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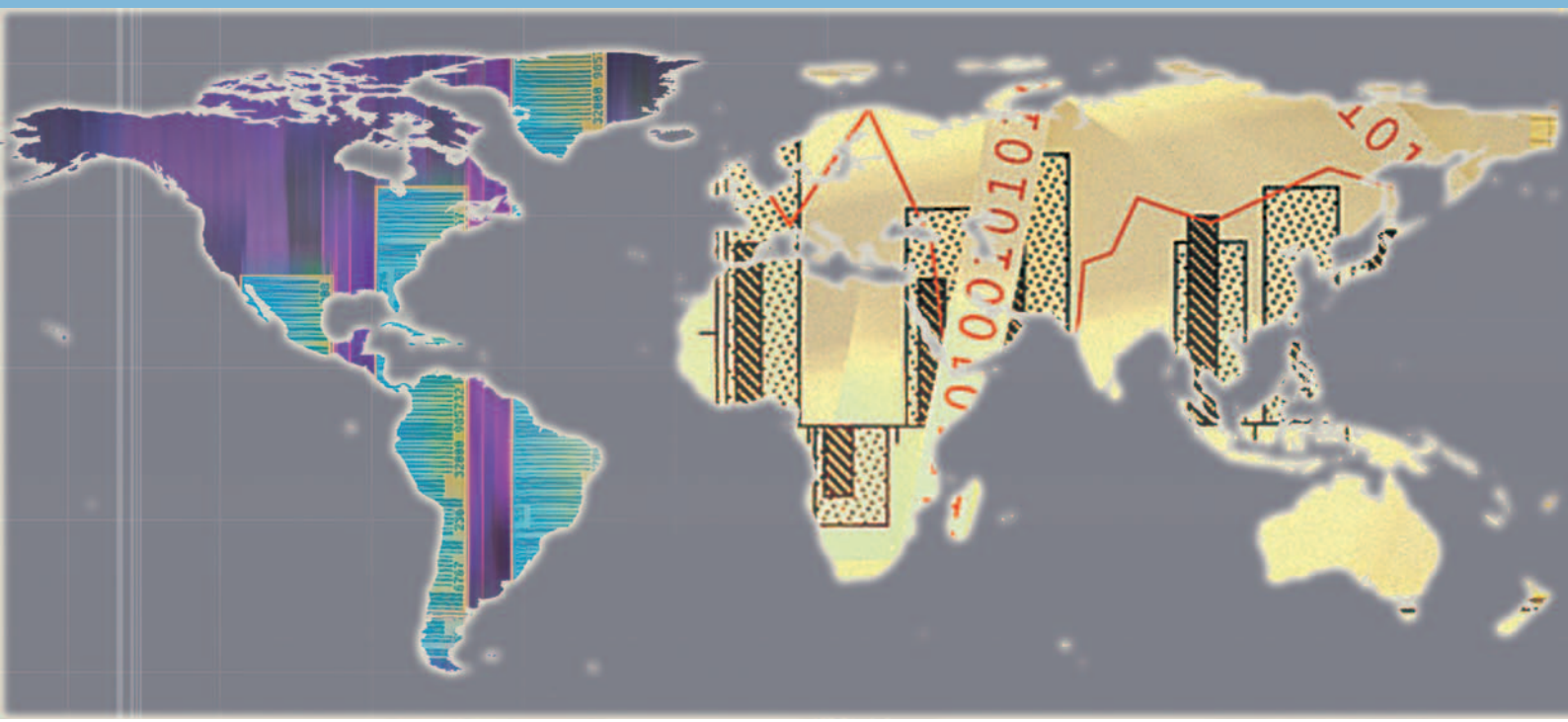

Growth, Exports and Technological Change in Developing Countries:
Contributions from Young Scholars

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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I. Introduction

In the current global environment, trends are changing fast and a vast amount of novel research is being carried out worldwide, breaking new knowledge frontiers and bringing new ideas to the table. It is vital that UNIDO keeps abreast of the latest developments in economic research by emerging scholars in the areas of its activities if it is to strengthen its ability to deliver technical cooperation services.

To this end, a Young Scholars Expert Group Meeting was organized by UNIDO Headquarters in Vienna, Austria, on 2-3 August 2007, to bring together young researchers to present and discuss the results of their latest research on UNIDO's thematic areas. The meeting also served as a forum for UNIDO staff members to interact with the young researchers, identify future research partners and discuss their research findings.

In order to tap into a large pool of qualified candidates, the Organization opened up the application process to young scholars from leading universities and research institutions worldwide by sending out a call for papers on issues related to UNIDO's thematic activities. From the responses, ten papers covering the themes of macroeconomics of development small businesses, determinants of firm performance and trade were selected to be presented at the Young Scholars Expert Group Meeting. Nine of the ten papers presented, relating to trade and economic growth; technology and innovation as well as corporate social responsibility, are contained herein.

The papers presented at the Young Scholars Expert Group Meeting portray the challenges and opportunities facing the developing countries as they industrialize, attract FDI, undergo trade reforms, technology transfers, firm learning and improve productivity gains. It is anticipated that the readers of this proceedings will find the papers intellectually stimulating and a valuable source of policy information.

A. Trade and economic Growth

The importance of trade has long been established in the economic literature as a main driver for economic growth and development. It is also acknowledged that the relationship between trade and development is a complex one, and that there is no guarantee that trade will automatically lead to economic growth for developing countries. In order to increase the likelihood of this happening, trade and industrial policies ought to be tailored to reflect the different vulnerabilities and potential strengths of each country. Hence research at a macro and micro level is required to inform the policy making process. For example, there is to this day little consensus among economists on the sources of output fluctuations of developing countries. Even for developed countries, the sources of volatility of growth output are notoriously obscure. Can a country's geographical characteristics influence its trade performance? What are the implications of using a common production technology/blueprint across manufacturing sectors? Another area where the current empirical literature is also inconclusive is the impact of free trade policies, trade facilitation and reforms on economic performance. How do these influence economic growth? If all firms face the same macro-economic condition, why do they respond and perform differently in their export activities? Five of the invited research papers contribute to these open discussions by focusing on the influence of production and trade on economic growth for developing countries. A brief description of the papers on the theme of trade and economic growth is given below.

The first paper, by Markus Eberhardt, analyses the impact of globalization on growth. This paper introduces the idea of dual economy modeling into growth empirics in the history of growth theory and current standard approaches to empirical analysis. Results from two sets of empirical analyses are presented: first, a cross-country comparison of the production processes in agriculture and manufacturing and second, an investigation of cross-country differences in the production process within manufacturing. From this analysis, the author shows that production methods and processes (production function estimation) differs across sectors and that even within the same industrial division (manufacturing), production technologies/blueprints seem to differ across countries. The implication of this conclusion is vital as the literature commonly assumes all countries to have the same production technology/blueprint. This implicitly assumes that certain time-series properties of the data do not interfere with the empirical approach taken. The analysis presented in this paper strongly suggests that this assumption is violated. The author therefore provides a new twist to growth modeling by including the agriculture and manufacturing sectors as separate elements, which proves crucial due to the different production processes of the agriculture and manufacturing sector. These findings make a case for a more careful consideration of the differences between sectors and countries in empirical growth analysis.

The paper by Adeel Malik is the second paper within the trade and economic growth category. It analyses the highly debated topic of sources of output volatility and its effect on growth stability. This paper argues that the country's geographical characteristics can be an important determinant of its trade structure. Various forms of remoteness from large markets, but especially a lack of access to the sea, have been shown to be significant barriers to trade due to higher transportation costs. The author suggested that as a result, countries that are remote find it much harder to participate in trading activities and hence tended to specialize in primary commodities. Since primary commodity prices are more volatile in global markets, developing countries are more susceptible to terms of trade fluctuations. This paper explicitly describes the strong association between remoteness, export concentration and exposure to world price shocks in order to explain why remoteness and output volatility are so closely correlated. The author suggests a conscious policy effort to overcome these geographical constraints. The concrete example of improving transport infrastructure within land-locked countries as well as surrounding and transit countries is given.

The third paper looking at the influence of trade on economic growth for developing countries is by Tomas Iwanow, who examines how trade facilitation measures can help promote development. The importance of trade facilitation is being increasingly recognised in an effort to enable developing countries to increase their exports and benefit more fully from multilateral trade liberalisation. It is as such becoming an integral part of the policy package for trade-capacity building and is the centre of discussion in the aid for trade agenda. Based on a survey of literature, the author reports that the short- to medium-term supply elasticity of manufactured exports can be increased through trade facilitation. The point is also made that developing countries have less efficient customs and logistics and hence stand to benefit most from trade facilitation reforms. The paper draws attention to the need for complementary longer term regulatory and infrastructure reforms to improve the quality of the institutional and physical infrastructure and also for complementary additional trade reforms that aim at relaxing export supply capacity. A warning note however accompanies the potentially considerable gains. The gains are reported to be gradual and the success of trade facilitation reforms is found to depend heavily on a combination of country-specific factors as well as comprehensiveness and coordination of the reform's execution. A main recommendation of the paper is that diagnostic trade studies be carried out in order to identify the key constraints on export growth, and that the findings of such studies be integrated into the national strategies for economic growth and poverty reduction. Due to the complexity of international trade procedures, the author reports major difficulties in the monetary evaluation of gains from trade facilitation. Strong supporting evidence of a causal link between trade facilitation reforms and trade performance is therefore still lacking from the literature.

