance at 1, 5, and 10 per cent levels, respectively, using robust standard errors.

Source: Elasticity estimates are from Equation (1) using data from the UN Comtrade database (United Nations 2013), World Bank (2013), World Economic Forum (2013), and Heritage Foundation (2011).

Export levels do vary with different types of capital equipment imports. For the full sample, elasticity estimates are all significantly different from zero, with the exception of beverage exports. Estimates (average of cross-section estimates) range from 0.23 per cent (wood products) to 1.17 per cent (meat and fish products). The coefficients for *limp* are consistently statistically significant at the 5 per cent level for the following six item groups for the low-income sample: meat and fish

[23] Complete results are available upon request. For the full- and low-income samples, exports are positively associated with market size and income, but contrary to expectations are negatively correlated with the competitiveness indicators or economic freedom indices (when statistically significant at the 5 per cent level).

products, tobacco, wood products, books and newspapers, footwear, and textile and apparel articles. Among these, the elasticity estimates are largest for meat and fish products and textile and apparel articles. In particular, a 1 per cent increase in machinery imports is estimated to increase relevant exports by about 1.2 per cent. These are substantially higher than the estimates for tobacco, wood, and footwear.

As a robustness check, a pseudo-panel version (5) of specification (4) is estimated, as shown in Table 4. For the full sample, subsequent exports are positively associated with all equipment imports, but the elasticity estimate is smaller than in the cross-section regressions. With the exception of beverages in the low-income sample, none of the elasticity estimates are significantly different from zero at the 5 per cent level of significance. This is not surprising as the panel is only three periods long. Recall that panel regression exploits within-country variations. The panel results suggest that there is not much variation in countries' imports of capital equipment over time to explain variations in their subsequent exports over time. However, between-country variations in capital equipment imports do explain variations in their exports. This section has provided evidence of an export–import link in select manufactured products across countries at a given point in time but not within countries over time. Beyond quantitative trade effects, it is also important to ask whether any changes are observed in the quality of countries' exports. Note that no direct connection between export quality improvements and capital goods imports is established here. Quality improvements may occur with or without capital augmentation from abroad.

5 Export quality indices

5.1 Methodology and data

Khandelwal's (2010) methodology for estimating product quality is used here. To estimate quality changes over time requires that the product classification scheme is at the finest level possible and is consistent over time. Import penetration of the domestic market is also required information. These minimum data requirements are available for the United States. Import data for the United States are available at the ten-digit HS code level.[24] Moreover, Pierce and Schott (2009) provide a concordance for US ten-digit HS codes over time to account for periodic changes in how products are classified.

Each ten-digit HS code will be referred to as product *p* and import of product *p* from country *c* will be referred to as variety *cp*. Each product *p* belongs to industry *j*. Product quality estimates are based on consumers' preferences for variety *cp* among all products and varieties belonging in industry *j*. Industry *j* is defined using the five-digit SITC (Revision 3) scheme. For example, HS code 6204.62.20.10 is 'women's bib and brace overalls' while HS code 6204.62.20.25 is 'girls' bib and brace overalls as part of playsuits', both HS codes belong in SITC 84260 (women's or girls' trousers, bib and brace overalls, breeches, and shorts, not knotted or crocheted). This SITC maps to the North American Industry Classification System (NAICS, 1997 version) code 315239 (women's and girls' cut and sew other outerwear manufacturing). Following Khandelwal (2010), the model hereunder is estimated for each industry *j*:

$$ln(s_{cpt}) - ln(s_{0t}) = \lambda_{1,cp} + \lambda_{2,t} + \alpha p_{cpt} + \sigma ln(ns_{cpt}) + lnpop_{ct} + \lambda_{3,cpt} \qquad (2)$$

[24] US import data (imports for consumption) at the ten-digit HS code level are available from Professor Peter Schott's data page: http://faculty.som.yale.edu/peterschott/sub_international.htm.

where s_{cpt} is the overall (industry) market share of variety cp at period t, s_{0t} is the domestic variety share (import substitutes) at period t, p_{cpt} is the import unit value of variety cp at period t, ns_{cpt} is the market share of variety cp in product p at period t, pop_{ct} is the population of country c at period t (proxy for hidden varieties), $\lambda_{1,cp}$ is consumers' valuation of variety cp which remains constant over time (variety-specific fixed effect), $\lambda_{2,t}$ is consumers' time-dependent valuation of all varieties in industry j (time-specific fixed effect), and $\lambda_{3,cpt}$ is the unobserved error term. As noted by Khandelwal (2010), since the unobserved error term might be correlated with a variety's price and market share, Equation (2) is estimated using instrumental variables.[25]

Since production (shipments) data for the United States are at the six-digit NAICS level, import penetration is calculated at the NAICS level.[26] Exploiting the HS–NAICS information in the data set and available HS–SITC concordance, one can then calculate an industry's import penetration level. Domestic variety share (s_{0t}) is then 1 minus import penetration in the industry. Total industry output (*MKT*) is defined as $\Sigma_{p\neq 0} q_{cpt}/(1-s_{0t})$, where q_{cpt} is the quantity of import variety cp at time t. It is important to emphasize the distinction between s_{cpt} and ns_{cpt}. The former is the overall market share (quantity is divided by *MKT*) whereas the latter is the market share in product p (nest share). Unit values are inclusive of freight, insurance, other charges, and duties.

From Equation (2), the quality of variety cp at period t is calculated as follows:

$$\lambda_{cpt} = \hat{\lambda}_{1,cp} + \hat{\lambda}_{2,t} + \hat{\lambda}_{3,cpt} \tag{3}$$

It is important to note that the estimated quality indices are not comparable across industries; they can take on positive or negative values, and larger values indicate higher quality. The estimated quality indices provide an average US consumer's valuation of variety cp at time t. The intuition behind Equation (2) is that variety cp is of high quality if it does not lose market share as its price increases. These variety-level quality estimates will form the distribution of the quality estimates for λ_{pt} which is constructed for each product p at period t. One can then track how variety cp (e.g. Kenyan variety) has moved along this quality distribution.

