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What Explains the International Location of Industry? -The Case of Clothing

Sven Tengstam[*]

The clothing sector has been a driver of diversification and growth for countries that have graduated into middle income. Using a partial adjustment panel data model for 61 countries 1975-2000, we investigate the global international location of clothing production by using a combination of variables suggested by the Heckscher-Ohlin theory and the New Economic Geography (NEG) theory. Our Blundell-Bond system estimator results confirm that the NEG variables do help explain the location of the clothing industry, and point to that convergence is not as inevitable as sometimes assumed. We find that closeness to various intermediates such as low-cost labor and textile production has strong effects on output. Factor endowments and closeness to the world market have inverted U-shaped effects. This is expected since above a certain level several other sectors benefit even more from closeness and factor endowments, driving resources away from the clothing industry.

Keywords: global clothing industry, new economic geography, comparative advantages, industrial agglomeration.

JEL classification: F12, F13, L13, L67, R3, R12.

1. Introduction

This article examines one aspect of the globalization process: the determinants of the international location of the clothing industry. While it is an in-depth study of the clothing industry per se, it should also be seen as a study of industry location in general, where clothing is used as a case. Clothing is especially important from a development perspective since it has played a major role in the early stages of development in many countries. This has been possible since it is labor intensive and prone to relocation as wages increase. For low-income countries, the clothing industry still provides an opportunity for expansion of the manufacturing industry (Brenton and Hoppe, 2007). The main contribution of this study is that it includes both New Economic Geography (NEG) variables and Heckscher-Ohlin variables in an empirical test of the determinants of the location of the international clothing industry. This has to our knowledge not been done before. We find that the NEG variables do help explain the location of the clothing industry.

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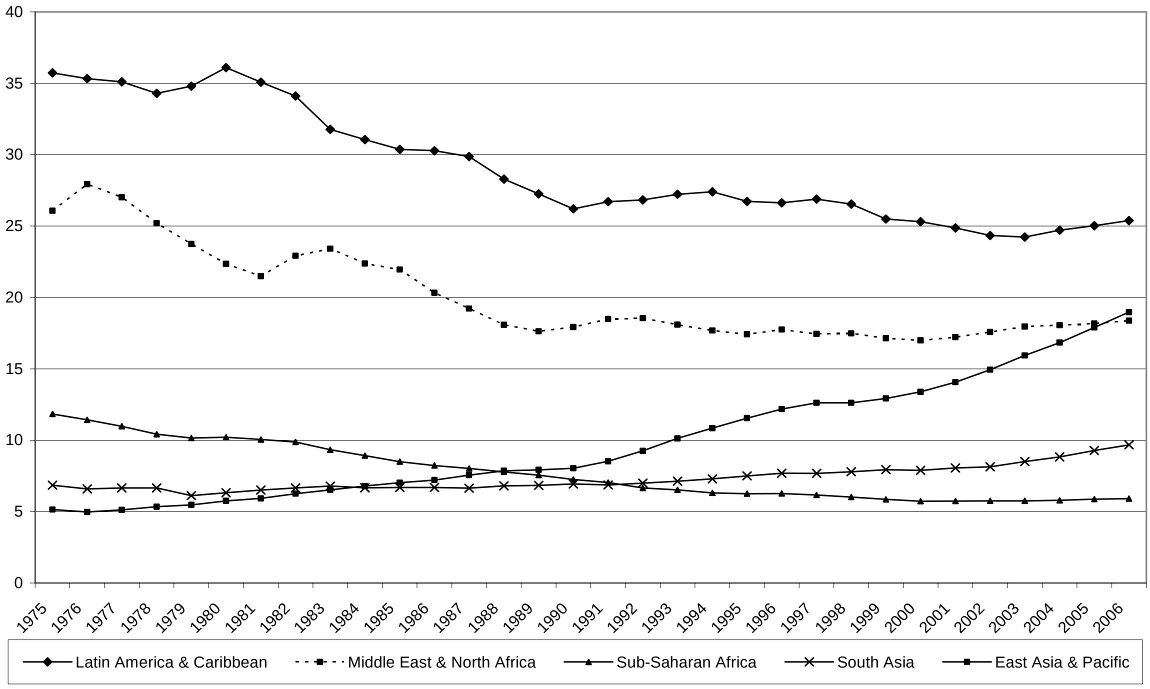
Figure 1. GDP per capita, PPP (% of OECD)



Source: World Bank (2007).

Gaining a better understanding of what drives the international location of industry sectors could be an essential contribution to the convergence-divergence discussion, and to the general understanding of the globalization process. This is an urgent topic since globalization has had such different impacts in different parts of the world.

The global economic development has until recently been a disappointment for large parts of the world. For example, Easterly and Levine (2001) find that national income levels have diverged over the long run. Figure 1 shows the big picture: East Asia has converged fast and steadily toward rich country income levels during the last 30 years, while South Asia has converged since the late 1980s, and at a slower pace. At the same time, the other developing regions have been diverging more or less throughout and, compared to OECD, Sub-Saharan Africa has reduced its relative income since 1975 by half. This is alarming since poverty is much more widespread and incomes are much lower in Africa than in any other region. The relationship between international economic integration and growth in less developed countries does not seem to follow one common pattern. The fact that not all countries benefit from globalization is in contrast to the convergence predicted by standard neoclassical theory (e.g., Lucas, 2000).

According to the Heckscher-Ohlin theory, a country will specialize in the sectors in which it has a comparative advantage due to factor endowments such as land, labor, and capital. Although factor endowments can explain a lot of the basic patterns in the industry location in the world, there is considerably more to it. For example, there has been an increasing focus on the importance of institutions. In fact, a common explanation of the East-Asian miracle relates to good institutions and policy (see, e.g., World Bank, 1993). However, while there is no doubt that a lack of good institutions can help explain why some regions are less successful, we have also seen examples of the opposite: One is parts of East Asia, which come out as badly as Africa on many measures of institutional quality (e.g., corruption), yet show much better development over the last 30-40 years.

Two patterns observed in several sectors are the existence of agglomeration and that industrialization happens in waves. This agglomeration is somewhat surprising since the concentration of an industrial sector in one geographical area should boost wages and hence induce firms to move to other regions. What we instead often observe is that firms cluster more than what can be motivated by factor endowments. And when reallocation from the core to the periphery does occur, this process is not uniform. The NEG literature[1] has tried to tackle these questions by considering second-nature geography, i.e., the geography of distance between economic agents. By assuming increasing returns to scale and imperfectly competitive markets, agglomeration is possible in this framework. But what drives agglomeration? The core in NEG is that industries are linked in an input-output structure, which creates forward and backward linkages. A straightforward example is a textile industry plant that moves to a town and thereby makes the demand for cotton in the area go up. It also creates forward linkage to the clothing industry.

The main purpose of this article is to test empirically whether NEG can add something to traditional Heckscher-Ohlin theory in explaining the location of the clothing industry; i.e., are factor endowments all that matter or does closeness to markets and suppliers of intermediate goods also play a role? Crafts and Mulatu (2004) and Antweiler and Trefler (2002), among others, find empirical support for including NEG variables together with Hechscher-Ohlin variables.[2] Our study is to our knowledge the first to do this for the international clothing industry.

We use a partial adjustment panel data model, and the empirical strategy is inspired by the study of industry location in Europe by Tony Venables and others (Midelfart-Knarvik et al., 2000). Our framework uses more detailed variables to capture proximity to suppliers, and adds variables for trade restrictions. The clothing industry has been strongly affected by trade restrictions (see, e.g., Spinanger 1999).[3] In the decades following the Second World War, world trade was liberalized and grew tremendously. Due to growing low-price competition from developing countries in labor-intensive industry sectors, especially in the clothing industry, trade in clothing has been regulated in different ways since 1955 to protect jobs and production in the OECD countries. The most important agreement has been the Multi-Fiber Agreement (MFA) from 1974, which included quantitative restrictions on textile exports from developing countries, and was discriminatory by country of origin; the exporting countries captured the quota rents from the export constraints. While the agreement stipulated a 6 % annual growth of export from developing countries, the growth rates of quotas were frequently lower than that (Yang et al., 1997). MFA was phased out 1995-2005, although very little happened before the last year. Textiles and clothing are now (almost) fully deregulated, and a new agreement, the Agreement on

[1] This literature is said to have started with Krugman (1991a and 1991b). Its roots go back to Samuelson (1952), Dixit and Stiglitz (1977), Krugman (1979), and Krugman (1980). It was further explored in, e.g., Fujita and Krugman (1995) and Krugman and Venables (1995). Fujita et al. (1999) is a synthesized presentation of the field. Geographers such as J. H. von Thünen have been working with related models for a long time (Fujita, 2000). NEG is also related to gravity models, and already Harris (1954) argued that the potential demand for goods produced in one location depends on the distance-weighted GDP of all locations.