Within the trade and economic growth category is also a paper presented by Riham Shendy which examines the impact of trade policies on economic performance for the manufacturing sector in South Africa. The study concentrates on the period between 1994 and 2004, when the sector experience intensive trade reform. Tariffs are used as the measure of changes in trade policy, as recommended by new empirical literature, instead of the more traditional approach of employing trade flow variables. The results are tested for four different productivity estimates to prove robustness with respect to the widely documented challenges of estimating productivity. Lag of tariff rates is also employed in the estimation procedure to ensure that the results are not driven by endogeneity bias. Furthermore, industry fixed effects are used to control for the unobserved time invariant industry characteristics that may affect both productivity and tariffs. From the study, the author concludes that reductions in normal tariff rates (NTR) led to higher productivity and wages. The limitations of the studies are reported to be firstly the inability to control for firm and worker-specific characteristics in the estimations from industry-level data; secondly the fact that the study only addresses the impact of import competition on the product and labour markets in South Africa's manufacturing sector, and as such concentrates on only one side of the trade debate. The first limitation may give rise to some omitted variables bias, which can only be overcome by using micro-level data. The paper identifies the economic gains attributed to increases in export capabilities as interesting topic for future investigation.

The final paper contribution within this category was from Teresa Dueñas-Caparas. Unlike the other papers in this category, this one concentrates on firm-level analysis. The study employs the information-rich survey conducted by the Asian Development Bank in 2002 to examine the influence of firm-specific characteristics, on the export performance of firms in the food processing, clothing and electronics sectors in the Philippines. Factors investigated include: size, percentage of skilled labour to total labour, training activities, foreign affiliations, R&D activities, capital intensity and firm age. A novel econometric model by Papke and Wooldridge, which is specifically designed to address fractional response behaviour, was employed in the study. Among the firm-level characteristics tested, foreign affiliation, in the form of foreign equity infusion, joint ventures, licensing agreements or direct investment, plays a highly important role in a firm's propensity to export due to its strong network linkages with the international community. The contribution of R&D and the development of human capital through training are only significant for science-based firms, as a higher capital per worker. This is reflective of the capital-intensive nature of the sector and the possibility of knowledge and technology embodied in the capital goods used by these firms. A non-linear inverted U-shape relation between firm size and export performance was revealed predominantly in the clothing sector, but is also across all sectors. Firm age is found to be an important factor in the export performance of electronics and clothing sectors, with the clothing sector thriving on mature firms, while a threshold

age exists for electronic firms whereby maturity in operations is only beneficial up to that point, reflecting the rapid technological change within that sector.

B. Technology and Innovation

The other category within which the accepted papers fell into is technology and innovation. Technology and innovation are essential components of industrialization, economic growth and sustainable human development. In the current environment of globalization, trade liberalization and the emergence of knowledge-based industries, the importance of innovation is increasingly becoming a force majeur in determining the potential of developing countries to compete for international markets. The new competitive environment brought about by globalisation has fuelled the growth of knowledge-intensive production by increasing scientific and technological interactions and the need for innovation. It is therefore imperative that developing countries invest in their human capital in order to cope and thrive in this knowledge-rich environment. Foreign direct investment is regarded as one of the driving forces integrating underdeveloped countries into the globalization process which has characterized the world economy over the past several decades. It is presumed to be an important channel through which international diffusion of knowledge and technology takes place. But what enables developing countries to benefit from this international diffusion of technology, to reduce technology gaps, to improve their absorptive capacities, to catch up and to leapfrog? What is the role of multinational corporations as actors in innovation systems of developing countries? It is very important that any policy recommendation concerning industrial development considers the role of knowledge and the capacity to generate innovations from the industrial sectors in a globalized world. The three papers presented under the theme of technology and innovation explore these areas and provide policy recommendations for developing productive capacities and expanding employment. A brief description of the three papers is given below.

The first paper in the technology and innovation section was presented by Simon Baptist, who used firm-level panel data to try to explain the how the Republic of Korea managed to increase its GDP per capita by ten fold that of Ghana between the period of 1964 to 2000. The author suggests that the difference lies in the ways in which firms used technology and in the way in which skills are appreciated and used by firms which in turn affect workers' wages in those two countries. Effort was put into understanding why and how Ghanaian firms use production techniques and how these techniques link to the return on skills. It is reported that on average, an extra year of education increases output by 2 per cent for a Ghanaian worker but 12 per cent for a worker in the Republic of Korea. Hence firms in Ghana do not receive many benefits from employing workers with more years of education, resulting in a low demand for education. The paper recommends a technological shift in

Africa to one with a higher marginal product of labour combined with an increase in the quality and number of years of education. This will result in firms receiving a higher rate of returns from education, and consequently higher wages. This is crucial as poverty reduction through productive activities occurs mainly through the channel of wages. The technology used by Ghanaian firms not only have lower marginal product of labour, but is also much more intensive in their use of raw materials. The recommended technological change will therefore also address the energy and material conservation concerns. The author concludes that a technological shift towards less labour, material and energy intensity will ensure that there is no trade-off between poverty reduction and the environment.

The paper by Geoffrey Gachino within the technology and innovation section examined the spillover effects from multinational companies in the food processing and machine engineering sectors in Kenya. The paper argues that in addition to contributing to the international transfer of technology and skills to underdeveloped countries, foreign direct investment (FDI) can also act as a stimulant to technological development process by contributing to learning and development of technological capabilities in locally-owned firms. Firm-level survey data are utilized to examine the extent and determinants of spillovers based on three strands of literature, namely, literature on foreign direct investment, cluster and network dynamics and technological innovations. The results show that on an average, spillovers occurred in two major forms: pertaining to products and manufacturing processes; and demonstration effects and competition. The paper generated some general lessons to inform policies, including:

- consistency in policy stance to attract FDI;
- formulation of policies geared towards the promotion of linkages between and among firms, sectors and institutions;
- formulation of policies geared towards improving absorptive capacity and human capital accumulation;
- formulation of policies which strengthen institutions' capacity to perform a systematic and coordinated manner;
- adequate governmental support for an effective industrial facilitation;
- the need for formal and informal interactions where manufacturing experiences, market information, skills and technological knowledge can be shared;
- establishment of an institution to assess incoming FDI on its potential generating technological spillovers without crowding out local investment;
- elimination of import barriers for capital goods, technology, machinery and equipment that could serve as sources of learning and capability development through imitation, replication and reverse engineering

The final paper in this category is from Miguel Garcia-Torres who analyses the four dimensions of a national system of innovation—human capital, knowledge creation, supply innovation capacity, demand innovation capacity and their complementarities—in a sample of European countries. The novelty of this research lies in the addition of the role of demand into the system by asking: 'How is demand affected by the other factors? Are knowledge and demand complementary in any way?' Three main roles of international demand were identified: information, specialization and a time lag. International demand is used as a source of information to identify new needs; it affects the sectoral specialization of the country and, since it develops faster than international supply, allows the country to enjoy monopoly income during this time lag. Emphasis is put on:

- the importance of habit formation, which in the long-run will enable innovation to contribute to the economic growth;
- The causality from growth to savings, which argues that an environment with an active demand and consumption will favour the appearance of innovations, generate more growth and more savings;
- Novelty and marketing expenditure, is related to the effort invested by the firm to make its innovation known to consumers and therefore affects preferences

The methodology adopted for this research is a quantitative one, based on composite indicators of the system, which allows comparison between countries. A framework is developed to help policy makers identify the weak links in their national innovation systems and therefore inform policy decisions. This paper offers a good way to map problems at the macro level considering the dynamics of demand and supply.

C. Corporate Social Responsibility

The role of Corporate Social Responsibility (CSR) in the developing countries is framed by the Millennium Development Goal One—'a world with less poverty, hunger and disease, greater survival prospects for mothers and their infants, better educated children, equal opportunities for women, and a healthier environment'. UNIDO believes that support for SME development can be an important part of the CSR commitment of large companies in the context of responsible supply chain management. Hence, improvements in social and environmental impacts can go hand in hand with better quality and management. Alessandra Mezzadri presented the final paper at the Young Scholars Expert Group Meeting on the ability and limitations of corporate social responsibility (CSR) policies to reduce poverty in the case of the small business clusters in India. The paper builds on cluster studies and value chain analysis to investigate the effectiveness of CSR in the garment cluster in Delhi, India.

Results show that CSR policies had only a limited impact because of the structure and characteristics of local labour markets. Within the factory real, it was found that the functioning of CSR is undermined by the diffusion of local practices. Moreover, CSR policies tended to be applied to factory-based employment, while home-based work outsourced to artisanal workers was being ignored. For the case at hand, the main limitation of CSR is due to the lack of consideration of local social structures of production and labour dynamics internal to the industry. Bridging clustering and poverty reduction was identified as a new area with research needs. A deeper understanding is required of how forms of household, or home-based, labour are integrated into local and global value chains, again for the purpose of poverty reduction.