Unit values (import value divided by quantity) are deflated using the consumer price index (1997=100). Since unit values are inherently noisy, procedures commonly used in the literature are used to discard extreme values at both tails of the import unit value distributions. First, observations (cpt level) where quality is either missing, equal to zero, or one, and when it is less than US$5,000 in 1997 are excluded. Second, observations at the lower 5 and upper 5 per cent of the unit value distribution for the industry are also excluded.

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[25] Khandelwal's (2010) approach is followed as closely as possible. Transport cost per unit, the interaction between the oil price and distance from the United States, the number of varieties country c exports, and the number of countries exporting product p are as used as instruments. Instruments need to satisfy two important properties: They must not be correlated with the error term in Equation (2), but are correlated with the endogenous regressors they are instrumenting for (for an intuitive discussion, see Murray 2006). Because unit costs (price) include transport cost, it satisfies the second property. But one might question its validity as an instrument, as higher-quality items may be exported to the United States because of transport cost. However, Khandelwal (2010: 1458) argues that 'the instruments remain valid as long as shocks to transportation costs do not affect deviations from … average quality …' Items with a higher price travel longer distances, so the interaction between oil price and distance also satisfies the second property. Both the number of varieties country c exports and the number of countries exporting product p are expected to be correlated with a country's market share in product p, and are valid instruments as long as decisions to enter markets are made before quality choices are made.

[26] Shipments (1997=1000) data are obtained from the Manufacturing Industry Database of the National Bureau of Economic Research (NBER) and the US Census Bureau's Center for Economic Studies (CES) (NBER-CES 2013).

Owing to shipment data availability, only manufactured products (SITC 5, 6, 7, and 8) are considered. Analysis is conducted from 1996 to 2006, covering years prior to and after the implementation of the AGOA in 2000.[27] This paper focuses on quality estimates from 81 apparel and clothing SITC industries. A fifth of SSA countries' manufactured exports to the United States for 1996–2006 are apparel and clothing, and just ten SITC industries account for almost all of these exports.[28] In fact, only four industries account for 16.1 per cent of manufactured exports.[29] Table 5 contains the results for 16 apparel and clothing SITC industries satisfying the following conditions: (i) Evidence that the instrument set is valid.[30] (ii) At least two of the regressors in Equation (2) are statistically significant at the 5 per cent level. (iii) The null hypothesis that the equation is weakly identified is rejected.[31] For the most part, as expected, the relative overall market share is negatively correlated with price and (when significant) positively correlated with the number of hidden varieties (using population as proxy). Interestingly, nest share has negative coefficients in the overall relative market share regressions. Recall that nest share is the country's market share in a given product (ten-digit HS code level). The results suggest that when countries narrowly specialize in certain apparel items, their overall relative market shares in the apparel categories these items belong to are lower.

Table 5: Quality regression results from selected apparel industries

SITC	Description	IV Estimates			Hansen's *J* statistics *p*-value	Kleibergen–Paap rk Wald *F* statistics	Number of varieties	Number of observations
		Price	Nest share	Hidden varieties				
84112	Men's and boys' overcoats, raincoats, and similar items (not wool or fine animal hair)	-0.005*** (0.001)	-0.442*** (0.119)	0.048 (0.159)	0.15	47.40	352	2120
84119	Men's and boys' other overcoats, raincoats, and similar items	-0.006*** (0.001)	-0.524*** (0.164)	-0.016 (0.206)	0.69	16.14	725	4918
84151	Men's and boys' cotton shirts	-0.265*** (0.093)	-16.481*** (5.739)	-79.920*** (29.900)	0.19	2.93	127	5304

[27] Pierce and Schott's (2009) HS–NAICS concordance ends in 2006.

[28] For reference, the region's top manufactured exports (five-digit SITC) to the United States in 1996–2006 are platinum and platinum alloys (15.5 per cent), other metals of the platinum group and alloys (9.6 per cent), and unworked diamonds (8.1 per cent). The values in parentheses here are the industries' shares in total manufactured exports after data have been trimmed as described earlier.

[29] This includes jerseys, pullovers, cardigans, similar items (4.89 per cent), men's and boys' trousers (4.45 per cent), and women's and girls' trousers, and similar items (4.15 per cent), and men's and boys' cotton shirts (1.70 per cent). Unfortunately, only the last satisfies the conditions for quality regressions described later.

[30] Varieties observed for only one period (singletons) are dropped in the estimations. This condition is satisfied in 29 (out of 81) apparel industries when the number of products *p* a country exports is excluded from the instrument set. These results are presented in Table 5. In contrast, only 13 industries satisfy this condition when this particular instrument is included. In fact, for the 1059 industries considered by Khandelwal (2010), the null hypothesis that the instrument set is valid is rejected for at least 25 per cent but no more than 50 per cent of the industries.

[31] This criterion may be problematic for three industries as the Kleibergen–Paap rk Wald *F* statistics is smaller than the Stock Yogo critical values of 13.43 and 8.18 at the 10 and 15 per cent maximum IV size, respectively. These critical values are based on independent and identically distributed (i.i.d.) errors; no critical values are available for the non-i.i.d. case (Baum et al. 2007). Take SITC 84159, with a Kleibergen–Paap rk Wald *F* statistics of 9.78. Since this is greater than 8.18, one can conclude there is no weak-instrument problem at the 5 per cent level, and proceed to use the IV estimates. However, this conclusion might only be appropriate at the 10–15 per cent level of significance.