[2] Antweiler and Trefler (2002), among others, claim that scale economies are an important source of comparative advantage in general. Craft and Mulatu (2004) find that NEG does matter, although it was mainly factor endowments that determined the location of the pre-1931 British industry.

[3] Trade barriers have a strong effect on the geographical distribution of industries. E.g., Sanguinetti and Martincus (2005) present empirical evidence of this.

Textiles and Clothing (ATC), is in place. Since it is notoriously difficult to find good data on MFA quotas, we use dummies for facing the risk of quotas. Adjustment costs (lagged dependent variable) are used as well. The available data allows us to study 61 countries 1975-2000.

Our Blundell-Bond system estimator results confirm that the NEG variables do help explain the location of the clothing industry, and suggests that the standard neoclassical view (e.g., Lucas, 2000), which sees convergence as inevitable, is too narrow-minded. We find that closeness to intermediates (low-cost labor and textile production) has positive effects on output. However, closeness to high technology suppliers is negative; it benefits other more sophisticated industries and thereby drives resources away from the clothing industry. Access to markets via low transport costs due to a high fraction of the population living close to the coast has a positive effect. Factor endowments and closeness to the world market have inverted U-shaped effects. This is expected since above a certain level several other sectors benefit even more from closeness, and as factor proportions change, comparative advantages change as well. Consequently, resources shift to other sectors.

The remainder of this paper is organized as follows. Section 2 presents theory and earlier studies, Section 3 describes the estimating equations and choice of variables, and Section 4 discusses econometric considerations. Section 5 reports the results and, finally, Section 6 concludes the paper.

2. Theory and earlier studies

NEG starts from an analytical model of monopolistic competition including economies of scale a la Dixit and Stiglitz (1977) and transport costs (Samuelson, 1952). We follow Puga and Venables (1996) when presenting the NEG framework. Like many other trade theories, it is a very simplified model, giving us broad suggestions about what to consider. The model assumes that countries have identical technology and endowments, and contains two sectors: agriculture and industry. Firms in the industrial sector are linked by an input-output structure, which creates forward and backward linkages. The interaction of these forces creates externalities, encouraging agglomeration of industry. In fact, if these forces are strong enough, industry will become concentrated to one single country.[4] Since exogenous overall growth increases the size of the industry relative to agriculture, wages will increase in this country relative to wages elsewhere. Eventually it will be profitable for firms to move out of this country, but since all countries are assumed to be identical in technology and endowments, it is random to which peripheral country the firms will move. And so it continues: as one country gets one step ahead of the others in the periphery, agglomeration forces strengthen the process. As predicted, Barrios et al. (2003) find some empirical support for convergence as total market size increases.

Puga and Venables (1996) try to establish circumstances under which industrialization takes this form. The process of growth is captured in a simple way by assuming an exogenous increase in the labor endowment (in efficiency units). We can think of it as a process of technical change, raising the productivity of labor in both agriculture and industry. The model is a general equilibrium model and has a structure similar to Krugman and Venables (1995) and Dixit and Stiglitz (1977). However, Puga and Venables (1996) expand these models by having *s* industry sectors instead of two. The model includes N countries, and for the *i*th of them we have (all exogenous) labor force L_i and arable land K_i. Agriculture is perfectly competitive and has constant returns

[4] Brakman et al. (2005) argue that agglomeration effects are so strong that it is very hard to carry out regional policy.

to scale. The production function for agriculture is Cobb-Douglas in land and labor, with a labor share of θ. The industrial sector produces a number of varieties of differentiated products, and $\sigma > 1$ is the elasticity of demand for a single variety. The input-output matrix consists of η^s, the share of agriculture inputs in the industry sector *s*, and $\mu^{r,s}$, the share of industry sector *r* in industry sector *s*. $\tau_{i,j}$ is the iceberg transport cost from country *i* to country *j* (the fraction of any shipment that "melts away" in transit). The consumer preferences are such that the consumers have a linear expenditure system. The subsistence level of agriculture consumption is e^0, and a proportion γ^s of income above this level is spent on industry *s* products. Raw materials are not included.

We do not present all the details of the model here, but given the production functions, consumer preferences, and the parameters, the model predicts the equilibrium output $y^*_{i,u,t}$ of each industry sector *u* in each country *i* at each point in time *t*:

(1) $$y^*_{i,u,t} = f_u(\{\tau_{j,k}\}_t, \{L_j\}_t, \{\mu^{r,s}\}, \{\eta^s\}; \sigma, \theta, e^0, \{\gamma^s\}).$$

This means that the variables explaining the size of an industry sector are all transport costs (even those between two other countries), labor in every country, and the full input-output matrix. σ, θ, e^0 and $\{\gamma^s\}$ are parameters.

$f_u(\{\tau_{j,k}\}_t, \{L_j\}_t; \sigma, \theta, e^0, \{\gamma^s\}, \{\mu^{r,s}\}, \{\eta^s\})$ is not necessarily linear. This kind of complex general equilibrium model seldom has a simple solution. As a general equilibrium model it only predicts how the equilibrium responds to, for example, exogenous overall growth, but says nothing about the speed of this transition. By expanding the model to a dynamic model we make it more realistic.

Puga and Venables (1996) ask which industries relocate first when the world economy grows and transport costs decrease, and doing simulations they find that the answer depends largely on the strength of the linkages among industries, which involve the structure of the input-output matrix (the elements in this matrix are $\{\mu^{r,s}\}$ and $\{\eta^s\}$). They find three basic aspects: First, when industries differ in labor intensity, the prediction is that labor-intensive industries move first. Second, when we can rank industries from upstream to downstream, there is no clear prediction. Third, when some industries are strongly linked to the rest and some are weakly linked, the weakly linked move first. Since the clothing industry is labor intensive and quite weakly linked, it should be one of the first to move. This is also what we observe.

The conclusion of the NEG theory is that the agglomeration forces act both through closeness to intermediate suppliers and through closeness to output markets. The clothing industry benefits from such closeness, *ceteris paribus,* but since other sectors might also benefit from the closeness, and thereby drive away resources from the clothing industry, the total effect might be the opposite: the clothing industry might actually lose from being close to, e.g., suppliers of advanced capital and technology. An industry sector might also benefit from closeness up to a certain level, and then lose; i.e., there might be an inverted U-shaped effect of closeness. This could happen if the effect of other sectors driving away resources from the clothing industry is weak at low levels of closeness and stronger at high levels of closeness. The impact of the closeness variables is tested together with the comparative advantage in the form of physical capital, human capital, and arable land. These factor endowments might have negative or inverted U-shaped effects, since the arguments used regarding closeness also apply to factor endowments.

A lot of theoretical work has been done in the NEG tradition; recent papers include Holmes and Stevens (2005) and Gallo (2005). However, there is less empirical work focusing strictly on NEG. One implication of the NEG approach that can be tested is the "home market effects." Davis and Weinstein (1998) find strong such effects. On a sub-national level there are studies suggesting that clustering does exist. However, there are few empirical studies of clustering at the international level (see Overman et al., 2001, for an overview of the field). Very few empirical studies have been done on geography and the clothing industry. Elbadawi et al. (2001) analyze empirically the export performance of textile and clothing manufacturers in six Sub-Saharan African countries, and find that geography is important and that domestic transport costs are even more influential than international transport costs.

3. Estimating equations and choice of variables

We put the variables from equation (1) and the variables suggested by Heckscher-Ohlin theory in the same estimating equation, and use a partial adjustment panel data model. Our model is in line with Midelfart-Knarvik et al. (2000), whose econometric analysis includes 13 EU countries and 33 industries. They construct a very general simulation model, and use the simulation output to inform their choice of functional form. The model is estimated for several industries simultaneously, but if we express the estimating equation for only the clothing industry we get:

(2) $$\ln s_i^{clothing^*} = c + \alpha \ln pop_i + \beta \ln man_i + \sum_j \beta^j (x_i^j - \gamma^j)(z^{j,clothing} - \kappa^j) .$$

The share of country *i* in the total activity of the clothing industry is denoted $s_i^{clothing^*}$, which is the equilibrium value; c is a constant; pop_i is the share of the EU population living in country *i*; man_i is the share of the total EU manufacturing located in country *i*; x_i^j is the level of the *j*th country characteristic (the country characteristics are closeness variables and factor endowments) in country *i;* $z^{j,clothing}$ is the clothing industry value of the industry characteristic (e.g., capital intensity) paired with country characteristic *j*; and, finally, $\alpha, \beta, \beta^j, \kappa^j$, and γ^j are coefficients. γ^j is the "normal" level of the *j*th country characteristic, and κ^j is the "normal" level of the industry characteristic paired with country characteristic *j*. Dropping the superscript *clothing* and rearranging we can write equation (2) as:

(3) $$\ln s_i^* = \hat{c} + \alpha \ln pop_i + \beta \ln man_i + \sum_j \hat{\beta}^j x_i^j .$$

In equation (3), $\hat{c} = c - \sum_j \beta^j \gamma^j (z^j - \kappa^j)$ and $\hat{\beta}^j = \beta^j (z^j - \kappa^j)$. $\hat{\beta}^j$ measures the sensitivity of the clothing industry to variations in country characteristics, and is a combination of β^j, which measures the general sensitivity of all industries to country characteristic *j*, and $(z^j - \kappa^j)$, which measures how important characteristic *j* is for the clothing industry specifically.