II. The Empirics of Economic Growth: A Dual Economy Approach[1]

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Abstract

This research note introduces the idea of dual economy modelling into growth empirics. We discuss the history of growth theory and current standard approaches to its empirical analysis in broad brushes before motivating our own research agenda. Results from two sets of empirical analyses are presented: first, a cross-country comparison of the production processes in agriculture and manufacturing and second, an investigation of cross-country differences in the production process within manufacturing. Combined, these findings make a case for a more careful consideration of the differences between sectors and countries in empirical growth analysis. We conclude with a brief look at the impact of trade on growth.

1. Introduction

The questions why some countries produce so much more output per worker than others, and why certain economies have grown phenomenally, while others have stagnated or even regressed over the same period of time, lie at the very heart of development economics. In this context, the issue of 'globalization' is raised frequently: within academic circles, among policy makers and also among the wider public, everybody has an opinion whether globalization is essentially a force for 'good' or not. It is to be expected that opinions differ based on the identity of the respondent. A young migrant worker in China, sewing T-shirts exported to markets in Europe and the United States would most definitely argue that globalization has changed her life for the better: following her three-year stint in the coastal boom region, she can return to her home village in the interior and build a house, open up a small store, or start a little business, all of which would have been impossible had she remained at home and not been lured to migrate by the aggressive export drive pursued by the State and private entrepreneurs in her country. A low-skilled worker in the United States, on the other hand, may lament over the fact that she lost her job when her employer relocated production to a low-cost country in East Asia.

[1] Financial support from the Economic and Social Research Council is gratefully acknowledged. Parts of the above discussion are presented in greater detail in Eberhardt and Teal (2008).

Extrapolated to the level of countries, this example mirrors a debate whereby some argue that globalization is driven by a beggar thy neighbour mentality mirroring a zero-sum game in which the gains for one country are to the detriment of another (or a host of other countries), and there is no positive impact of globalization once these losses have been accounted. For a development economist, it is therefore of great interest to analyze the impact of globalization on growth: a positive result would reject the notion of zero-sum, and would imply that, on average, globalization is a force for good. In empirical work, globalization and its impact on development are commonly analyzed by studying the impact of 'trade openness' on economic performance.[2]

At the micro-level, looking at individuals, households or firms in one country or a small number of countries, we commonly cannot account for potential fundamental determinants of growth and development such as geography, institutions or trade openness, since they are arguably very similar or the same for all observations analyzed. For instance, a study investigating the performance of Ugandan manufacturing firms will ideally control for location of the firm within the country, but the common denominator across all firms, the fact that Uganda is a landlocked country in sub-Saharan Africa with poor transport routes to the nearest port (and not a coastal economy in East Asia like, say, Viet Nam), means that geography cannot enter our analysis. Similarly, the overall institutional and business environment in Uganda (for instance, bureaucracy and red tape, corruption, or government-business relations), as well as its trade openness are identical across all firms and can likewise not be analyzed using this data. In order for statistical analysis to reveal any impact of geography or institutions or trade openness, we require variation in this variable across the observations analysed—which is not present in the example of Ugandan firms.[3] The answers to questions relating to the fundamental determinants of growth and development can therefore only be found in the analysis of macro-data, comparing entire economies or industrial sectors across a large number of countries. Variation in the variables relating to geography or institutions or trade openness across the sample of countries can then reveal whether, on average, these impact the economic performance of a country or not, and whether the relationship is positive or negative.

My own research, parts of which were presented at the UNIDO Young Scholars EGM held in Vienna in August 2007, ultimately aims to identify the importance of this link between openness and growth in data. Before analyzing this link, however, it is necessary to get a clear understanding of the appropriate assumptions to make regarding how countries produce output. This analysis, which forms the main body of the research, is presented in this research note. We suggest that the approach taken

[2] For the statistical analysis, the concept of trade openness may be defined as a policy variable, such as a measure of tariffs and non-tariff barriers, or as an outcome variable, such as the actual volumes and/or growth rates of exports and imports (or some transformation of these variables).

[3] This, of course, does not to imply that we cannot learn anything from micro-studies – they can explain to us that given the situation Uganda is in, which characteristics make certain firms succeed. They, however, do not commonly provide insights into whether the institutional environment, trade openness or the geographical position of a country are crucial determinants of firms' performance.

in the majority of empirical studies, namely, to treat the economy, rather than the industrial sector, as the basic unit of analysis leads to distorted results. Further, more flexibility in the empirical specification is also necessary to avoid distortion of results. It is important to stress that these findings seriously question the conventional wisdom of empirical growth analysis and are thus important in their own right. They also question the validity of existing research into the link between globalization and growth, since this literature is based on the same set of assumptions. Although this research note cannot provide a definitive answer to the question of whether globalization is a force for good or not, some first tentative evidence in this regard seems to indicate this.

2. A brief history of growth theories and growth empirics

In the early academic literature on developing countries a distinction was made between the processes of economic development and of economic growth. Economic development was seen to be a process of transformation by which, in Arthur Lewis' frequently cited phrase, an economy which was "previously saving and investing 4 or 5 per cent of its national income or less, converts itself into an economy where voluntary savings is running at about 12 to 15 per cent of national income". An acceleration in the investment rate was only one part of this process of structural transformation; of equal importance was the process by which an economy moved from a dependence on subsistence agriculture to one where a modern industrial sector absorbed an increasing proportion of the labour force.

In contrast to the Lewis' approach, where duality between the modern and traditional sectors was a key feature, was the analysis of economic growth in developed economies. Here the processes of factor accumulation and technical progress occur in an economy which is already developed, in the sense that it has a modern industrial sector and agriculture has ceased to be a major part of the economy. Key contributions in this area of research were made in the 1950s by Solow and Swan, who focused on the growth experience of the United States. These theoretical models concluded that technical progress, which was determined by factors not considered within the model (exogenously), was the driver of long-run economic growth. It is perhaps quite fitting that cynics sometimes refer to the identified driver of economic growth as 'manna from heaven' given its uncertain origin. A formal definition has it as the unexplained part of output performance after inputs, such as labour, capital and materials, have been accounted for, which lead to terms such as Solow residual, or total factor productivity (TFP). Clearly, the fact that something that remains unexplained in the model turns out as the driver of long-run growth was not a very satisfactory outcome for policy makers.

It took until the contributions of Romer (1986) and Lucas (1988), among others, in the late 1980s for theories to emerge which succeeded in explaining long-run growth from within the theoretical model (endogenously). This endogenous growth literature emphasizes learning, innovation and research and development (R&D), and models these concepts formally to either explain manna/TFP[4] or to overcome diminishing returns to factor accumulation.[5]

Despite their strong intuitive appeal, endogenous growth theories have a number of shortcomings, primarily linked to the phenomenal growth experiences of a number of East Asian countries over the past decades: endogenous growth theories cannot explain why only some countries were able to grow miraculously, or why double-digit growth rates were only witnessed by initially poor countries, and not also by middle- or high-income countries.

Much of the early theoretical growth models discussed above proceeded without close consideration of observed data, but were inspired by stylized facts. Empirical studies employed a vast array of explanatory variables for empirical growth analysis, while methodological, statistical, and conceptual difficulties on top of sample heterogeneity made it difficult to draw reliable conclusions from existing literature. The key papers which brought theoretical growth models and aggregate cross-country data together were contributions of Barro (1991) and especially Mankiw, Romer and Weil (1992). Against Solow's intentions, these authors adopted an exogenous Solow growth model framework and applied it to data from both developed and developing countries. This was made possible by the recent emergence of a dataset which (following frequent updates) dominates the empirical growth literature to this day. The Penn World Table (PWT) data supplies aggregate macro-data which ensure that the Solow-Swan model can be readily estimated for a large sample of developed and developing countries. These two seminal papers initiated a major revival in the Solow-Swan model and effectively merged the concerns of economic development with those of growth neglecting, for the most part, implications of structural change within countries and structural diversity across countries.
The literature, starting from the early 1990s onwards, has yielded a large array of models in which there has been increasing interaction between theory and empirics. Within these literally thousands of academic studies, empirical analysis continues to be dominated by the empirical version of the models introduced by Solow and Swan, employing the aggregate PWT data. In contrast, dual economy

[4] This is achieved via models of imperfect competition: the successfully innovating firm is able to reap the benefits from the monopoly power (that is, monopoly profits) bestowed on it by the fact that no competitor has the advantage delivered by the innovation. If benefits of innovation were immediately shared with all other firms, for example, if there were no patents, no firm would ever regard it worth their while to engage in R&D activities.