84159	Men's and boys' shirts in textile materials other than cotton	-0.016*** (0.002)	-0.471*** (0.178)	0.578** (0.223)	0.18	9.78	555	3648
84211	Women's and girls' overcoats and similar items	-0.004*** (0.000)	-0.663*** (0.127)	0.165 (0.220)	0.16	42.00	600	4063
84222	Women's and girls' ensembles	-0.007*** (0.001)	-0.437*** (0.135)	-0.323* (0.190)	0.95	19.11	212	1003
84270	Women's and girls' blouses, shirts, and shirt blouses	-0.049*** (0.009)	-6.162*** (1.222)	6.366*** (1.686)	0.53	10.06	698	6278
84521	Garments made of fabrics, felt or non-woven	-0.028*** (0.007)	-1.881*** (0.452)	2.858 (5.753)	0.20	13.20	39	344
84522	Men's and boys' garments made of select special fabrics	-0.031*** (0.010)	-5.087*** (1.722)	2.702 (3.959)	0.90	3.53	145	1981
84551	Brassieres	-0.036*** (0.004)	-1.065*** (0.092)	-2.062 (3.070)	0.51	35.15	156	2194
84561	Men's and boys' swimwear (not knitted)	-0.045*** (0.018)	-1.272*** (0.503)	-1.981 (1.461)	0.12	2.81	118	898
84591	Track suits	-0.024*** (0.003)	-0.479*** (0.146)	0.101 (0.192)	0.26	23.02	385	1979
84599	Other knitted or crocheted garments	-0.035*** (0.005)	-2.235*** (0.390)	1.396*** (0.485)	0.12	18.15	986	6071
84619	Other made-up clothing accessories	-0.019*** (0.002)	-0.840*** (0.089)	1.178*** (0.271)	0.23	88.62	218	1952
84692	Other gloves, mittens, mitts	-0.065*** (0.011)	-1.115*** (0.289)	0.194 (0.169)	0.91	12.84	299	2021
84699	Other made-up clothing accessories	-0.032*** (0.004)	-0.789*** (0.151)	0.274 (0.186)	0.28	37.53	202	1271

Notes: Numbers in parentheses are robust standard errors. ***, **, and * denote significance at 1, 5, and 10 per cent levels, respectively. The Stock Yogo weak identification test critical values: 10 per cent maximal IV size is 13.43; 15 per cent maximal IV size is 8.18.

Source: Regression Equation (2) estimates using US import data from Professor Peter Schott's data page (http://faculty.som.yale.edu/peterschott/sub_international.htm) and shipments data from the National Bureau of Economic Research and the US Census Bureau's Center for Economic Studies (NBER-CES) (2013).

5.2 Quality estimates

Table 6 summarizes the pattern of these quality indices relative to exporting country income.[32] Recall the intuition behind Equation (2): An item is of higher quality if sellers do not lose market share when prices increase. Another way to interpret the patterns in Table 6 is that low-income countries export higher quality items (with three exceptions), after controlling for prices. However,

[32] Quality estimates are regressed against the natural log of income per capita, SSA region dummy, and indicators for each product belonging in the SITC industry.

just among low-income countries, export quality does increase with exporting country income. Also, SSA countries export low-quality items even after controlling for export prices.

Table 6: Quality, income, and Sub-Saharan African region indicator

SITC	Description	All countries		Low-income countries	
		lgdppc	*ssa*=1	*lgdppc*	*ssa*=1
84112	Men's and boys' overcoats, raincoats, and similar items (not wool or fine animal hair)	-0.29*** (0.04)	-1.43** (0.63)	2.07*** (0.31)	—
84119	Men's and boys' other overcoats, raincoats, and similar items	-0.57*** (0.03)	-1.85*** (0.33)	1.39*** (0.22)	-3.22*** (0.80)
84151	Men's and boys' cotton shirts	-41.63*** (1.45)	-147.55*** (6.53)	2.80 (8.94)	-115.13*** (7.58)
84159	Men's and boys' shirts in textile materials other than cotton	-0.02 (0.03)	-1.47*** (0.23)	1.62*** (0.19)	-2.07*** (0.36)
84211	Women's and girls' overcoats and similar items	-0.35*** (0.04)	-3.42*** (0.83)	2.69*** (0.27)	-3.28*** (1.09)
84222	Women's and girls' ensembles	-0.67*** (0.06)	-2.79*** (0.47)	1.16*** (0.33)	-3.92*** (0.66)
84270	Women's and girls' blouses, shirts, and shirt blouses	0.79*** (0.15)	-7.96*** (1.07)	2.86*** (0.87)	-19.68*** (1.45)
84521	Garments made of fabrics, felt or non-woven	-0.04 (0.35)	—	6.15** (2.32)	—
84522	Men's and boys' garments made of select special fabrics	-0.10 (0.21)	-13.38*** (3.76)	5.49*** (1.14)	—
84551	Brassieres	-1.59*** (0.10)	-10.97*** (0.73)	3.37*** (0.71)	-9.66*** (1.24)
84561	Men's and boys' swimwear (not knitted)	-2.00*** (0.13)	-9.52*** (1.03)	1.19 (0.89)	-8.86*** (1.42)
84591	Track suits	-0.04 (0.04)	-0.80*** (0.27)	0.99*** (0.21)	0.04 (0.37)
84599	Other knitted or crocheted garments	0.25*** (0.06)	0.10 (0.46)	2.89*** (0.34)	0.94 (0.67)
84619	Other made-up clothing accessories	0.34*** (0.05)	-1.23* (0.75)	2.23*** (0.39)	4.96*** (0.49)
84692	Other gloves, mittens, mitts	-0.76*** (0.06)	-4.04*** (1.41)	4.18*** (0.43)	—
84699	Other made-up clothing accessories	-0.05 (0.07)	-1.78** (0.76)	3.08*** (0.49)	-3.32** (1.53)

Notes: Numbers in parentheses are robust standard errors. The quality index is the dependent variable. Quality indices are regressed against the natural log of income per capita (*lgdppc*), SSA region indicator (*ssa*), and product dummy variables. Missing estimates indicate that the United States does not import the item from an SSA country. ***, **, and * denote significance at 1, 5, and 10 per cent levels, respectively.