Equation (3) can be seen as a special case of equation (1). We estimate a partial adjustment equation where equation (3) is considered the desired (or equilibrium) value. The country characteristics x_i^j are the factor endowments, closeness to markets, and intermediate suppliers. There are also a couple of differences compared to Midelfart-Knarvik et al. (2000). We focus on one industry sector, but go further in trying to capture forward and backward linkages. Instead of using market potential as a country characteristic that captures all NEG aspects, we use the relevant factors (textile output, etc.). We also expand the model by making it dynamic. Our model is linear in the parameters, but in contrast to Midelfart-Knarvik et al. (2000) we allow the variables to be nonlinear.

When the equation is expanded and includes partial adjustment, we have a dynamic linear model. The adjustment equation is:

(4) $$\ln s_{i,t} - \ln s_{i,t-1} = (1-\lambda)(\ln s_{i,t}{}^{*} - \ln s_{i,t-1}) .$$

$(1-\lambda)$ is the coefficient of adjustment. This is rewritten as:

(5) $$\ln s_{i,t} = \lambda \ln s_{i,t-1} + (1-\lambda)\ln s_{i,t}{}^{*} ;$$

that is:

(6) $$\ln s_{i,t} = \lambda \ln s_{i,t-1} + (1-\lambda)(\hat{c} + \alpha \ln pop_{i,t} + \beta \ln man_{i,t} + \sum_j \hat{\beta}^j x_{i,t}^j) .$$

Equation (6) is our estimating equation, and the variables described below are included as country characteristics $x_{i,t}^j$ (the details concerning the variables are discussed in Appendix 1).

Closeness to intermediate suppliers is represented by manufacturing wage, textile industry output, and distance to advanced technology (airdist). Manufacturing wage is used instead of size of the labor force,[5] since labor force is strongly correlated with the already included population ($pop_{i,t}$); i.e. having labor force and population in the same regression would give severe multicolinearity. When interpreting the results for manufacturing wage one should be aware that this variable might capture more than intended. The textile industry output is included as the share of total world output. Distance to advanced technology (airdist) is measured as the shortest distance to the closest city of Tokyo, Rotterdam, and New York. This variable was first used in Gallup et al. (1999), and is assumed to be a proxy for international transport cost of advanced capital goods that are unavailable in local or regional markets.

Closeness to output markets is represented by the distance-weighted world GDP (GDP-dist),[6] coastal population, tariffs, and infrastructure. GDP-dist captures how well located a country is with respect to markets, or in other words how close it is to the world market. It is calculated as the sum of the GDPs of all countries divided by the distance to that particular country. Coastal

[5] There is not always a clear distinction between NEG variables and comparative advantage variables. Labor force can also be seen as a comparative advantage variable.

[6] Measures like this are often used in empirical NEG work, but usually not as one of many variables. Breinlich (2005), for example, uses a "transport cost weighted sum of the surrounding locations' GDP" and relates it to income levels.

population is calculated as the percentage of the population living less that 100 km from the coast or a navigable river. This variable was first used in Gallup et al. (1999). Tariffs on clothing exports is the most difficult variable to find a good measure of; Appendix 2 provides a deeper discussion on this. A dummy indicating being under the risk of Multi-Fiber Agreement (MFA) quotas is to our knowledge the best available alternative and is therefore used. Unfortunately, this dummy is quite rough, and there might be a risk of endogeneity. A country might be classified as an LDC and thereby avoid quotas because it has been less successful in expanding its industry. Two alternative measures, import duty (in percent of imports) and a developing country dummy, are used as robustness test. The developing country dummy refers to all countries except those that were OECD countries before 1994 (plus Turkey).[7] There is therefore no risk of endogeneity in this dummy. Telephone connections per 1,000 people is used as a proxy for infrastructure.

The comparative advantage effects are represented in the regressions by capital per worker, human capital, and arable land per worker. Capital per worker is based on the Bosworth and Collins (2003) estimate of capital stocks, human capital is represented by average years of schooling in the total adult population (older than 15) from the Barro and Lee (2000) dataset, and arable land per person is measured as hectares per person.

As mentioned earlier, the total effect of closeness and factor endowments might not be linear and positive, but could be inverted U-shaped or negative, since other sectors may benefit even more from the closeness and factor endowments and thereby attract resources away from the clothing industry. In the estimating equation, manufacturing output as a share of world manufacturing output is controlled for. Therefore the effects of the right hand variables, given the level of manufacturing, are estimated. This makes it even more likely that we will find a negative or inverted U-shaped effect of closeness and factor endowments. What the effect is expected to be depends on the importance of the variables for the clothing industry and for other industry sectors. Among the other industries we find many that are advanced, but also ones that are less advanced than clothing.

The size of the textile industry is expected to have a positive effect on clothing production, while being under the risk of MFA quotas is expected to have a negative effect. For most of the other closeness variables we expect a mostly positive, but perhaps inverted U-shaped, effect. Physical and human capital, as well as distance to advanced technology, are expected to have inverted U-shaped, mostly negative, effects. Arable land per person is expected to have a negative but probably small effect.

Based on the simulation results of Midelfart-Knarvik et al. (2000), we use the logarithms of all but four variables: Schooling is included without logarithms in line with the Mincer equation (Mincer, 1974), which relates the logarithm of earnings linearly to years of education. Coastal population can not exceed 100 % and airdist can not exceed approximately 10,000 km, and often when a variable has an upper limit it is more realistic to include it without logarithms. Including the logarithm of coastal population would be based on the assumption that going from 2 to 4 percent has the same effect as going from 20 to 40 percent, which is implausible. The same reasoning can be applied to airdist. MFA is a dummy.

[7] The developed countries are in other words defined as Western Europe, USA, Canada, Australia, New Zealand, and Japan.

Table 1. Countries in the dataset, with year of gaining LDC and/or Lomé country status (when appropriate).

Developed countries	Developing countries	LDC status	Lomé status	Developing countries, cont.	LDC status	Lomé status
Australia	Algeria			Kenya		1969
Austria	Argentina			Korea, Rep.		
Canada	Bangladesh	1975		Malawi	yes	1975
Denmark	Bolivia			Malaysia		
Finland	Brazil			Mauritius		1975
France	Cameroon		1963	Mexico		
Greece	Chile			Mozambique	1988	1984
Ireland	China			Nicaragua		
Italy	Colombia			Pakistan		
Japan	Costa Rica			Panama		
Netherlands	Dominican		1984	Peru		
N. Zealand	Ecuador			Philippines		
Norway	Egypt			Senegal	2000	1963
Portugal	El.Salvador			Singapore		
Spain	Ghana		1975	South Africa		1995
Sweden	Guatemala			Sri Lanka		
UK	Honduras			Thailand		
USA	India			Trinid. & To.		1975
	Indonesia			Tunisia		
	Iran			Turkey		
	Israel			Tanzania	yes	1969
	Jordan					

Notes: A country is considered to have Lomé status if it is included in the Yaoundé or Lomé agreement. Developed country refers to all OECD countries before 1994 except Turkey.
Source: UN (2005), European Commission (2007).