[5] Diminishing returns to, say, capital accumulation is the notion that piling more and more machines on a single worker does not increase her productivity by a constant proportion: with two rather than one machine she may produce double the output, but once a third machine is added she may struggle to service all of them satisfactorily, with the result that her output is likely somewhat less than three times that of her working a single machine (that is, her returns on adding the third machine have diminished somewhat as compared to those when she was adding the second). Eventually, adding the, say, 30th machine will not increase her output over that using 29 machines – machine number 30 will simply sit there unused because the worker will not be able to service it on top of the 29 she is working already.
One stream of endogenous growth models thinks of means and ways to prevent this from happening; for instance, a smart worker may come up with a computer programme which automatically services a multitude of machines, with per worker output of 30 machines exactly 30 times that of a single machine.

models, like that by Lewis, do not form part of the standard textbook canon on economic growth. This is primarily due to the fact that until recently few datasets existed to provide data for both manufacturing and agriculture in a suitably large sample of developed and developing countries.

Thus, to summarize, the empirical growth literature at present only pays scant attention to structural diversity and structural change within countries; in technical terms, this means that the production technology is typically assumed to be the same in agriculture and manufacturing—a production technology is the representative combination of labour, capital and materials that produces output; we can think of a production technology as a blueprint or recipe which specifies how to combine the various inputs.[6]

In addition to this, the current empirical growth literature typically assumes that there is an identical production technology/blueprint for all countries, that is, that output in Malawi is produced with (proportionally) the same combination of inputs as in the United States. With regard to manna/TFP, which was already introduced as what is left to be explained of output performance after all the inputs have been accounted for, it is assumed that both its *level* attained by the first year of the period studied as well as its rate of growth over the entire period differ across countries.

3. The research agenda

As a motivation for the empirical analysis which follows, present some descriptive statistics, underlining the importance of the agricultural sector and indicating how this importance may have changed over time, are presented. Table 1 gives the share of agricultural employment in total employment (labelled as *a*) and the value share of agriculture in total economy GDP (labelled as *s*) for various geographical regions vis-à-vis high-income OECD countries. The numbers are taken from a survey article by Temple (2005) and represent the average values (medians) for each country grouping.

Two things are particularly striking about these figures. First, the diversity of employment and GDP shares of agriculture across the country groupings for each of the three sample years. This implies that agriculture plays very different roles across countries in terms of its importance. For instance, in sub-Saharan Africa, some 70 per cent of economically active individuals worked in agriculture in 1996, whereas in the same year only some 5 per cent of economically active individuals in OECD countries worked in this sector. Similar diversity is present in the GDP share numbers. Second, the growth

[6] A simple mathematical argument shows that if there are different Cobb-Douglas production technologies across sectors (Cobb-Douglas is a certain mathematical form, which is commonly used in the growth literature), it is impossible to represent them in an *aggregate* model following Cobb-Douglas production technology. In simpler terms: if production technologies/'blueprints' differ across industrial sectors the validity of using aggregate economy data—as is practice in 99 per cent of cross-country growth analysis—is seriously undermined.

experiences within country groupings over time display considerable diversity: the importance of agriculture has changed dramatically in some, but much less so in other country groupings. For instance, compare the experience of East Asia, where the share of agriculture in GDP dropped from 30 per cent in 1960 to less than 10 per cent in 1996, with that of sub-Saharan Africa where, over the same period of time, the share of agriculture in GDP remained stable at some 38 per cent.

Table 1. Employment- and GDP- shares of the agricultural sector
Reported figures are medians within each country grouping

	(a) Employment share			(s) GDP share		
Year	1960	1980	1996	1960	1980	1996
Sub-Saharan Africa	0.88	0.76	0.71	0.39	0.30	0.37
East Asia & Pacific	0.62	0.39	0.17	0.29	0.19	0.08
South Asia	0.75	0.70	0.60	0.46	0.34	0.25
Latin America/ Caribbean	0.53	0.36	0.23	0.23	0.12	0.09
High-income OECD	0.19	0.08	0.05	0.11	0.05	0.03

Source: Data taken from Temple (2005).
Notes: (a) share of agricultural employment in total economy productive employment.
(b) Share of agriculture value-added in total economy value added.

These figures certainly draw attention to the differential importance of structural make-up across time and country groupings, and indicate that separating the analysis by sector may perhaps be a fruitful first exercise to acknowledge these differences.

The data presented only covers the period to 1996, such that some may argue that it is outdated. I want to take this opportunity to counter some criticism of research using similar outdated data: as an empirical economist, my analysis crucially relies on the availability of reliable data. In growth empirics, it seems that the availability of the above-mentioned PWT dataset (frequently updated and at the time of writing covered the period 1950-2004) has lured a vast majority of empirical economists to think of growth and development being appropriately analyzed at the country-level. For agriculture and manufacturing, cross-country macroeconomic data in panel form (such that it covers several decades) is hard to come by – a team at the World Bank, headed by Larson and Mundlak (2000), have assembled such data from national accounts for a considerable number of developed and developing countries, covering the period 1967-1992. This data may be grossly outdated for some research questions, but not for the one we are interested in, namely, whether we can gain insights into the development process by analyzing sector-level data, rather than aggregate data.

The research on which this paper is based seeks to challenge the standard empirical approach to growth analysis and represents a conceptual return to the dual-economy model literature initiated by Lewis. A first departure is to make the industrial sector, rather than the aggregate economy, the unit of analysis, by conducting cross-country analysis of agricultural and manufacturing production separately. The first part of the empirical analysis presented uses the above-mentioned Larson-Mundlak dataset and suggests that the differences between the two sectors matter for growth analysis, and that aggregate analysis leads to distorted empirical results.

A second departure allows for a much more flexible structure for manna/TFP and production technology/blueprints, which are allowed to vary across countries, while globally common evolvement of output (affected, for instance, by the oil-shocks in the 1970s) is also recognized. Further, while this technical aspect of the analysis is not discussed in great detail below, the time-series properties of the data are treated in a more formal way. Based on UNIDO data for the manufacturing sector of a cross-section of countries from 1970 to 2002, the second part of the empirical analysis presented suggests that the terms, production technology/blueprints as well as manna/TFP growth, differ across countries.

4. Empirical results

Our first empirical exercise represents an attempt to explain outputs from inputs in agriculture and manufacturing, respectively. We carried out separate analysis for these sectors using a panel dataset with annual observations from 1967 to 1992. In this analysis, we assume that within each sector, all countries have the same production technology/blueprints, and that the way manna/TFP evolves over time is also the same for all countries. Similar assumptions are made in the seminal Mankiw, Romer and Weil paper (1992), and this analysis is directly comparable to the approach by these authors, with the obvious exception that we model two sectors separately, while they use aggregate data, and the less obvious exception is that we use panel data and can thus allow for different levels of manna/TFP across countries (fixed effects; this includes time-invariant country differences, such as geography). Our data for agriculture is unique to the extent that in addition to fixed capital investments[7] it reports capital stocks for livestock as well as orchard capital (a measure of the asset value of fruit trees). Our empirical analysis for this sector also includes a measure for arable land. We end up with close to 700 observations from 46 countries in agriculture (some 15 observations per country), and slightly over 600 observations for 32 countries in manufacturing (around 19 per country).

[7] In agricultural economics the capital stock variable is commonly proxied by the number of tractors used. Our dataset however provides annual data on fixed capital investment in agriculture, from which a capital stock variable can be constructed.

Following a number of robustness checks, we select the fixed effects estimator applied to a dynamic specification as the preferred estimator for both sector analyses. Results indicate that some 20 per cent of value added in agriculture is attributable to fixed capital, while it seems that the other forms of capital mentioned are not statistically significant determinants of agricultural production. It is shown that allowing for differential manna/TFP levels across countries turns out to be the right specification, indicating that time-invariant or near-time-invariant differences across countries, such as geography or institutions, are important determinants of production.

For manufacturing, we find that some 40 per cent of value added (we translated the gross-output parameters into value-added equivalent ones) is attributable to fixed capital, thus around double the number for agriculture. Again it turns out to be crucial to allow for differential manna/TFP levels across countries.

Our analysis thus suggests that the production technologies/blueprints differ between agriculture and manufacturing. In a further exercise, we aggregate the data from agriculture and manufacturing for each country and year—thus we construct a stylized aggregate economy' dataset, similar to that used in the majority of empirical growth analyses[8]—and estimate an aggregate production function. The results from this exercise are striking: the parameter for fixed capital is considerably inflated compared to the 20 per cent and 40 per cent values from the sector-specific regressions. In addition, the time-invariant manna/TFP levels appear to be insignificantly different across countries. The combination of these results commonly led to the erroneous conclusion that attempts to estimate cross-country production functions using panel data with fixed effects were futile.[9] Our findings of sensible results for separate estimations for agriculture and manufacturing, on the other hand, indicate that this breakdown is the result of aggregation bias: lumping together data from two distinct sectors, as is standard in aggregate economy production functions, distorts the estimation results.[10] Thus the conclusion from this first set of estimations is that the production process is somewhat distinct across sectors, thus undermining the validity of standard aggregate cross-country growth and production analysis.

Our second empirical exercise is focused on the manufacturing sector, exploiting a more substantial UNIDO dataset, as we are not restricted to the period 1967-1992 in order to make a comparison with the agriculture data. We now investigate a sample of almost 900 observations from 38 developed and developing countries (around 23 per country) during the period 1970-2002. Our analysis allows for each country in the sample to possess its own production technology/blueprint, as well as its own

[8] Since we do not have gross-output data for the agricultural sector, our aggregated data model has to be value-added based. Parts of the distortions found in the results are therefore attributable to the misspecification of a value-added model versus a gross-output model.