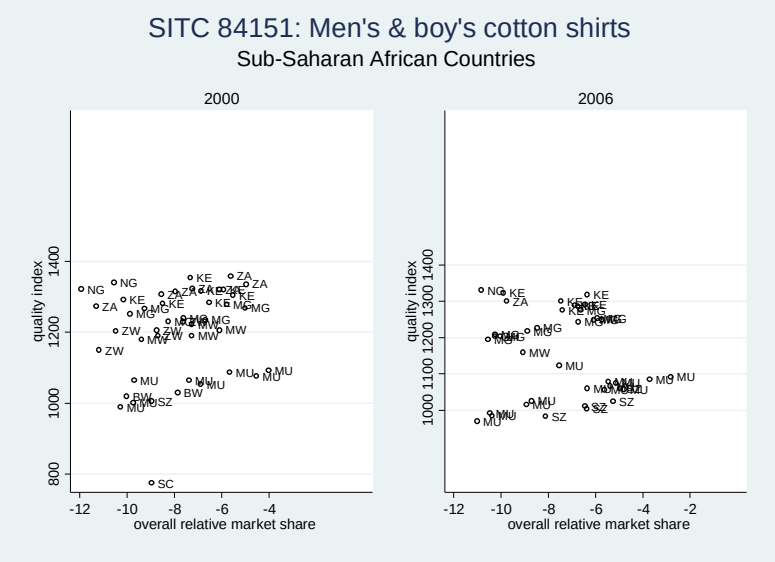
Source: Regression estimates using quality indices obtained from regression Equation (2) and income per capita data from the World Bank (2013).

Consider quality estimates for men's and boys' cotton shirts (SITC 84151) for SSA and other low-income countries shown in Figures 3a and 3b. Recall that one SITC industry encompasses several products. The estimates show that countries with high overall relative market share tend to have higher quality, on average. Exports from Mauritius tend to have lower estimated quality than exports from Kenya, Madagascar, or South Africa. This means that if Mauritius' export prices increase, it is more likely to lose market share compared to these other three countries. This is in contrast with the high estimated quality of Mauritius' exports of women's and girls' blouses, shirts, and shirt blouses (SITC 84270) shown in Figures 3c and 3d. However, the quality indices for this country dropped in 2006, albeit still high compared to its peers. The last apparel industry worth

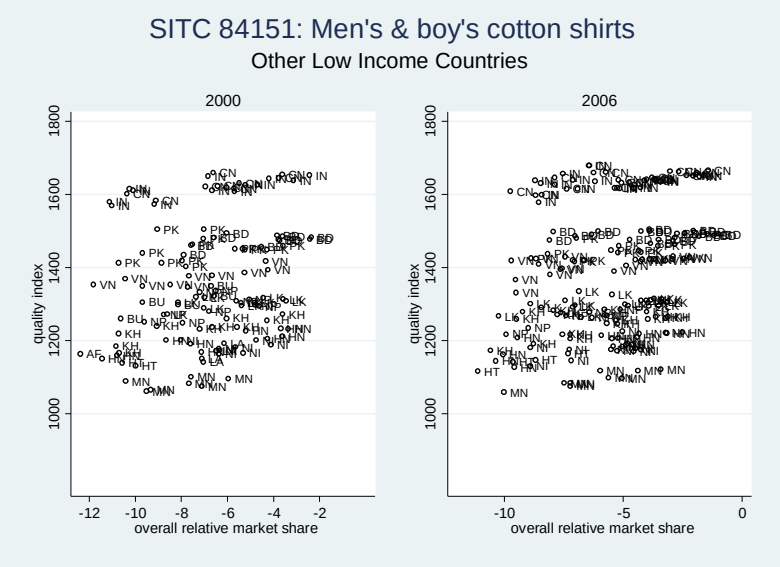
mentioning is other knitted or crocheted garments (SITC 84599). Figures 3e and 3f show an increase in the number of exporting SSA countries in 2006, with entrants such as Lesotho and Swaziland having high estimated quality (median quality index for all countries is −39.7 in 2006). All figures also show that SSA countries export lower quality items than their peers, even after controlling for export prices.

Figure 3: Quality estimates and overall market share

(a)



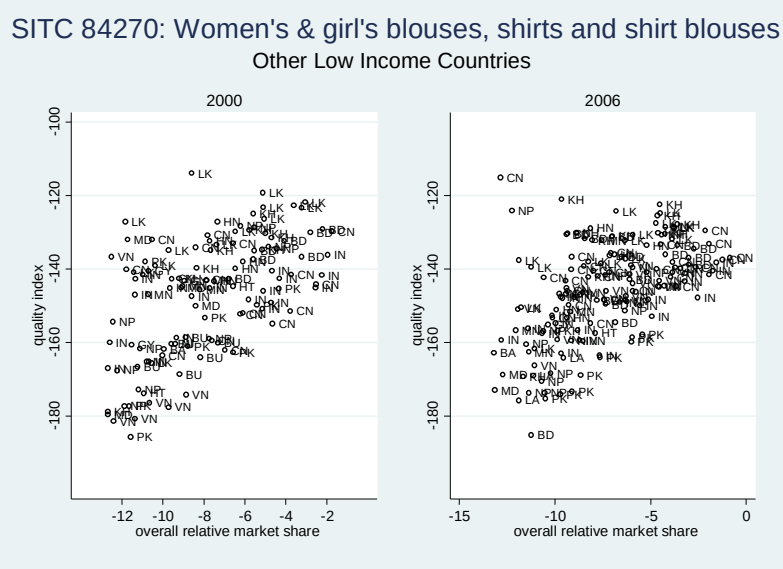
(b)


SITC 84151: Men's & boy's cotton shirts
Other Low Income Countries
2000
2006
quality index
1000
1200
1400
1600
1800
-12
-10
-8
-6
-4
-2
0
overall relative market share