Table 2. Summary statistics

Variable	Obs.	Mean	S.D.	Min	Max
Lnclothshare	1220	-6.12	2.14	-13.16	-0.93
Lnpopshare	1220	-5.81	1.57	-9.94	-1.48
Lnmanshare	1220	-6.01	2.02	-11.28	-1.00
Lntextshare	1220	-5.99	2.14	-11.37	-1.34
Airdist	1172	3.69	2.63	0.14	9.59
Lnmanwage	1220	8.91	1.14	5.39	10.73
Lngdpdist	1220	22.28	0.61	21.00	23.92
Coastal population	1172	70.10	31.61	0.00	100.00
Lninfrastructure	1220	4.24	1.78	-0.20	6.63
MFA	1220	0.52	0.50	0.00	1.00
Impduty	1034	9.27	9.36	0.00	73.71
Lnkapworker	1220	9.88	1.56	6.48	12.44
Schoolyears	1220	6.33	2.61	0.95	11.89
Lnarable	1210	-1.76	1.27	-8.30	1.12
Institutions	1141	5.90	3.61	2.00	13.00

Table 3. Regression analysis of the determinants of clothing production with successively fewer quadratic terms included (using Blundell-Bond system estimator, dependent variable: ln Clothing Share)

	1.	2.	3.	4.	5.	6.
Lagged lnclothshare	0.537***	0.550***	0.550***	0.458***	0.453***	0.444***
	(0.114)	(0.111)	(0.107)	(0.116)	(0.119)	(0.110)
Lnpopshare	-0.277**	-0.293**	-0.279**	-0.306**	-0.298**	-0.276**
	(0.132)	(0.133)	(0.121)	(0.123)	(0.118)	(0.119)
Lnmanshare	0.554***	0.549***	0.528***	0.646***	0.640***	0.620***
	(0.155)	(0.148)	(0.144)	(0.154)	(0.151)	(0.146)
Lntextshare	0.153**	0.157**	0.162**	0.171***	0.175***	0.183***
	(0.063)	(0.062)	(0.063)	(0.063)	(0.064)	(0.065)
Airdist	-0.033	-0.019	-0.023	0.099***	0.101***	0.090***
	(0.131)	(0.127)	(0.124)	(0.032)	(0.031)	(0.030)
Airdist2	0.012	0.011	0.011			
	(0.013)	(0.013)	(0.012)			
Lnmanwage	-0.659	-0.735	-0.682	-0.910	-0.869	-0.167**
	(0.470)	(0.488)	(0.501)	(0.545)	(0.526)	(0.083)
Lnmanwage2	0.031	0.036	0.033	0.044	0.041	
	(0.026)	(0.027)	(0.028)	(0.030)	(0.029)	
Lngdpdist	14.426**	13.791**	13.105**	12.953**	12.866**	12.730**
	(5.758)	(5.586)	(5.459)	(5.303)	(5.100)	(5.007)
Lngdpdist2	-0.319**	-0.303**	-0.288**	-0.283**	-0.281**	-0.279**
	(0.129)	(0.125)	(0.122)	(0.118)	(0.114)	(0.112)
Coastal population	0.000	0.001	0.004	0.005*	0.004*	0.004*
	(0.009)	(0.009)	(0.003)	(0.003)	(0.002)	(0.002)
Coastal population2	0.000	0.000				
	(0.000)	(0.000)				
Lninfrastructure	-0.139	-0.103	-0.087	-0.102	-0.160*	-0.144
	(0.231)	(0.216)	(0.223)	(0.231)	(0.089)	(0.088)
Lninfrastructure2	0.002	-0.004	-0.005	-0.008		
	(0.031)	(0.028)	(0.029)	(0.028)		
MFA	-0.041	-0.056	-0.075	-0.213	-0.218	-0.239
	(0.180)	(0.169)	(0.159)	(0.191)	(0.188)	(0.162)
Lnkapworker	1.343*	1.360**	1.324**	1.903**	2.035***	1.865***
	(0.680)	(0.670)	(0.658)	(0.777)	(0.695)	(0.626)
Lnkapworker2	-0.073**	-0.076**	-0.074**	-0.103**	-0.109***	-0.100***
	(0.035)	(0.034)	(0.033)	(0.039)	(0.035)	(0.032)
Schoolyears	0.157	0.141	0.136	0.143	0.168*	0.167*
	(0.111)	(0.104)	(0.100)	(0.088)	(0.095)	(0.088)
Schoolyears2	-0.011	-0.010	-0.009	-0.009	-0.011*	-0.010*
	(0.009)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Lnarable	0.029	0.047	0.031	0.042	0.042	0.029
	(0.099)	(0.057)	(0.046)	(0.046)	(0.044)	(0.046)
Lnarable2	-0.000					
	(0.011)					
Constant	-166.028**	-159.511**	-151.749**	-152.630**	-152.467**	-152.651***
	(64.393)	(62.601)	(61.406)	(60.323)	(58.201)	(57.071)
Observations	1128	1128	1128	1128	1128	1128
Number of countries	61	61	61	61	61	61

Note: Robust standard errors. * significant at 10%; ** significant at 5%; *** significant at 1%.

The data used for clothing, textile, and manufacturing is from the Industrial Statistical Database from UNIDO (2005). It is mostly the data availability in this database, and in the capital stock estimates by Bosworth and Collins (2003), that has limited our study to 61 countries 1975-2000. The countries are presented in Table 1, and summary statistics for the variables are presented in Table 2. We use yearly data. Doing the regressions with five year averages instead gives similar estimates, but lower statistical significance due to smaller sample size. Using yearly data forced us to interpolate years of schooling between the reported values for every five years (see Appendix 1 for a presentation of the variables). We believe that the benefit of not having to throw away information by averaging variables over time outweighs that we have to interpolate one variable.

The effects might be diminishing, which can be captured by a quadratic term. We test this successively (see Table 3) and find that only GDPdist, capital per laborer, and years of schooling have a statistically significant quadratic term. This, finally, gives us the following estimating equation:

(6')
$$\begin{aligned} \ln clothingshare_{i,t} &= \lambda \ln clothingshare_{i,t-1} + (1-\lambda)(const + \beta_1 \ln popshare_{i,t} + \\ &\beta_2 \ln manshare_{i,t} + \beta_3 \ln textshare_{i,t} + \beta_4 airdist_i + \beta_5 \ln manwage_{i,t} + \\ &\beta_6 \ln gdpdist_{i,t} + \beta_7 (\ln gdpdist_{i,t})^2 + \beta_8 \ln pop100cr_i + \beta_9 \ln infrastructure_{i,t} \\ &+ \beta_{10} MFA_{i,t} + \beta_{11} \ln kaplabor_{i,t} + \beta_{12} (\ln kaplabor_{i,t})^2 + \beta_{13} schoolyears_{i,t} + \\ &\beta_{14} (schoolyears_{i,t})^2 + \beta_{15} \ln arable_{i,t}) \end{aligned}$$

4. Econometric considerations

We use a panel model since we want to control for unobserved heterogeneity in the form of time-invariant country-specific effects. When estimating a dynamic panel data model the lagged dependent variable is correlated with the compound disturbance, which makes it necessary to take some extra steps. The general approach relies on IV estimators. We use the Blundell-Bond (1998) system estimator (Bond, 2002, is a good introduction), which is based on the Arellano-Bond (1991) estimator – sometimes called "the difference GMM estimator." Consider the model

(7)
$$y_{it} = \alpha y_{i,t-1} + \beta x_{it} + (\eta_i + \upsilon_{it}),$$

where x_{it} is a vector of explanatory variables that might be strictly exogenous, predetermined, or endogenous; η_i are unobserved group-level effects; and υ_{it} is a disturbance term. First-differencing (7) gives:

(8)
$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \beta \Delta x_{it} + \Delta \upsilon_{it}.$$

Now $\Delta \upsilon_{it}$ is correlated with $\Delta y_{i,t-1}$, so we need an instrument. $\Delta y_{i,t-1}$ is instrumented with lagged $y_{i,t-2}$. Endogenous and predetermined (lagged) variables in first differences are instrumented with two time lags of their own levels.

The difference GMM estimator can be expanded to a system estimator (Arellano and Bover, 1995; Blundell and Bond, 1998). A system uses both difference equations and level equations.

The level equations include a random effect.[8] The system has two advantages: The estimations are more efficient than when only using differences, since lagged levels are often poor instruments for first differences, and we can estimate the parameters of the time-invariant variables. In the level equations, predetermined (lagged) and endogenous variables are instrumented with lags of their differences.

The instruments we use in the instrument matrix are standard 2SLS and not GMM instruments, since GMM instruments are highly biased in small panels. We use the two step estimator with the Windmeijer (2000) correlations of the robust standard errors. The Arellano-Bond (1991) test for serial correlation is applied to the first-difference equation residuals, $\Delta\upsilon_{it}$. First order serial correlation is expected, but higher order serial correlation indicates that υ_{it} is serially correlated. If υ_{it} itself is MA(1) , then $\Delta\upsilon_{it}$ is MA(2); hence $y_{i,t-2}$ is not a valid instrument for $\Delta y_{i,t-1}$, while $y_{i,t-3}$ remains available as an instrument. If υ_{it} is AR(1), then no lags are valid as instruments.[9] The Arellano-Bond test for serial correlation is applied in our regressions to the difference-equation residuals. These residuals are found to be first order serial correlation as expected in most regressions, but the test does not indicate second order serial correlation in any of them. All our system regressions pass the Difference-in-Hansen tests of exogeneity of instrument subsets.[10]

Looking at the correlation matrix in Table 4, we see that schoolyears, lninfrastructure, and lnkapworker mainly have correlation coefficients of 0.8 and higher between each other. This is also true for lnclothshare, lnmanshare, and lntextshare. This indicates multicolinearity and leads to lower power with higher standard errors and lower statistical significance, since our system estimator includes level equations.