[9] Problems with the direction of the causal relationship between inputs and output (endogeneity of regressors) were suggested as prime suspects for this empirical breakdown.

[10] A number of tests suggest that 'endogeneity' of regressors has less of a distorting impact than commonly claimed/assumed.

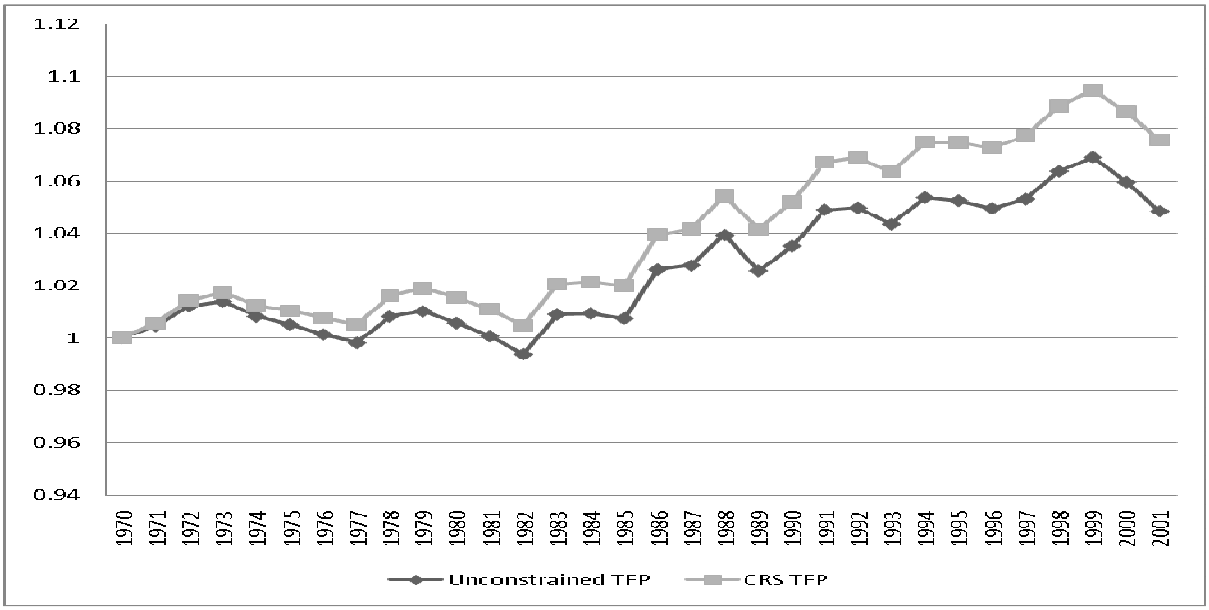
manna/TFP level and growth rate. Our analysis also treats the time-series properties of variables and specification in a more formal way than the analysis in the previous section. A further contribution of this research is the idea to capture information about the 'global' environment at each point in time from a 'pooled' model and then to apply this information in the individual country estimation.

Our primary interest with this exercise is whether countries truly display different production technologies, and whether manna/TFP growth rates display patterns that are in line with certain priors about individual countries given their growth experience over the past three decades.

Our first step is to establish the evolvement of globally common shocks to production and output[11]—note that in this context, global refers to the set of countries in our sample. The following graph illustrates this evolvement; an alternative would be to view this as the path of globally common manna/TFP.

Figure 1 shows quite clearly how output per worker (the light-grey line) dipped in the years after the first and second oil crises in 1973 and 1979, respectively. From around the mid-1980s, we can see sustained growth until the end of our period of observation.[12]

Figure 1. Common TFP evolution in manufacturing



Source: Author's calculations using UNIDO (2004) data for manufacturing.

[11] We achieve this via a set of year dummies in a pooled regression of variables in first differences (output growth, capital stock growth, etc.) – this specification allows us to neglect the time-series properties likely to be present in the untransformed variables in levels (output, capital, etc.). We can transform the information we obtain about the globally common shocks to represent the evolvement of global output over time.

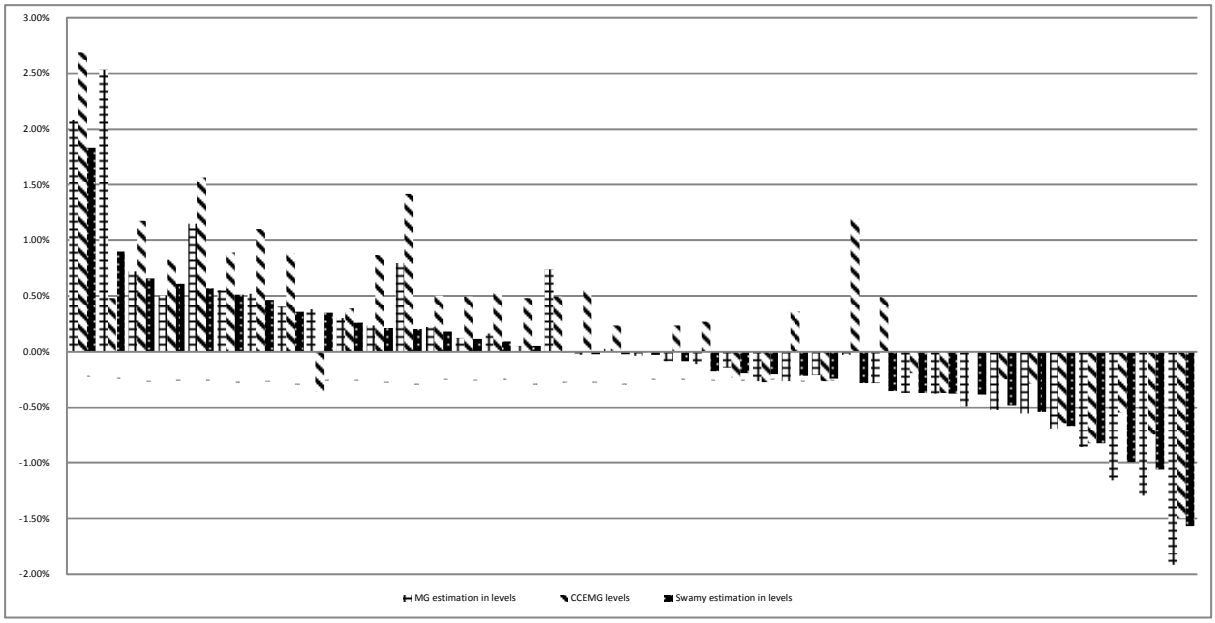
[12] The panel dataset used is unbalanced, that is, individual countries have different numbers of observations. The data thins out toward the late 1990s, such that the last few points on our graph are less informative than those in the early and middle years, where data for the majority of sample countries exists.

In a second step, we estimate the production process in each country separately, but account for the informaion obtained in the previous step.[13] Furthermore, we include a linear trend to account for country-specific manna/TFP growth, in addition to an intercept to represent manna/TFP levels. Our findings for this more flexible estimation framework reveal that, on average, 30 per cent of value added in manufacturing is attributable to fixed capital (again we transform the results from the gross-output estimation into value-added equivalent parameters). This result emerges from a number of different estimation approaches, including one where the above illustrated common output evolvement is dropped and its common effect on all countries mimicked by an alternative method.[14] If we assume that all countries have the same production technology/blueprint, this parameter shoots up to some 80 per cent, and as we know from macro data, beyond the value of around a third is attributable to capital.

The fact that our results are robust across specifications (levels versus first difference) bodes well for any concerns about the time-series properties of the variables leading to biased results.

A closer look at the country-specific manna/TFP growth terms (Figure 2), ranked for three estimators in the levels specification in the following graph, also reveals sensible patterns: Ireland, Finland and the United States find themselves taking the top spots, with annual TFP growth of between 0.5 and 2.5 per cent depending on the estimator, while Senegal, Bolivia and Bangladesh find themselves at the bottom end, with negative growth rates.

Figure 2: Country-specific TFP growth in manufacturing



Source: Author's calculations using UNIDO (2004) data for manufacturing.

[13] We achieve this by subtracting the common evolvement (shock) from country output levels (growth).
[14] The so-called common correlated effects estimator, developed by Pesaran.

5. Implications and some speculations on fundamental growth determinants

Why are these findings interesting? It is important to recall that the vast majority of macro growth analysis has three features:

- It assumes that treating the economy as the basic unit of analysis is the right thing to do. As our analysis has shown, a typical way of investigating how things are produced (production function estimation) indicates that this process differs across sectors—the production process in agriculture differs from that in manufacturing, which is quite intuitive (compare subsistence agriculture with profit-maximizing manufacturing firms).

- The literature commonly assumes all countries to have the same production technology/blueprint. Again, our analysis suggests that even within the same industrial division (manufacturing) production technologies/blueprints seem to differ across countries.

- It implicitly assumes that certain time-series properties of the data do not interfere with the empirical approach taken. Our analysis strongly suggests that this assumption is violated.