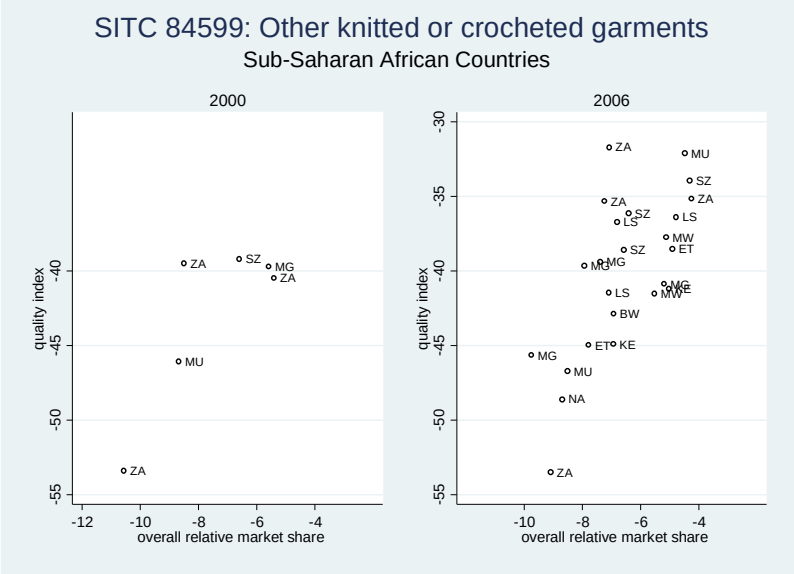
(c)


SITC 84270: Women's & girl's blouses, shirts and shirt blouses
Sub-Saharan African Countries
2000
2006
quality index
-120
-130
-140
-150
-160
-170
-180
-200
-14
-12
-10
-8
-6
overall relative market share

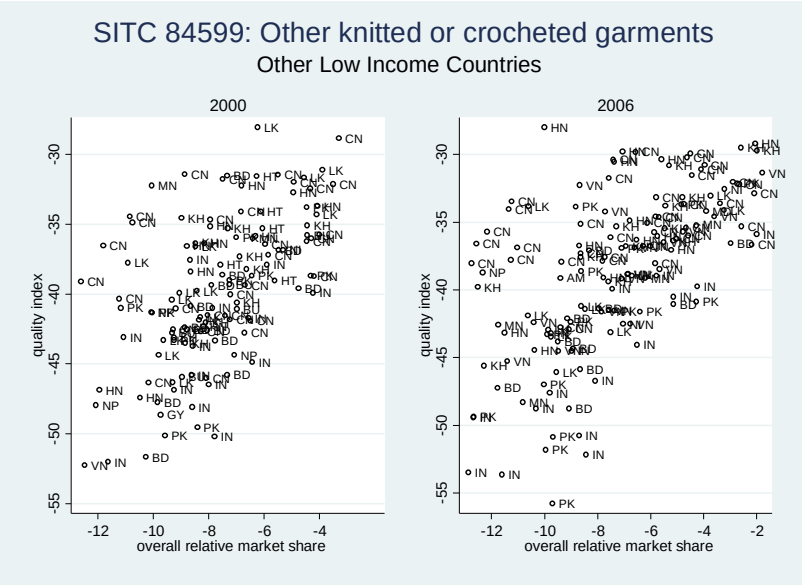
(d)


SITC 84270: Women's & girl's blouses, shirts and shirt blouses
Other Low Income Countries
2000
2006
quality index
overall relative market share

(e)


SITC 84599: Other knitted or crocheted garments
Sub-Saharan African Countries
2000
2006
quality index
overall relative market share

(f)



Source: Regression Equation (2) estimates using US import data from Professor Peter Schott's data page (http://faculty.som.yale.edu/peterschott/sub_international.htm) and shipments data from the National Bureau of Economic Research and the US Census Bureau's Center for Economic Studies (NBER-CES) (2013).

6 Discussion

What might explain the patterns uncovered by this paper, and what are their implications for policy? Let us consider the patterns one at a time. First, the relative importance of capital goods in SSA countries' imports is comparable to those of other low-income countries, with a median share of about a quarter of total imports. Telecommunications equipment is the largest category of equipment imports by SSA countries, with close to a 20 per cent share in 2008–11. This is understandable as 13 countries in the region have a virtually open telecommunications sector (Borchert et al. 2012a, 2012b) which has attracted private sector investments. World Bank (2014a) data show that 47 SSA countries report private sector participation in telecommunications investment in 2008–11, with a total project size ranging from US$800,000 in the Seychelles to US$10.6 billion in Nigeria. These investments have brought market price information to farmers for their produce and access to mobile banking services for the unbanked, among other benefits. These also provide the infrastructure necessary if development initiatives such as Mauritius' strategy to turn itself into a cyber-island were to succeed.[33]

Second, there is movement away from traditional sources of capital goods. For some SSA countries (e.g. Somalia in 2008–11), as much as 80 per cent of their capital goods imports are sourced from China. Although telecommunications equipment is noted to be the top import from China in 2008–11 by a large number of SSA countries,[34] a wide variety of other items are also being sourced from China. While electrical and non-electrical machinery account for 30 per cent of China's

[33] Mauritius' economy is dominated by sugar, textile and clothing, tourism, and financial services. In an effort to diversify its economic base, the country has made access to information and communication technologies a priority. The country has eliminated tariffs on information technology products and has an open telecommunications sector (WTO 2008).

[34] In fact, Huawei Technology Company Limited generated the largest revenue (7.5 per cent of the total) from foreign contracted projects at US$6.9 billion in 2010 (China Editorial Board 2011). It is followed by China State Construction Engineering Corporation and Sino-Hydro, with 5.3 and 4.4 per cent shares, respectively.

exports to SSA countries in 2008–11, items such as ships, boats, and floating structures have a 7–10 per cent share, vehicles a 6–9 per cent share, and articles of iron and steel a 5 per cent share in China's exports to SSA countries. Some of these items (e.g. dredgers, excavators, and bulldozers) make their way to Africa as part of the infrastructure-building work of Chinese contractors in the continent. As of 2012, Chinese contractors have a 44.8 per cent market share in Africa, a 35.2 percentage point increase from 1998 (see *Engineering News Record* 1999, 2013). This increase is mostly at the expense of European contractors whose market share dropped to 31.6 per cent from 50.7 per cent in 1998.