In this type of regression there is always a risk of spurious regression. The left hand variable is most likely stationary. On the right hand we have five non-stationary variables: schoolyears, capital per worker, GDPdist, manufacturing wage, and infrastructure, plus the squared terms of the first three of these. Since we have more than one non-stationary variable on the right hand side, the regression might still be legitimate, even if the left hand variable is stationary. At the end of the day the question is whether our model is correctly specified or misspecified; can these explanatory variables that are growing over time have a constant effect on the stationary variable on the left hand side? During this limited time period (1975-2000) and in the nearest future, it is not unreasonable to assume that the variables included with a quadratic term are correctly included in the model. This would mean that the "optimal level" of these variables is constant during this period, which in turn means that nothing indicates that our model is misspecified or that we have a problem with spurious regression. Still, one should be cautious. A Multivariate Augmented Dickey-Fuller panel unit root test cannot be done since the panel is not balanced.

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[8] The level equations work as an extension of the Hausman and Taylor (1981) formulation of the random effects model, which utilizes instrumentation. Time-invariant variables correlated with the country effect are instrumented with time-varying variables uncorrelated with the country effect. However, we have no reason to suspect such a correlation in our model.

[9] If we suspect that υ_{it} is serially correlated, a Hansen J-test can be carried out to determine whether υ_{it} is MA or AR.

[10] This is used instead of a Difference-in-Sargan test since the Sargan statistic is not robust to heteroskedasticity or autocorrelation.

Table 4. Pairwise correlation coefficients for the independent variables

	Lnclo	Lnpop	Lnman	Lntex	Airdi	Lnmanw	Lngdp	Coast	Ininf	MFA	Lnkap	School
Lnclothshare	1.00											
Lnpopshare	0.50	1.00										
Lnmanshare	0.89	0.67	1.00									
Lntextshare	0.80	0.76	0.90	1.00								
Airdist	-0.47	-0.13	-0.52	-0.43	1.00							
Lnmanwage	0.48	-0.16	0.48	0.25	-0.38	1.00						
Lngdpdist	0.48	0.12	0.48	0.38	-0.70	0.42	1.00					
Coastal population	0.39	-0.04	0.39	0.21	-0.46	0.37	0.34	1.00				
Lninfrastructure	0.52	-0.19	0.48	0.30	-0.51	0.65	0.64	0.49	1.00			
MFA	-0.03	-0.12	-0.10	-0.10	-0.11	-0.16	0.21	0.08	0.29	1.00		
Lnkapworker	0.63	-0.19	0.60	0.37	-0.48	0.87	0.61	0.48	0.95	-0.01	1.00	
Schoolyears	0.60	0.02	0.59	0.40	-0.38	0.68	0.55	0.48	0.87	0.16	0.81	1.00
Lnarable	0.07	0.41	0.12	0.26	0.06	-0.05	-0.16	-0.33	-0.20	-0.21	-0.03	-0.05

Using time dummies will make the potential problem of non-stationary variables smaller. We use time dummies as a robustness test, and the statistical significance falls as expected. However, the parameter estimates change only slightly (see Table 6).

5. Discussion of results

Table 3 reports regressions where we successively exclude the quadratic terms that are not statistically significant. As can be seen in Column 6, only GDPdist, capital per laborer, and schoolyears have statistically significant quadratic terms. This finally gives us the estimating equation (6') as reported earlier. Table 5 reports the main regressions and Table 6 reports regressions for robustness tests. Heteroskedasticity-consistent asymptotic standard errors are used in all estimations.

The first two columns in Table 5 report OLS level estimates and within-group estimates. As discussed earlier, these are strongly biased and are only reported for comparison. The Arellano-Bond difference estimates reported in the third column are unbiased but less efficient than the Blundell-Bond system estimates reported in the fourth column. We have reason to believe there is causality in both directions between clothing and textile, which if so will bias our parameter estimate for textile upwards. We therefore instrument textile with lagged values in Column 5. However, this makes the parameter estimate go up and not down as expected, indicating that something is wrong. When using arable land per person as an instrument, the same problem arises (as can be seen in Table 6, Column 5). While both instrumenting approaches pass the Hansen test, neither gives reasonable results.[11] We therefore do not instrument for textile. Columns 3-5 reveal that the difference estimation and the two systems produce very similar results.

[11] The Difference-in-Hansen test gives chi2(14) = 11.91 (p = 0.615) in the first approach and chi2(13) = 11.41 (p = 0.577) in the second.

Table 5. Main regression analysis of the determinants of clothing production (using various estimators, dependent variable: ln Clothing Share)

	OLS levels	Within groups	Arellano-Bond difference	Blundell-Bond system	Blundell-Bond system IV: lagged
Lagged lnclothshare	0.912***	0.813***	0.722	0.445***	0.381***
	(0.021)	(0.040)	(2.661)	(0.110)	(0.100)
Lnpopshare	-0.100***	-0.498***	-0.437	-0.276**	-0.533***
	(0.029)	(0.183)	(0.451)	(0.119)	(0.185)
Lnmanshare	0.131***	0.348***	0.783***	0.620***	0.422**
	(0.030)	(0.075)	(0.183)	(0.146)	(0.170)
Lntextshare	0.059***	0.106*	0.167	0.183***	0.576***
	(0.015)	(0.054)	(0.126)	(0.065)	(0.176)
Airdist	0.016			0.090***	0.092**
	(0.010)			(0.030)	(0.036)
Lnmanwage	-0.093**	-0.027	-0.076	-0.168**	-0.161
	(0.038)	(0.042)	(0.252)	(0.083)	(0.114)
Lngdpdist	1.570	3.876**	12.680	12.556**	13.268***
	(1.501)	(1.890)	(20.030)	(4.961)	(4.579)
Lngdpdist2	-0.034	-0.079*	-0.264	-0.275**	-0.290***
	(0.033)	(0.043)	(0.425)	(0.111)	(0.102)
Coastal population	0.001**			0.004*	0.003
	(0.001)			(0.002)	(0.003)
Lninfrastructure	-0.038	-0.069	-0.260	-0.143	-0.166*
	(0.032)	(0.054)	(0.759)	(0.088)	(0.092)
MFA	0.024	-0.272***	0.000	-0.239	-0.068
	(0.049)	(0.059)	(0.000)	(0.162)	(0.259)
Lnkapworker	0.355*	0.342	0.114	1.863***	1.480
	(0.191)	(0.515)	(20.075)	(0.626)	(0.992)
Lnkapworker2	-0.020**	-0.034	-0.042	-0.100***	-0.084
	(0.009)	(0.025)	(0.936)	(0.032)	(0.052)
Schoolyears	0.032	0.215***	-0.224	0.167*	0.262**
	(0.024)	(0.079)	(1.034)	(0.088)	(0.123)
Schoolyears2	-0.002	-0.013***	0.014	-0.010*	-0.013*
	(0.001)	(0.004)	(0.084)	(0.006)	(0.007)
Lnarable	0.013	0.175**	0.029	0.029	-0.018
	(0.010)	(0.079)	(0.631)	(0.046)	(0.040)
Constant	-19.025	-47.936**		-150.688***	-158.130***
	(17.800)	(21.159)		(56.530)	(51.656)
Observations	1162	1162	1073	1128	1128
R-squared	0.980	0.824			
Number of countries		61	61	61	61

Note: Robust standard errors * significant at 10%; ** significant at 5%; *** significant at 1%.

As expected, the standard errors are much higher in the difference estimation, giving us lower statistical significance, although the estimates are similar. Looking carefully at the preferred fourth regression (the Blundell-Bond system estimation without instruments), we see what follows below.

5.1. Partial adjustment

Regression 4 in Table 5 shows that the parameter of the lagged clothing output is estimated at around 0.44, which means that 56 % of the desired adjustment is completed after one year. A permanent rise in an independent variable has not only a direct effect but also an indirect effect via lagged clothing output. The total effect is the long-run effect. Since we are estimating eq. (6'), the estimates we get from our regression are estimates of $(1-\lambda)\beta_i$. However, we are primarily interested in eq. 3 and the long-run effects, β_i. Therefore we should divide our parameter estimates by (1-0.44) = 0.56, the estimate of $(1-\lambda)$, to get the estimates of the long-run parameters. These long-run parameters are what we discuss from here on.

5.2. Size variables

Population and manufacturing are control variables, but if the estimates of their parameters are unreasonable we should be worried. The parameter of manufacturing has a statistically significant positive point estimate and a long-run elasticity of approximately one, which is reasonable. The estimated parameter of population is negative and statistically significant. Since we control for manufacturing, one could expect population to have no effect at all. However, it is not unreasonable that smaller countries on average have more clothing production, since smaller countries generally are more export oriented and being export oriented could support expansion of the clothing industry.