Thus, we posit that three fundamental assumptions of standard growth empirics are violated, which questions the validity of the results obtained from these studies.

Further, preliminary results from this research suggest that developing countries display higher capital coefficients (and thus returns to capital) than more developed ones. This indicates that investment in developing countries is below what it should be, since large benefits accrue from further investment; naturally, the question that then needs answering is why firms do not invest more in developing countries. Returning to our overarching topic of interest, informal analysis suggests that trade openness[15] and production of manufactured goods for export play a crucial role: countries with higher capital coefficients display systematically lower trade openness, which is also systematically associated with higher country-specific manna/TFP growth.

A sensible argument for development, based on these findings, might read as follows: export diversification away from natural resource goods is important. Labour-intensive manufacturing for export increases the demand for low-skilled workers and with time also that for more skilled workers once work is diversified. In this context, the destination of exports may play a pivotal role: regional trade arrangements within, say, Africa, will lead to the most efficient country dominating the limited market. Exporting to developed country markets is crucial, but may be hampered by the strong

[15] We adopt this variable from a seminal paper by Jeffrey Sachs and Andrew Warner. They construct openness in a way to cover both tariff and non-tariff barriers.

competition from South and East Asia. Therefore, using trade arrangements, such as AGOA,[16] extended for a limited period of time to, say 2015, could shelter least developed country (LDC) manufacturing against the up-and-coming manufacturing power-houses of China and India. A further ten years of AGOA lifetime would be long enough to build an industrial base within African countries, but short enough not to shelter uncompetitive infant-industries, and would represent an incentive for LDC governments to push through reform of governance, improve transparency, investment climate, openness, property rights, etc.

These are tentative and preliminary results, which require further scrutiny—it is particularly important to expand the analysis to manufacturing sub-sectors, in order to identify which of these follows the pattern for openness and growth suggested in the aggregate manufacturing data.[17] The aim of this research note was to develop an important question of development (globalization and growth), and then to indicate that empirical results from existing studies may be seriously distorted, given the scant attention paid to possible differences in production technologies/blueprints across sectors and countries.

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[16] AGOA stands for African Growth and Opportunity Act – an initiative by the United States Government, which provides beneficiary countries in Sub-Saharan Africa with the most liberal access to the United States market available to any country or region with which the United States does not have a Free Trade Agreement.

[17] This agenda is the focus of a background paper to the UNIDO *Industrial Development Report 2008/2009* by the author.

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III. Geography and Trade Structure: Implications for Volatility

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1. Introduction

In most of the developing world, sustained growth is a precarious achievement. The long-standing volatility of output in sub-Saharan Africa and Latin America is well known and, in the 1990s, instability extended even to some of the strong performers of East Asia. The sources of volatility remain somewhat obscure, however. There is little consensus among economists on the sources of output fluctuations even in developed countries, and since poorer countries appear to show a much wider range of volatility patterns, the intellectual challenge is a formidable one.

Literature on the causes and consequences of volatility is growing by the day. Some of the leading explanations for output volatility include the role played by macroeconomic distortions, low levels of financial sector development and weak political institutions.[1] Popular accounts of volatility in developing countries are based on the terms of trade fluctuations. The story is deceptively simple. Growth in a typical developing country may be more volatile by virtue of its specialization in primary commodities. Since primary commodity prices are more volatile in global markets, developing countries are more susceptible to terms of trade fluctuations—and, thereby—greater output volatility.

But this is an incomplete description of growth instability in developing countries. It begs the question: why do poor economies tend to specialize in a narrow range of commodities. From the perspective of small open economies, changes in world prices can be considered as exogenous. But the effect of a given price change depends on a country's trade structure. And this is clearly endogenous in the long run.

Why do some countries remain locked in primary commodity exporting, while others diversify their export structures and achieve greater specialization in manufactured exports? This paper argues that a country's geographical characteristics can be an important determinant of its trade structure. In particular, it highlights the adverse effects of remoteness for export patterns and exposure to growth shocks resulting in high levels of volatility. Focusing on structural causes of volatility, this paper concludes that there is considerable empirical support for geography-based explanations for volatility. The effect of geography on volatility survives even after controlling for other determinants of

[1] See Malik and Temple (2009) for a more detailed review.

volatility traditionally considered in the literature. The analysis in this paper is based on a forthcoming article in the *Journal of Development Economics* (Malik and Temple, 2009; an earlier, more detailed working paper version, Malik and Temple, 2006).

2. Geography and volatility: the role of trade structure

Recent literature on growth and development attaches growing attention to geography as an explanation for underdevelopment (Sachs, 2003a). The basic story is simple: there appears to be a strong connection between tropical location and underdevelopment. Adverse geographical conditions, such as remoteness from large markets, higher incidence of disease, poor natural resource endowments and unfavourable climate, can predispose countries to remain underdeveloped. Geography is not destiny but it can condemn countries to remain mired in poverty and low growth. Some of these considerations have been highlighted in the work of Diamond (1997), Gallup, Sachs and Mellinger (1999) and Sachs (2001)**.** The relationship between geography and trade is also now well established through a range of scholarly contributions—see, for example, Frankel and Romer, 1999; Disdier and Head, 2003; and Redding and Venables, 2003 and 2004.

Despite its growing recognition in explaining development outcomes, the specific consequences of geographical characteristics for volatility are not well understood. In my joint research with Jonathan Temple of the University of Bristol (Malik and Temple, 2009), we explored the relationship between geography and volatility and assessed the importance of this relationship in relation to other competing explanations. In doing so, we focused on one key aspect of this relationship: the role of geography in determining the structure of trade.

Consider the case of countries that are remote, landlocked or distant from major markets. Countries that are situated far from main trade and shipping routes are often marginalized in international trade and are usually unable to exploit the immense economic possibilities that trade offers. This is because distance may translate into higher transport costs which can then limit possibilities for the expansion and diversification of trade. Geographic distance in this case acts as a natural barrier to trade—a barrier no less important in its implications than other trade barriers created by society. Yet, while international trade theory and policy have long recognized the implications of man-made barriers, such as tariffs and non-tariff barriers, the significance of natural barriers to trade is seldom acknowledged.

Let us begin by providing a brief sketch of the main arguments. The adverse effect of geography on trade structure has direct implications for explaining growth shocks in developing countries. A special disadvantage of geography is that it can act as a barrier to trade diversification. Remote countries

generally face high transport costs and are thus likely to find it especially hard to diversify their export structures. This could be a particularly binding constraint for countries that are landlocked and stuck in a narrow range of export specialization, often primary commodities. This may increase their exposure to global price shocks and translate into higher volatility in terms of trade and output growth. The geography of market access can therefore provide an important explanation for why some countries are more prone to external shocks.

To sum up, geographic distance—by virtue of its impact on transport costs—can be a structural determinant of trade structure. The trade structure can in turn influence a country's vulnerability and expose it to shocks.[2] Thus, distance can provide one concrete mechanism through which geography, trade structure and volatility could be linked. These mechanisms could be more formally described in the following schema:

Distance from coast or navigable river => Transport costs => Patterns of export specialization => Terms of trade volatility => Output volatility

These mechanisms are sometimes recognized in popular discourse but have not yet been systematically examined. The 2003 *Human Development Report* refers to remoteness as a structural barrier to export diversification:

> "Lack of market access contributes to the countries' dependence on natural resources and consequent exposure to major fluctuations in commodity prices"—(UNDP, 2003).