Data also show that in 2008–11, 2.6 per cent of China's exports are to SSA countries (up from 0.8 per cent in 1996–99) whereas 3.9 per cent of the country's imports are from the region (up from 0.7 per cent in 1996–99). Although crude oil is still China's largest import from SSA countries, with a 44.7–65.7 per cent share in 2008–11, China's increased income level has changed the composition of its imports slightly, with about 5 per cent of its imports from the SSA region consisting of natural or cultured pearls, precious stones and metals, and coins. Additionally, it is also worth emphasizing how important China is now to SSA countries' trade. Trade data as reported by SSA countries in the UN Comtrade show that in 2008–11, 12.1 per cent of their imports originate from China (up from 2.7 per cent in 1996–99) and 6 per cent of their exports are destined for the Chinese market (up from 1 per cent in 1996–99). Because the Forum on China–Africa Co-operation—the main venue for collective dialogue between China and the 49 African member states—only started in 2000, most incorrectly assume that Chinese presence in Africa is a recent phenomenon. Brautigam (2009) documents that Chinese presence in Africa started much earlier.[35] The root of Chinese firms' current dominance in Africa as infrastructure contractors, trade partners, and foreign direct investment sources can be traced to the Chinese government's relationship-building investment in the region since the 1960s.

Third, there is a connection between specific types of equipment imports and countries' subsequent exports, with elasticity estimates ranging from 0.23 to 1.17 per cent. Of course, the presence of complementary labour and a predictable business environment are among other necessary ingredients. If most equipment is sourced abroad, it is then not good policy to continue to charge high import duties on these imports. Although actual (average) applied rates range from 0.4 to 17.4 per cent (0.2–12.3 per cent) for electrical (non-electrical) equipment among the 39 SSA countries with data, the bound rates are as high as 98.7 per cent for Rwanda for electrical equipment and 120 per cent for Tanzania for non-electrical equipment (see WTO 2014). This means that there is potential for import duties to increase to these maximum rates. At the minimum, a manufacturing-led development strategy necessitates that investors (both local and foreign) face no duties for equipment imports. This might negatively impact revenue collection in the short-term, a factor upon which SSA countries rely on with varying degrees,[36] but this revenue-hit is worth taking as the elasticity estimates are suggestive of augmented local production and employment either directly (industry-specific equipment) or indirectly (general-purpose equipment).

Fourth, at the industry level, evidence suggests that the overall relative market share of countries tend to be low when they are too narrowly specialized. This is because adjustment to adverse

[35] In the 1960s, albeit still poor, China provided aid to newly independent African countries principally out of ideological kinship with the new socialist regimes in the region. Later, the country's struggle for diplomatic recognition against Taiwan was the prime driver of Chinese foreign aid. By the 1980s and to this day, emphasis is placed on potentially mutually beneficial transactions (for details, see Brautigam 2009).

[36] For 2008–11, the median share of import duties to total tax collection is 19.4 per cent for SSA countries, with a range of 0.97 per cent for Equatorial Guinea and close to half for Madagascar (World Bank 2014a).

shocks is limited when exporters are too narrowly specialized. At the macro level, this means that policy makers need to enact and implement policies conducive to the creation, growth, and survival of a diverse set of firms. The importance of diversity to various indicators of economic performance (e.g. productivity or employment growth) has been observed not only in the trade literature (e.g. Feenstra and Kee 2008) but also in the urban and regional economics literature (e.g. Glaeser et al. 1992).

Lastly, this paper estimates that controlling for price, the quality of SSA countries' apparel exports is lower than that of their peers. This means that if SSA export prices were to increase, their US market share would suffer despite the price advantage provided by the AGOA, which could be as high as 32 per cent (e.g. bodysuits and body shirts) or as low as 0 per cent (e.g. men's or boys' silk overcoats). US apparel imports from SSA countries are noted to increase by as much as 37.7 per cent in 2002–03 compared to a worldwide growth rate of 7.4 per cent, and there is econometric evidence that the AGOA raised US apparel imports from eligible countries (e.g. Frazer and van Biesebroeck 2010). Despite high growth rates, the United States sources less than 2 per cent of its apparel imports from the SSA region, and with the expiration of the quota regime (Agreement on Textiles and Clothing) on apparel in 2005 competition from higher-quality substitutes from China and Vietnam have become more intense. China's share in US apparel imports increases to 36.6 in 2008–11 from 9.5 per cent in 2000–03, and Vietnam's share increases to 8 from 1.5 per cent in the same period. The top source from the SSA region is Kenya (ranked 31), with only a 0.32 per cent share in 2008–11. The AGOA expires in September 2015, and its extension is currently under discussion. The biggest challenge is determining the additional mechanisms to put in place to increase both the market share and the quality of SSA apparel exports to the United States.

Data from 2013 show that almost all US apparel imports from AGOA-eligible countries (US$915.6 million) enter under the preference programme (US$903.9 million), and most (93 per cent) are made from foreign-made fabric or yarn. The special rule on the use of third-country fabric and yarn is, in fact, one of the key provisions of the current version of the AGOA. Apparel assembled or knit-to-shape from third-country fabric or yarn originating from qualified less-developed countries in the region enter duty-free (subject to a cap).[37] The critical role of this special rule is clearly evident when coinciding with the financial crisis: US imports from SSA countries are observed to drop by as much as 20 per cent in 2008–09 compared to a 11 per cent drop for apparel imports from the rest of the world. Note that this drop was partly due to US apparel buyers shifting orders to Asian suppliers as it was unclear whether the third-country fabric and yarn provision under the AGOA would be renewed after its expiration in September 2012 (African Cotton & Textile Industries Federation (ACTIF) 2013). Congress did renew the provision on August 2012. Subsequently, US apparel imports from the region increase by 8.4 per cent in 2012–13 compared to a growth rate of 3.9 per cent for US apparel imports from the rest of the world.[38] The ACTIF, thus, has called for the renewal of the AGOA well in advance of its expiration on 30 September 2015, and for the full-term renewal of this special provision. However, despite relaxation of the requirement that material inputs originate from the United States or the SSA region, the quota fill-rate is less than 25 per cent, and, after more than a decade of the AGOA, a viable textile industry has not developed in the region and 93 per cent of apparel imports under the AGOA are made from foreign fabric and yarn. According to Edwards and Lawrence (2010: 54), 'the special rule distorts decisions on value-addition and fabric use … the incentives are most powerful in lower quality products that require less value-addition … it encourages the use of more expensive

[37] As of 3 January 2014, 39 SSA countries are AGOA-eligible and 26 countries qualify for this special provision.