5.3. Closeness

In our regressions we control for the manufacturing industry, so if we find that one of our explanatory variables has a positive parameter,[12] the interpretation is that it has a more positive effect on the clothing industry than on other industries.

5.4. Closeness to intermediate factors

Textile output has a positive and statistically significant effect. The elasticity is estimated to 33 %. A one standard deviation (see Table 2 for summary statistics) change makes the *clothout-share*, and thereby the clothing output, approximately 100% larger. As mentioned earlier, we suspect reversed causality here, although we have not been able to find any strong and valid instruments. This parameter estimate is therefore probably biased upwards. As expected, closeness to advanced technology has a statistically significant negative effect; a one standard deviation rise changes the clothing output by about 50%. The parameter estimate of manufacturing wage is negative and statistically significant; the elasticity is estimated to 0.30.

5.5. Closeness to output markets

Distance-weighted world GDP has a statistically significant inverted U-shaped effect. The effect turns negative quite close to the mean value of the variable in our dataset. Hence, the clothing industry benefits from being close to output markets, but only to a certain point. Other industries probably benefit more from being very close to markets. As predicted, coastal population has a positive effect, with an elasticity of 0.70. However, infrastructure has no statistically significant effect.

[12] In the case with a squared term included, e.g., $\beta_1 X + \beta_2 X^2$, the marginal effect is given by $\beta_1 + 2X\beta_2$. We focus on this linear combination of the two parameters instead of on the parameters separately.

Table 6. Robustness test of the regression analysis of the determinants of clothing production (using Blundell-Bond system estimator, dependent variable: ln Clothing Share)

	Institutions	Developing	Impduty	Time dummies	IV: Arable land
Lagged lnclothshare	0.507***	0.457***	0.594***	0.689***	0.378***
	(0.128)	(0.097)	(0.123)	(0.084)	(0.098)
Lnpopshare	-0.273**	-0.336**	-0.308**	-0.232**	-0.529**
	(0.109)	(0.133)	(0.129)	(0.103)	(0.217)
Lnmanshare	0.584***	0.653***	0.513***	0.428***	0.480**
	(0.153)	(0.146)	(0.142)	(0.124)	(0.198)
Lntextshare	0.165**	0.189***	0.169***	0.130**	0.527**
	(0.074)	(0.067)	(0.063)	(0.059)	(0.240)
Airdist	0.086***	0.095***	0.081**	0.097	0.099**
	(0.031)	(0.034)	(0.032)	(0.066)	(0.038)
Lnmanwage	-0.165**	-0.203**	-0.139	-0.128	-0.162
	(0.080)	(0.092)	(0.087)	(0.092)	(0.122)
Lngdpdist	12.742**	11.349**	9.715**	16.930	13.407***
	(5.061)	(4.400)	(3.974)	(13.111)	(4.777)
Lngdpdist2	-0.279**	-0.246**	-0.211**	-0.372	-0.292***
	(0.112)	(0.098)	(0.088)	(0.288)	(0.107)
Coastal population	0.003*	0.004	0.004*	0.003**	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Lninfrastructure	-0.167	-0.150	-0.064	-0.161	-0.165
	(0.103)	(0.090)	(0.082)	(0.105)	(0.106)
MFA	-0.237			-0.178	-0.081
	(0.154)			(0.124)	(0.318)
Developing		-0.001			
		(0.168)			
Impduty			-0.002		
			(0.003)		
Lnkapworker	1.895***	1.393***	0.891**	1.224**	1.575
	(0.637)	(0.517)	(0.436)	(0.498)	(1.053)
Lnkapworker2	-0.100***	-0.075***	-0.054**	-0.066***	-0.090
	(0.032)	(0.027)	(0.021)	(0.024)	(0.057)
Schoolyears	0.132	0.143	0.098	0.094	0.243*
	(0.088)	(0.086)	(0.085)	(0.075)	(0.125)
Schoolyears2	-0.007	-0.008	-0.006	-0.005	-0.012
	(0.006)	(0.005)	(0.006)	(0.005)	(0.007)
Lnarable	0.032	0.073	0.055**	0.019	
	(0.043)	(0.044)	(0.026)	(0.035)	
Institutions	0.003				
	(0.016)				
Constant	-152.924**	-135.457***	-114.293**	-196.914	-160.426***
	(58.146)	(50.068)	(45.061)	(149.805)	(53.923)
Observations	1079	1128	963	1128	1128
Number of countries	61	61	57	61	61

Note: Robust standard errors * significant at 10%; ** significant at 5%; *** significant at 1%.

Since we use telephone connections as a proxy, this should be interpreted carefully; the result might not hold for infrastructure in general, for example in terms of roads. The MFA dummy is not statistically significantly different from zero (p = 0.14), but the point estimate is negative and substantial.

5.6. The comparative advantage variables

Both capital per worker and years of schooling seem to have the expected effects; positive to start with but negative for higher values. If the parameter estimates are true, then one extra year of schooling is associated with a 25 % higher clothing production at low levels of schooling. Then the effect declines, and when a country is at an educational level of 8 years, the effect disappears. One should not take these computations too literally, but rather see them as hints of what the results say. For low levels of capital per worker the effect might be huge, with an elasticity of 0.85. The effect disappears at a capital per worker level around 10,000 USD, which is quite close to the mean value of the variable in our dataset. The parameter of arable land per person is far from statistically significant, and the economic effect is, if any, very low.

5.7. Robustness

Our results seem to be robust to several changes: Including the variable institutions,[13] using import duty (in percent of imports) instead of the MFA dummy, or using a developing country dummy instead of the MFA dummy does not change anything substantially, as seen in Table 6, Columns 1-3. When using time dummies (Column 4) we see that the results are very similar, although a bit less statistically significant. Column 5 reports the results when instrumenting textile with arable land per person, as discussed earlier. The Arellano-Bond test for serial correlation is applied to the difference equation residuals, and we get the same result in all regressions. First order serial correlation is expected, but there is no indication of second order serial correlation. All regressions pass the Hansen J test.

6. Conclusions

The clothing sector has been a driver of diversification and growth for countries that have graduated into middle income. This study tries to explain the international location of clothing production by using a partial adjustment panel data model and a combination of variables suggested by the Heckscher-Ohlin theory and the New Economic Geography theory. While it is an in-depth study of the clothing industry per se, it should also be seen as a study of industry location in general, where clothing is used as a case. The global economic development has until recently been a disappointment for large parts of the developing world. Several regions have been diverging more or less constantly. The worst performer, Sub-Saharan Africa, is half as rich today as in 1975 compared to OECD, which is alarming. It appears puzzling why all countries have not benefited from globalization. In fact, we have even been witnessing the opposite of the convergence predicted by standard neoclassical theory.

Our results confirm that the New Economic Geography variables do help explain the location of the clothing industry, and suggest that the standard neoclassical view (e.g., Lucas, 2000), which sees convergence as inevitable, is too narrow-minded. The results further point to the critical importance of being close to intermediate suppliers of textile and low wage labor. How-

[13] We include institutions as a robustness test and use the Freedom House dataset since it covers the entire period. The data used is discussed in more detail in Appendix 1.

ever, being close to high technology suppliers is negative, probably since such closeness primarily benefits other more sophisticated industries and thereby drives resources away from the clothing industry. Being close to output markets is also positive, but under a certain distance other sectors seem to benefit even more. Access to markets via low transport costs from a high fraction of the population living close to the coast has a positive effect. The comparative advantage variables have the expected effect. The effects of physical and human capital are initially strongly positive, but then inverted U-shaped. This is expected since above a certain level several other sectors benefit even more from an abundance of capital, attracting resources away from the clothing industry.

Given our results, can we expect Africa, the region most in need of attracting investments and production, to increase its market share in the clothing industry? Given the relative lack of both physical and human capital in African countries, one would expect them to have their comparative advantages in a low-tech sector like clothing. Nevertheless, our results indicate that too little physical and human capital can indeed be a disadvantage, even in the clothing industry. However, the fact that African countries are located far from high technology providers does not seem to constrain the expansion of their clothing industry. The result concerning the coastal population highlights the importance of physical infrastructure; hence, African economies need to improve this to become better connected to the world market. That low wage levels have an effect is good news for Africa, since the rising wages in Asia should make African wages relatively lower. However, it is worrisome that African wages have been surprisingly high in some formal sectors compared to the informal sector. In conclusion, while the prospects for expansion of the African clothing industry seem to be good, certain preconditions have to be further improved to make it actually happen.

Appendix 1. Data

GDP, industry output, and all other variables that indicate a monetary value of something, are expressed as constant 2000 US dollars.