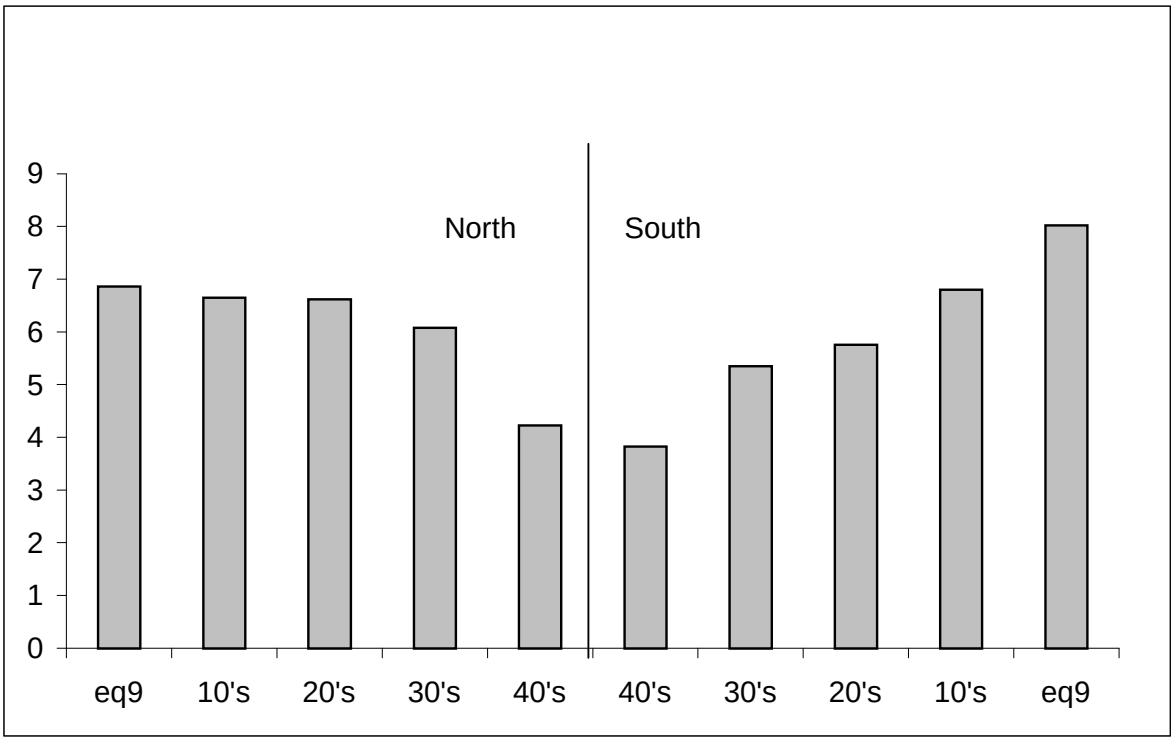
However, the mechanisms linking geography and volatility may not be straightforward. For example, countries that are landlocked or distant from large markets can be less exposed to external shocks, precisely because these natural barriers tend to limit trade. At the same time, even if a lack of market access inhibits trade, it could also lead countries to specialize in a relatively narrow range of exports (often primary commodities) that leaves them especially vulnerable to changes in world prices. In sum, the geography of market access can determine a trade structure as well as vulnerability to external shocks—and these effects can sometimes operate in opposing directions.

[2] Primary commodities experience a higher degree of price instability. Average annual price changes for primary commodities have generally exceeded those for all non-oil commodity index.

2.1. Some preliminary evidence

Using some broad statistical data, a cursory look at the numbers suggests a strong association between broad geographical characteristics and volatility. Figure 1 shows how the average extent of growth volatility for groups of countries varies across different latitude bands. It displays a clear pattern of volatility declining with distance from the equator. Tropical countries situated closer to the equator tend to experience higher volatility. Table 1 provides a comparative picture of the evolution of output volatility across broad geographical categories. Output volatility is defined throughout this analysis as the standard deviation of the first log-differences of real GDP per capita series from PWT 6.1.

Figure 1. Output volatility by latitude



Source: Malik and Temple (2006).

Table 1 provides some interesting contrasts. Median volatility during the 40-year period, 1960-1999, was about three times as high in tropical countries as in high-income OECD countries. The same fate befalls low-income countries, where average volatility is significantly higher than in their rich country counterparts. The temporal patterns generally paint a similarly depressing scenario. While growth volatility has fallen in the overall sample over the past four decades, volatility in tropical and low-income countries is still considerably greater than in high-income OECD countries.

Table 1. Evolution of output volatility – by decade

Country grouping, Type		1960-99		1960s		1970s		1980s		1990s	
	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
All		0.055 (0.029)	0.046	0.050 (0.036)	0.041	0.054 (0.036)	0.041	0.050 (0.035)	0.039	0.046 (0.043)	0.032
Developing[a]	47	0.054 (0.028)	0.046	0.047 (0.031)	0.041	0.053 (0.037)	0.041	0.058 (0.039)	0.043	0.044 (0.042)	0.034
Low-income	42	0.069 (0.029)	0.066	0.062 (0.039)	0.051	0.068 (0.038)	0.057	0.058 (0.035)	0.051	0.062 (0.049)	0.055
High income OECD	22	0.028 (0.007)	0.026	0.026 (0.012)	0.025	0.030 (0.011)	0.030	0.023 (0.007)	0.023	0.022 (0.009)	0.019
Tropical[b]	66	0.065 (0.031)	0.063	0.057 (0.039)	0.047	0.061 (0.038)	0.048	0.059 (0.032)	0.051	0.057 (0.051)	0.038
Koeppen-Geigger *Tropics-Subtropics* [c]	70	0.059 (0.031)	0.052	0.048 (0.029)	0.042	0.055 (0.037)	0.042	0.054 (0.033)	0.044	0.055 (0.051)	0.035
Non-tropics	34	0.046 (0.029)	0.038	0.046 (0.042)	0.033	0.050 (0.036)	0.034	0.035 (0.023)	0.026	0.028 (0.016)	0.024
Temperate	42	0.042 (0.024)	0.036	0.039 (0.028)	0.030	0.044 (0.034)	0.032	0.034 (0.019)	0.028	0.029 (0.015)	0.026
Non-temperate	62	0.064 (0.032)	0.061	0.053 (0.037)	0.042	0.059 (0.037)	0.049	0.057 (0.034)	0.049	0.058 (0.054)	0.038
Key Export Categories *Primary Commodity*[d]	34	0.072 (0.035)	0.064	0.060 (0.039)	0.053	0.066 (0.039)	0.052	0.064 (0.038)	0.058	0.067 (0.061)	0.047
Manufactures	16	0.043 (0.028)	0.037	0.032 (0.017)	0.025	0.031 (0.008)	0.032	0.025 (0.011)	0.021	0.026 (0.013)	0.023
Fuel-exporters	8	0.084 (0.022)	0.085	0.077 (0.045)	0.066	0.087 (0.034)	0.094	0.072 (0.031)	0.070	0.070 (0.060)	0.049

Source: Malik and Temple (2006)**.**

Notes: Output volatility is defined as the standard deviation of log-first differences of the real per capita GDP series from PWT6.1.

The statistics are reported for non-overlapping decades: 1960-69, 1970-79, 1980-89, and 1990-1999.

Figures in parenthesis are standard errors.

Regions are defined on the basis of World Bank classification.

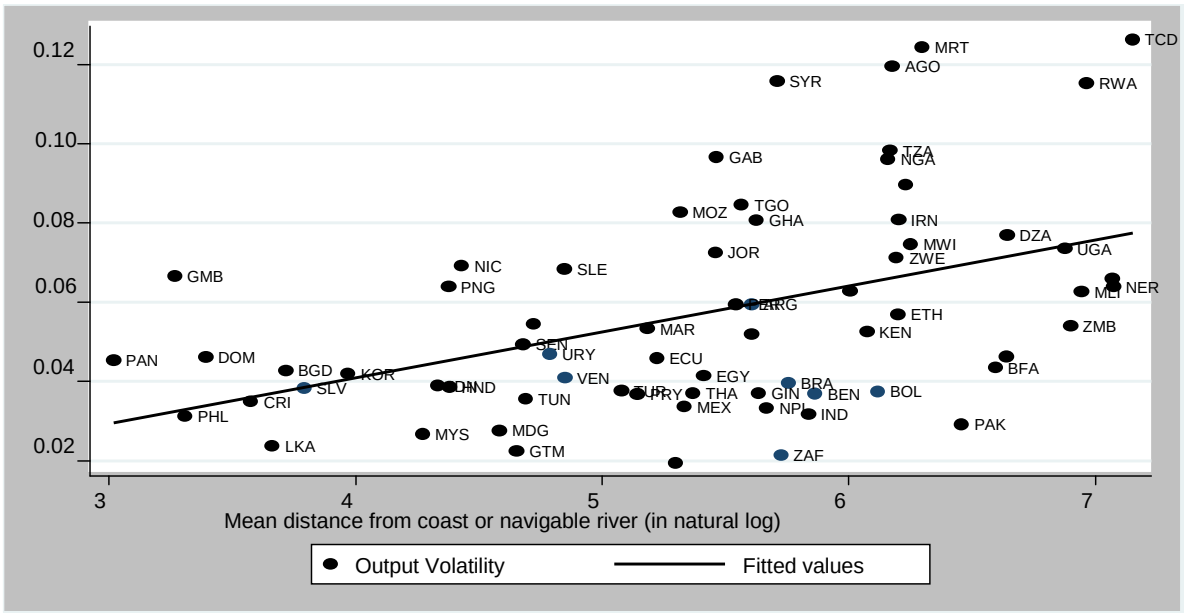
a. Figures for developing countries that are NOT "low-income".
b. Based on the tropical (0,1) dummy from GDN database.
c. Countries classified as non-tropical if 0 per cent of their area falls in the tropics subtropics eco-zone. The rest are treated as tropical countries. A parallel definition is used for temperate and non-temperate zones.
d. Countries are classified as tropical if more than 50 per cent of the total land is in the tropics-subtropics eco-zone (similarly for temperate zones).

The second part of table 1 provides another comparison of growth volatility between tropical and temperate countries. The geographical categories are now defined on the basis of an ecological definition of the tropics, which takes into account a wider set of characteristics such as climate, precipitation, ecology, soil conditions, etc. Even on this more nuanced classification, tropical countries seem to have experienced greater growth volatility than their temperate counterparts during the same period.

Summarizing output volatility across countries with different trade structure presents similarly interesting contrasts. Growth in fuel and non-fuel primary commodity exporting countries has been at least twice as volatile as in exporters of manufactured goods. This accords well with conventional wisdom: prices of primary commodities are generally more volatile in international markets. Over the previous four decades, however, growth volatility has declined for these categories regardless of the trade structure. Yet, perhaps more interestingly, volatility differences between primary and non-primary commodity exporters seem to have preserved over time.