[38] The estimates here and in the next paragraph are from the US Imports of Textiles and Apparel database (US Department of Commerce 2014).

fabrics.' Thus, the special rule has effectively discouraged the emergence of a viable textile industry in the SSA region.

Despite the price advantage provided by the AGOA, US imports from (exports to) the SSA region is less than 4 per cent (1.4 per cent) of total US imports (exports) in 2008–11, not much different from the 1.4 per cent (0.4 per cent) share in 1996–99. Preferential market access to the US market has also not led to a diversification of US imports from the region, with crude oil continuing to be the predominant import. Surprisingly, crude oil's 77.4 per cent share of total US imports from the region in 2008–11 is higher than in China's case (45–66 per cent). As of 2008–11, main US exports are machinery and vehicles, with a combined share of close to 40 per cent. One of the chief aims of the AGOA is to make SSA countries viable markets for US exporters. The SSA region's 2008–11 data show that 7 per cent of their imports originate from the United States (up from 5.43 per cent in 1996–99) while close to a fifth of their exports go to the US market. The United States is an important market for SSA exporters, but US exporters have not expanded their market share in the region to the same extent as Chinese exporters, with a market share of 12.1 per cent in 2008–11 (up from 2.7 per cent in 1996–99).

7 Concluding remarks

Currently, strategies for African countries that will bring sustained growth are being re-examined. Rodrik (2014: 15) suggests that it might be 'different from earlier miracles based on industrialization. Perhaps it will be agriculture-led growth. Perhaps it will be services. But it will look quite different than what we have seen before.' Regardless of development strategy, access to reliable electricity is crucial. Latest data show that 45.2 per cent of firms surveyed in the SSA region identify electricity as a main constraint to business, with average outage lasting 6.6 hours translating to losses equivalent to 4.6 per cent of annual sales[39] (World Bank 2014b). Andersen and Dalgaard (2013) estimate a 2.86 per cent increase in long-run GDP per capita for a 1 per cent decrease in electricity outage in Africa. Likewise, Moyo (2013) finds a negative correlation between firm level productivity and the length of electricity outage.

Ondiege et al. (2013) highlight limited private sector participation and lack of access to long-term financing for the SSA region's inadequate power infrastructure. But, as the opening of several countries' telecommunications sector has shown, with suitable operating environment and incentives, the region can attract sizeable private investments. The authors also identify the need for co-ordinated national and regional efforts among government agencies responsible for the power infrastructure. This is where US President Barack Obama's Power Africa initiative launched in June 2013 shows promise. Power Africa emphasizes government–private sector co-ordination and technical assistance (for project prioritization, co-ordination, and implementation) extended to African government partners that currently include Ethiopia, Ghana, Kenya, Liberia, Nigeria, and Tanzania. Essentially, Power Africa aims to jump-start power generation investment in the region by making a commitment of US$7 billion over five years, US$5 billion of which are the Export–Import Bank of the United States financing US companies' power generation projects in the SSA region. The administration has also secured US$9 billion worth of commitments from US corporations (e.g. General Electric) to expand the SSA region's power-generation capacity.[40]

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[39] For reference, the corresponding rates for East Asia and Pacific are 34 per cent, 4.1 hours, and 1.7 per cent, respectively.

[40] See Plumer (2013) and the press release on Power Africa by the US White House Office of the Press Secretary (2013).

The International Energy Agency (2011) estimates that the SSA region requires an annual investment of US$19 billion until 2030 to achieve universal electricity access by 2030. Although the five-year US commitment of US$7 billion is lower than that required to achieve universal access, it is a reasonable magnitude when compared to the entire region's import of US$11.6 billion worth of electric and non-electric generating equipment in 2008–11. As of March 2014, five notable Power Africa transactions are reported by the US Agency for International Development (2013): The largest is a privately owned 1000-megawatt geothermal project in Ethiopia and the smallest is a privately owned 60-megawatt wind farm in Kenya. Harbert (2014) reports 26 deals in the pipeline. These indicate good momentum for an initiative that is only a year old.

To complement the AGOA, in conjunction with the Power Africa initiative, President Obama launched Trade Africa in June 2013, which initially involves the five countries of the East African Community, namely Burundi, Kenya, Rwanda, Tanzania, and Uganda. This initiative commits additional resources to expand US trade with the SSA region (e.g. by expanding the Department of Commerce's 'Doing Business in Africa' campaign), and efforts are being directed towards ensuring that intra-Africa trade is increased (e.g. by supporting the work of the East African Community to harmonize custom rules and operations). There is commitment to double the number of US Foreign Commercial Service offices in Africa to eight, with new offices opening in Angola, Ethiopia, Mozambique, and Tanzania (US Department of State 2014). The expectation is that these new initiatives will lead to more US exports and investments in the region.

A US International Trade Commission (2014) report identifies various recommendations on how to improve the AGOA. Most important is to make the AGOA permanent. With regard to apparel, to make the investment–production–export environment predictable, the third-country fabric and yarn provision needs to be renewed for the full-term of the AGOA extension period and this special rule needs to apply to all SSA countries. There is also a clear need for mechanisms that will enable the formation of backward linkages to apparel production. Kenya has recently unveiled such a mechanism with the creation of Textile City (AGOA News 2014), and similar commitments are much needed.