Clothing industry, ln(clothshare) UNIDO (2005)
ISIC category 322 "wearing apparel, except footwear"
The share of the world clothing production located in country *i* is calculated as

(9) $$clothingshare_{i,t} = \frac{clothingproduction_{i,t}}{worldclothingproduction_t}.$$

In this calculation we use output and not value added. The same goes for everything from Unido. To make the denominator worldclothingproduction more correct we fill in the missing values for the biggest countries by interpolating linearly US 1996 and Italy 1995, and extrapolating linearly China 1974-76. In the nominator these are still missing values.

Textile industry, ln(textshare) UNIDO (2005)
The share of the world textile production located in country *i* is calculated in line with (9). To make the denominator worldtextileproduction more correct we fill in the missing values for the biggest countries by interpolating linearly US 1996 and Italy 1995, and extrapolating linearly China 1974-76. In the nominator these are still missing values.

Manufacturing industry, ln(manshare) UNIDO (2005)
The share of the world manufacturing production located in country *i* is calculated in line with (9). To make the denominator worldmanufacturingproduction more correct we fill in the missing values for the biggest countries by interpolating linearly Italy 1995, and extrapolating linearly US 1996-2000, China 1974-76, and UK 1996-2000. In the nominator these are still missing values.

Population, ln(popshare) World Bank (2004)
The share of the world population living in country *i* is calculated.

Distance to advanced technology, airdist Gallup et. al. (1999)
The distance, in 1,000 km, from the country's capital to the nearest city of Tokyo, Rotterdam, and New York.

Wage, ln(manwage) UNIDO (2005)
Wages and salaries / employees for total manufacturing.

The distance weighted world GDP, ln(gdpdist) Subramanian and Wei (2003) and World Bank (2004)
We use the following definition:

(10) $$GDPdist_i = \sum_j (GDP_j / dist_{i,j}); \; dist_{i,j} \text{ is distance between capitals when } i \neq j,$$

where the own distance $dist_{i,i}$ (when $i = j$) is calculated as ((area / pi)^0.5) / (3/2).

Coastal population, Coastal population Gallup et al. (1999)
The share of the population living within 100 km of the coast or a navigable river.

Infrastructure, ln(infrastructure) World Bank (2004)
Telephone connections (per 1,000 people) is used as a proxy.

Capital per worker, ln(kapworker) Bosworth and Collins (2003) and World Bank (2002)
Bosworth and Collins (2003) estimate the capital stock with a perpetural inventory model,

(11) $$K_t = K_{t-1}(1-d) + I_t,$$

where the depreciation rate, *d*, equals 5%. 1950 is the first year. This can be compared to Weil (2005) who uses the capital stock from Bernanke and Gurkaynak (2001), who in turn assume a depreciation rate of 6%, following Hall and Jones (1999).[14] Their calculated capital stocks include both residential and nonresidential capital.

[14] Initial capital stocks are found by the assumption that capital and output grow at the same rate. If 1949 is the initial year, then the capital stock is
$$K_{1949} = I_{1950} / (g + \delta),$$
where *g* is the ten-year average growth rate of output and δ is the assumed rate of depreciation.

Education, schoolyears Barro and Lee (2000)
Barro and Lee provide a further update of educational attainment up to 1995, and also construct projections to 2000. Average years of schooling for the total adult population (older than 15) is used. However, since this is only given for every fifth year (1970, 1975, 1980 etc. up to 2000), we interpolate linearly between these years.

Arable land per person, ln(arable) World Bank (2004)
Hectares per person

Rule of law, institutions Freedom House (2004)
As a proxy for Rule of Law we use Political Rights and Civil Liberties from Freedom House since we want numbers for 1975-2000 and most alternative measures do not cover such a long period. Political Rights and Civil Liberties are measured on a one-to-seven scale, with one representing the highest degree of freedom and seven the lowest. Freedom House only gives numbers for every fifth year, so we give all years in for example the interval 1963-1967 the 1965 value. We use the sum of these, and call it "bad institutions," since a high score means lack of Political Rights and Civil Liberties. We are aware of the fact that this proxy is far from perfect, and we only use it as a robustness test. The dataset includes some figures that clearly show that it is a shaky proxy for good institutions. For example, both Chile and Uruguay have had a perfect score in the 00s. In the 90s China and Vietnam scored 14, the worst, yet the business climate was obviously not that bad.

Trade barriers, MFA dummy and import duty World Bank (2002)
The MFA dummy indicates that a country is in the position where it can potentially be the object of quotas. Although it would have been better to have information on actual quotas, this has not been possible.[15] Therefore we simply use dummies for being under the MFA system. A developing country dummy is also used. How these dummies are constructed is discussed in detail in Appendix 2. Import duties, in percent of imports, is used as an additional robustness test. Import duties comprise all levies collected on goods at the point of entry into the country. The levies may be imposed for revenue or protection purposes and may be determined on a specific or ad valorem basis, as long as they are restricted to imported products. However, this seems to be an imprecise proxy: 228 of 2,548 observations are under 0.1 %.

Appendix 2. Trade restrictions for the clothing industry

To understand how trade restrictions in the clothing industry have evolved, one has to look back in history. In the decades following the Second World War, world trade was liberalized and grew considerably. The rich countries started to see growing low-price competition from developing countries in labor intensive industry sectors, especially in the clothing industry. To protect jobs and production in the OECD countries, trade in clothing became regulated in different ways starting in 1955 when Japan unilaterally restrained exports to the US (Francois et al., 2000). The Multi-Fiber Agreement (MFA) from 1974, which used the route of quantitative restrictions on textile exports from developing countries, provided rules for the imposition of quotas. The agreement was discriminatory by country of origin. Voluntary export restraints (VERs) were

[15] This is discussed in more detail in Appendix 2.

used, and thereby the exporting countries captured the quota rents. The MFA stipulated a 6 % annual growth of export from developing counties, but the growth rates of quotas were frequently below this (Yang et al., 1997). OECD (2003:9) notes that “Whenever textiles and clothing quotas became binding in one country under the MFA, investment was directed to initially unconstrained exporting countries, who then later became constrained also, with investment flowing yet elsewhere.” The Uruguay Round Agreement on Textiles and Clothing (ATC) required a gradual phasing out of the quota restrictions during 1995-2005. Textiles and clothing were as of 2007 (almost) fully deregulated.

The developed countries did not face the risk of quotas (“developed country" refers to all OECD countries before 1994 except Turkey),[16] while most other countries did. However, there were a few exceptions, of which two in particular need to be mentioned. The Yaoundé and Lomé agreements, which started in 1963 and were then successively expanded, gave the African, Caribbean, and Pacific (ACP) countries the possibility to export to the EU under better terms than the MFA countries (Curran, 2007). The other very important exception was made for the LDCs (the Least Developed Countries) when the EU implemented the Generalized Scheme of Tariff Preferences (GSP) in 1971. Market access for products from the LDCs has gradually become fully liberalized. The LDCs and the ACP countries are presented in Table 1.

Measuring trade restrictions is a difficult task. As Milanovic and Squire (2005) put it, “All of the various ways of specifying variables representing trade liberalization are useful and answer interesting questions.” In other words, there are a lot of measures out there that measure things that for most purposes are irrelevant. One has to choose carefully. We want to specify our variable representing trade restrictions in a way that answers the question we are asking. We are interested in the effect of tariffs and quotas. For example, what export tariffs does Tanzania impose on Tanzanian firms, and what import tariffs does the country face when it tries to reach, say, the EU market? And what are the effects of quotas? Ideally one would use a measure of the total yearly effect of tariffs and quotas on clothing by exporting country. This exists by importing region, but not by exporting region.[17] We therefore try to use a measure of only the MFA quotas, which have been the most important trade restrictions for clothing.

Since to our knowledge there is no detailed information available on the actual quotas, we are forced to use a dummy for facing the risk of quotas.[18] The dummy has the value 0 for developed countries, LDCs, and ACP countries, and the value 1 for all other countries. Tariff equivalents could be an alternative, but it appears that tariff equivalents are only available for one or two years in the late 1990s. Even if actual quotas were available, there would be problems: The MFA system was not transparent and had effect even when not binding (Linkins and Arce, 2002). For example, Francois et al. (2000:11) state that Japan and Switzerland did not impose MFA quotas, but “did send signals.“

It can be argued that all developing countries in one way faced risk of quotas – even the LDCs ACP countries – since if these countries were to become very successful they might lose their preferences. Botswana actually did graduate from LDC status in 1994. Therefore we also use a developing country dummy as an alternative measure. As an additional robustness test we would

[16] Western Europe, USA, Canada, Australia, New Zealand, and Japan.

[17] Francois and Strutt (1999) offer average tariff rates by importing region, and Lankes (2002) offers export tax equivalents of MFA quotas also by importing region.

[18] Several papers deal with these quotas, but do not have the data we are looking for. These include: Francois and Wörz (2006), who deal with only the period from 1996 and forward; Trela and Whalley (1990) who deal with only two years; OECD (2003), which is a survey of studies that gives no fruitful suggestions about where to find the needed data; and Harrison et al. (1997), who report for only one year.

have liked to use a more general trade restrictiveness index. Kee et al. (2005) offer trade restrictiveness indices for 91 countries, the World Bank Overall Trade Restiveness Indices, but unfortunately only for one year. The IMF's overall trade restrictiveness indices (IMF-OTRI) were calculated on an annual basis for the period 1990-96 for 178 countries, but the IMF generally discourages the use of cross-country comparisons with the IMF-OTRI due to shortcomings in its methodology and data. Cline (2003) discusses these shortcomings. Market Access Maps did not start until 1999 and do not include any information on nontariff measures.

IMF (2005) discusses supplemental indicators and mentions that "collection rates," the amount of duties collected divided by imports, do provide useful information on the "effective" tariff rate. This value captures the effect of tariff rates and preferential arrangements etc. A problem discussed by IMF (2005) is that there is only a very weak correlation between the different trade policy indicators. Had they been strongly correlated one might have been able to argue that any of them could be used as a proxy for another, making the result robust to the choice of indicator. However, we cannot use that argument. Still, collection rates (as described above) are the only thing we are left with as an additional robustness test. Import duties from World Bank (2002) is used as this additional robustness test.

References

Arellano, M. and S. R. Bond (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58, 277-297

Antweiler W. and D. Trefler (2002). Increasing returns and all that: a view from trade. *American Economic Review* 92:1 (March)

Barrios, S., H. Görg and E. Strobl (2003). Multinational enterprises and new trade theory: evidence for the convergence hypothesis. *Open Economics Review* 14:397-418

Barro, R. and J. W. Lee (2000). International Data on Educational Attainment: Updates and Implications (CID Working Paper No. 42, April 2000) – Human capital updated files, February 2000

Bernanke, B. S. and R. S. Gurkaynak (2001). Is growth exogenous? Taking Mankiw, Romer, and Weil seriously. NBER working paper series 8365

Blundell, R. and S. Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87 (1998) 115-143

Bond, S. (2002). Dynamic panel data models: a guide to micro data methods and practice. Cemmap Working Paper CWP09/02

Bosworth, B. P. and S. M. Collins (2003). The Empirics of Growth: An update. *Brookings Papers on Economic Activity*, 2:2003, 113-206

Brakman S., H. Garretsen, J. Gorter, A. van der Horst and M. Schramm (2005). New Economic Geography, empirics, and regional policy. CPB Special Publications:56

Breinlich H. (2005) The spatial income structure in the European Union – what role for economic geography? LSE, march 2005

Brenton, P. and M. Hoppe (2007). Clothing and export diversification: still a route to growth for low-income countries? The World Bank, Policy Research working Paper 4343

Cline, W. R. (2003). Enhancing the IMF's Index of Trade Restrictiveness. Washington: Center for Global Development, mimeo

Crafts, N. and A. J. Venables (2003). Globalization in History: A Geographical Perspective. In (eds.) Bordo, M., A. Taylor and J. Williamson, *Globalization in Historical Perspective*, Chicago/NBER

Crafts, N. and A. Mulatu (2004). What explains the location of industry in Britain, 1871-1931? CEPR discussion paper 4356

Curran, L. (2007). Clothing's big bang: the impact of the end of the ATC on developing country suppliers. *Journal of fashion marketing and management*, 11(1) 122-134

Davis, D. R. and D. E. Weinstein (1998). Market access, economic geography, and comparative advantage: An empirical assessment. NBER working paper 6787

Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic Competition and Optimal Product Diversity. *American Economic Review* 67(3), 297-308

Easterly, W. and R. Levine (2001). It's not factor accumulation: stylized facts and growth models. *World Bank Economic Review,* 15:2, 177-219

Elbadawi I., T. Mengistae and A. Zeufack (2001). Geography, supplier access, foreign market potential, and manufacturing exports in Africa: an analysis of firm level data. the CSAE and UNIDO conference, 2001, Oxford

European Commission (2007). Home page

Francois, J., H. H. Glismann and D. Spinanger (2000). The cost of EU trade protection in textiles and clothing. Kiel Institute of World Economics working paper 997

Francois J. and A. Strutt (1999). Post Uruguay round tariff vectors for GTAP version 4. Erasmus University Rotterdam

Frankel, J. A. and D. Romer (1999). Does trade cause growth? *American Economic Review* 89(3): 379-399

Freedom House (2004). Freedom in the world country ratings 1972-2004. Freedom House home page

Fujita, M. (2000). Thünen and the new economic geography. Kyoto University, September 14, 2000

Fujita, M. and P. Krugman (1995). When is the economy monocentric? von Thunen and Chamberlin unified. *Regional Science and Urban Economics* 25: 505-528

Fujita, M., P. Krugman and A. J. Venables (1999). The spatial economy: Cities, regions and international trade. MIT Press, Cambridge MA

Gallo, F. (2005). Determining the level of transportation costs in the core-periphery model: a majority voting approach. Department of Economics, Lund University, working paper 32

Gallup J. L., J. D. Sachs and A. Mellinger (1999). Geography and Economic Development. CID working paper 1999:1

Hall, R. E. and C. I. Jones (1999). Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics*, 114(1)

Harris, C. (1954). The market as a factor in the localization of industry in the United States. *Annals of the Association of American Geographers*, 64: 315-348

Harrison, G. W., T. F. Rutherford and G. D. Tarr (1997). Quantifying the Uruguay round. *The Economic Journal*, 107 (September) , 1405-1430

Holmes, T. J. and J. J. Stevens (2005). Does home market size matter for the pattern of trade? *Journal of International Economics* 65 (2005) 489-505

IMF (2005). Review of the IMF's Trade Restrictiveness Index. The Policy Development and Review Department

Kee, H. L., A. Nicita and M. Olarreaga (2005). Estimating Trade Restrictiveness Indices. World Bank Policy Research Working Paper Series 3840
Krugman, P. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9: 469-479
Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *American Economic Review*, 1980: 950-959
Krugman, P. (1991a). Increasing returns and economic geography. *Journal of Political Economy* 99: 483-499
Krugman, P. (1991b) Geography and trade. MIT Press, Cambridge MA
Krugman, P and A. J. Venables (1995) Globalization and the Inequality of Nations. *Quarterly Journal of Economics*, 1995:857-880
Lankes H. P. (2002). Market access for developing countries. *Finance and Development* 2002/09
Linkins, L. A. and H. M. Arce (2002). Estimating tariff equivalents of nontariff barriers. Office of Economics working paper 94-06-A(r)
Lucas, R. E. (2000). Some macroeconomics for the 21st century. *Journal of Economics Perspectives*, 14(1): 159-168
Midelfart-Knarvik, K. H., H. G. Overman, S. J. Redding and A. J. Venables (2000). The Location of European Industry. Report prepared for the DG for Economic and Financial Affairs, EC
Milanovic B. and L. Squire (2005). Does tariff liberalization increase wage inequality? Some empirical evidence. NBER working paper series 11046
Mincer J. (1974). Schooling, experience and earnings. Colombia University Press, New York
Nordås H. K. (2004). The global textile and clothing industry post the agreement on textiles and clothing. WTO discussion paper 5
OECD (2003). Liberalizing trade in textiles and clothing: a survey of quantitative studies. Trade committee, TD/TC/WP(2003)2/final
Overman H. G., S. Redding, A. J. Venables (2001). The Economic Geography of Trade, Production, and Income: A Survey of Empirics. The Centre for Economic Performance, LSE
Puga, D. and A. J. Venables (1996). The Spread of Industry: Spatial Agglomeration in Economic Development. *Journal of the Japanese and International Economies* 10, 440-464
Sanguinetti, P. and C. V. Martincus (2005). Does trade liberalization favor spatial deconcentration of industry? Presentation at 5th spring school in economic geography, Center for economic policy research, May 2005
Subramanian, A and S-J Wei (2003). The WTO promotes trade, strongly but unevenly. NBER working paper series 10024, Dataset 1
Trela, I. and J. Whalley (1990). Global effects of developed country trade restrictions on textiles and apparel. *The Economic Journal*, 100 (December), 1190-1205
UN (2005). Home page
UNIDO (2005). Industrial Statistical Database
Weil, D. N. (2005). Economic Growth. Pearson Education
World Bank (1993). The East Asian Miracle: Growth and Public Policy. Oxford University Press, Oxford and New York
World Bank (2002). World Development Indicators
World Bank (2004). World Development Indicators
World Bank (2007). World Development Indicators Online

Yang, Y., W. Martin and K. Yanagishima (1997). Evaluating the benefits of abolishing the MFA in the Uruguay Round package. In (eds.) Hertel, T. W. *Global trade analysis: Modeling and applications*