On 5–6 August 2014, for the first time ever, a US president hosted a US–African Leaders Summit. In the past year, President Obama's administration has rolled out several initiatives to expand US commercial presence in Africa. These initiatives have the potential to expand US capital goods exports to the region. As briefly reviewed, the success of the Power Africa and Trade Africa initiatives rests crucially on co-operation and co-ordination among various entities both in the United States and in partner African countries. Ultimately, Africa will attract significant investments only if investors are convinced of the region's potential balanced against current perceived or real risks. African leaders need to clearly demonstrate their willingness to co-operate, co-ordinate, and work with each other. Moreover, African policy makers need to change the US public's perception of why the AGOA, Power Africa, and Trade Africa need support—from the perception that Africa is poor and, therefore, needs help to develop to the perception that these initiatives will create opportunities for US businesses which, in turn, will benefit American workers and consumers.

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Appendix: Country coverage

The top 35 capital goods exporters include Australia, Austria, Belgium, Brazil, Canada, China, Hong Kong SAR, Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Malaysia, Mexico, Netherlands, Norway, Philippines, Poland, Republic of Korea, the Russian Federation, Singapore, Slovakia, Spain, Sweden, Switzerland, Thailand, the United States, and the United Kingdom.

The following SSA countries are classified as lower-middle-income countries (as of 1996): Botswana, Namibia, and Swaziland. These are classified as upper-middle-income countries: Gabon, Mauritius, Seychelles, and South Africa. All other SSA countries are classified as low-income countries.

The comparison group includes the following non-SSA low-income countries (as of 1996): Afghanistan, Armenia, Azerbaijan, Bangladesh, Bhutan, Bosnia Herzegovina, Cambodia, China, Guyana, Haiti, Honduras, India, Kyrgyzstan, Laos, Mongolia, Myanmar, Nepal, Nicaragua, Pakistan, Moldova, Sri Lanka, Tajikistan, Vietnam, and Yemen.

Appendix Table A1: Correspondence between capital goods imports and subsequent product exports using these capital goods imports

Capital goods imports		Product exports	
HS	Description	HS	Description
843850	Machinery for the preparation of meat and poultry	16	Preparations of meat, fish, crustaceans, molluscs, or other aquatic invertebrates
843830	Machinery for sugar refining and manufacture	17	Sugars and sugar confectionery
843820	Machines, confectionery, cocoa, chocolate manufacture	18	Cocoa and cocoa preparations
841720	Bakery ovens, etc., non-electric	19	Preparations of cereals, flour, starch, or milk, and bakers' wares
842111	Cream separators		
843810	Bakery and pasta-making machinery		
843860	Machinery for preparation of fruits, nuts, and vegetables	20	Preparations of vegetables, fruits, nuts, or other parts of plants
842121	Water filtering or purifying machinery or apparatus	22	Beverages, spirits, and vinegar
842122	Filtering/purifying machinery/apparatus for beverages		
843510	Presses, crushers, etc., for wine, fruit juice, and beverages		
843840	Brewery machinery		
847810	Machinery for preparing or making tobacco	24	Tobacco and manufactured tobacco substitutes
843910	Machinery for pulping fibrous cellulosic material	47	Pulp of wood or other fibrous cellulosic material; waste and scrap of paper or paperboard
843920	Machinery for making paper or paperboard	48	Paper and paperboard; articles of paper pulp, paper, or paperboard
843930	Machinery for finishing paper or paperboard		

844110	Cutting machines for paper pulp, paper, or paperboard		
844120	Machines for making paper/board bags, sacks, and envelopes		
844130	Machines making paper/board boxes, etc., except moulded articles		
844140	Machines for moulding articles in pulp, paper, and board		
844180	Machinery for making pulp, paper, paperboard n.e.s.		
844010	Book-binding machinery including book-sewing machines	49	Printed books, newspapers, pictures, and other products of the printing industry; manuscripts, typescripts, and plans
844311	Reel-fed offset printing machinery		
844312	Sheet-fed office offset printers, sheet <22×36 cm		
844319	Offset printing machinery n.e.s.		
844321	Reel-fed letterpress printers, except flexographic		
844329	Letterpress printing machinery n.e.s., except flexographic		
844330	Flexographic printing machinery		
844340	Gravure printing machinery		
900610	Cameras for preparing printing plates or cylinders		
845320	Machinery for making or repairing footwear	64	Footwear, gaiters, etc.; parts of such articles
844400	Machines to extrude, draw, and cut man-made textile fibres	50–63	Textile and apparel articles
844511	Textile fibre carding machines		
844512	Textile fibre combing machines		
844513	Textile fibre drawing or roving machines		
844519	Textile fibre preparing machines n.e.s.		
844520	Textile yarn spinning machines		
844530	Textile yarn doubling or twisting machines		
844540	Textile yarn winding or reeling machines		
844590	Machinery for producing or preparing textile yarn n.e.s.		
844610	Machines for weaving fabric, width <30 cm		
844621	Shuttle-type power loom for weaving fabric >30 cm wide		
844629	Shuttle-type looms n.e.s., for weaving fabric >30 cm wide		
844630	Shuttle-less looms for weaving fabric >30 cm wide		
844711	Circular knitting machines, diameter <165 mm		
844712	Circular knitting machines, diameter >165 mm		
844720	Flat knitting machines, stitch-bonding machines		
844790	Machinery for making tulle, lace, embroidery, trimmings, etc.		
844900	Machinery for making felt, non-wovens, including hats		
845129	Drying machines n.e.s		
845130	Ironing machines and presses, including fusing presses		
845140	Washing, bleaching, or dyeing machines (non-domestic)		

845150	Machinery to reel, fold, cut, pink, etc., textile fabric
845180	Machinery to impregnate textiles, make linoleum, etc.
845221	Automatic sewing machines, other than book-sewing n.e.s.
845229	Sewing machines, other than book-sewing machines n.e.s.

Note: n.e.s.=not elsewhere specified.

Source: Correspondence developed by the author using the US Bureau of Census' concordance between the ten-digit HS codes and five-digit end-use codes. See text and footnote 16 for details.