The questions we would like to ask are in a sense much deeper than those afforded by the aggregate statistics presented above. One may ask, for example, if there is any overlap between the two categories; geography and trade structure. After all, many tropical countries are primary commodity exporters and tend to have a narrow range of export specialization. For additional insights, we now turn to a visual inspection of selected scatter plots. Figure 2 plots growth volatility against an important dimension of tropicality: coastal distance. The unconditional plot displays a positive association, exhibiting a strong tendency for remote countries to experience higher volatility.

Figure 2. Volatility and coastal distance

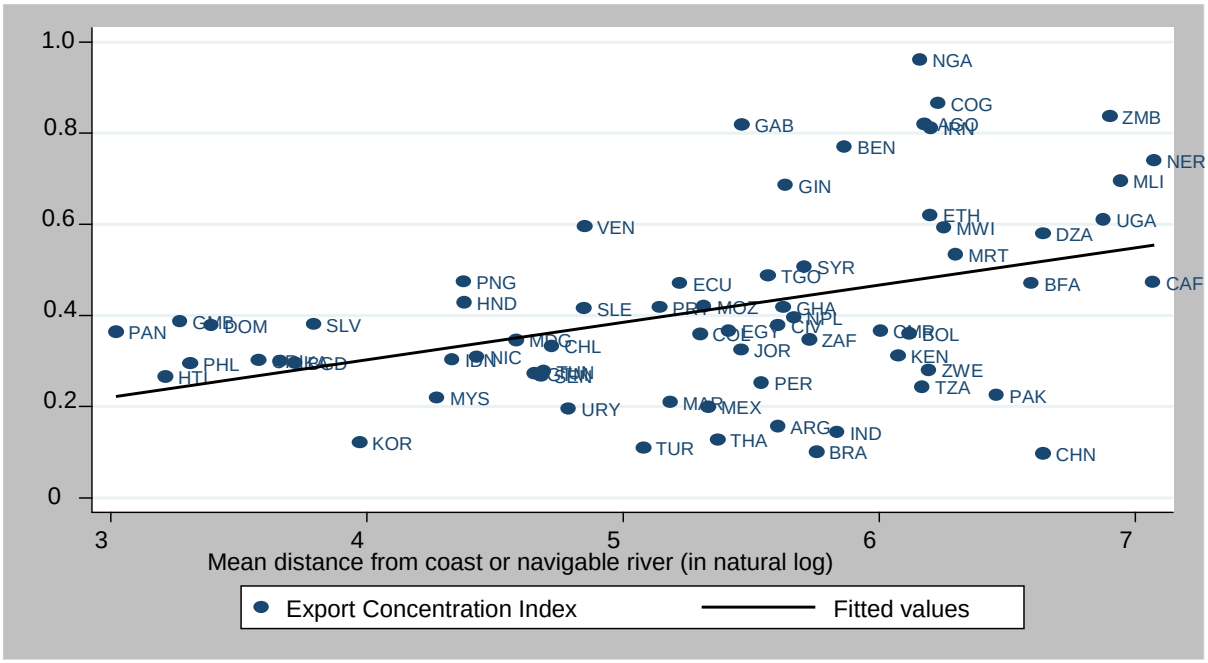


Source: Malik and Temple (2009).

Our maintained hypothesis in Section 1 attributes this strong association between coastal distance and volatility to the effect of geography on trade structure. In particular, lack of geographical proximity can translate into concentrated export structures that can invite higher terms of trade volatility. Figures 3-4 provide a graphical illustration of these relationships.

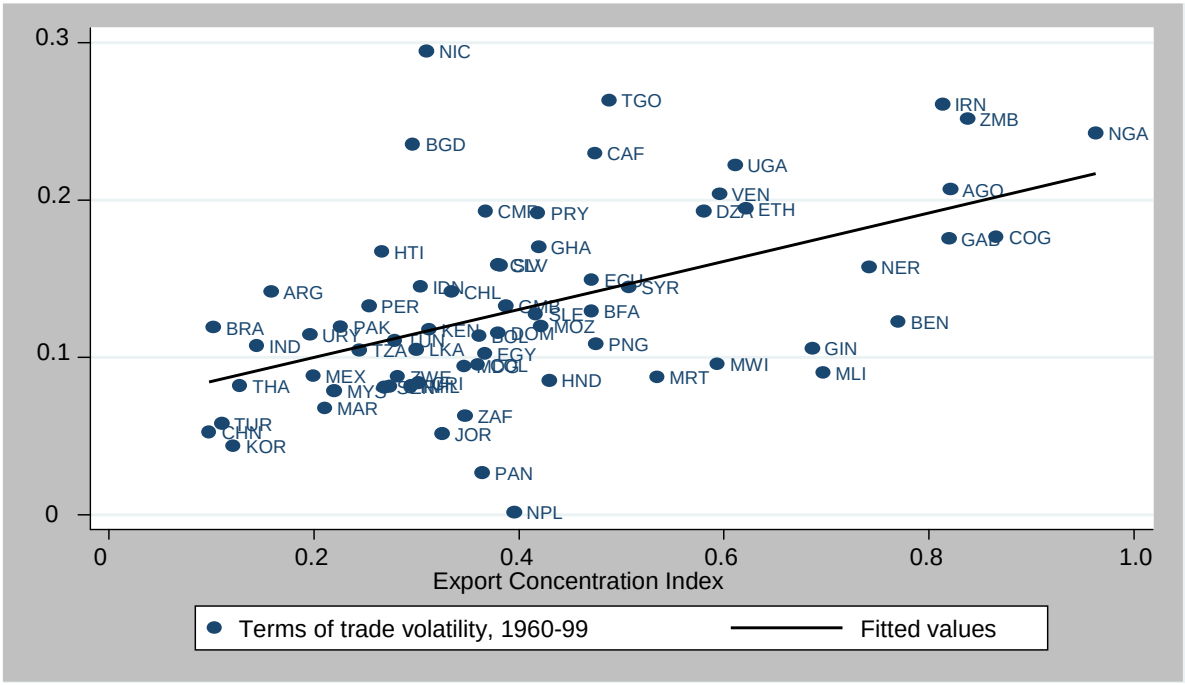
Figure 3 plots the UNCTAD export concentration index against mean distance from coast or navigable river. This confirms our initial prior statement that remote countries, defined here as those with high coastal distance, tend to have more concentrated export structures. Similarly, Figure 4 shows that countries which score high on the UNCTAD's export concentration index also appear to have experienced greater terms of trade volatility over the period 1960-1999. Taken together, these partial scatter plots point to the potential importance of the relationship between coastal distance, patterns of export specialization and terms of trade volatility. More formal empirical work will test the extent to which these relationships survive after conditioning for the level of development and other volatility determinants.

Figure 3. Export concentration and coastal distance



Source: Malik and Temple (2009).

Figure 4. Terms of trade volatility and export concentration



Source: Malik and Temple (2009).

2.2. Distance and transport costs

A crucial building block of our analysis is the connection between coastal distance and transport costs. To appreciate the nature of the argument, it is important to understand how distance can act as a common proxy for transport costs. It is now a well-received wisdom, thanks to the growing literature on economic geography, that geography is a key determinant of transport costs. It is easy to understand why a country's geography—its location, distance from the sea and distance from major markets—can influence the costs of transportation. Since ocean shipping is the cheapest and principal mode of transportation of goods, countries without easy access to the coast are likely to face high transport costs.

There is currently plenty of evidence to prove that geographic disadvantage in the form of long distances translates into higher transport costs. Using data on direct shipping costs, Radelet and Sachs (1998) found that the average cost of freight and insurance for landlocked developing countries was some 50 per cent higher than that for coastal countries. Similar evidence emerges from the empirical analysis in Limao and Venables (2000): transport costs in a median landlocked country are 55 per cent higher than that in a median coastal economy.

Defective or absent infrastructure can compound the costs of remoteness. Distance combined with a weak infrastructure is a double jeopardy in many developing countries, especially in sub-Saharan Africa. Together with geography, infrastructure is a key determinant of transport costs. As Limao and Venables (2000) demonstrate, the quantitative effects of infrastructure on transport costs can be substantial: "a deterioration of infrastructure from the median to the 75th percentile raises the cif/fob factor from 1.28 to 1.40, equivalent to becoming 2016km further away from all trading partners."

There is a sense in which infrastructure effects are more pronounced in distant or landlocked countries. While weak infrastructure explains only 40 per cent of the predicted trade costs in coastal countries, it accounts for 60 per cent of transport costs in landlocked countries. It is therefore clear that infrastructure improvements will result in a greater payoff in remote countries, mitigating the adverse effects of distance. "An improvement in own and transit countries' infrastructure from the 25th percentile to the 75th percentile overcomes more than half of the disadvantage associated with being landlocked" (Limao and Venables, 2000).

3. The penalty of distance: coastal distance and export concentration

Geographic proximity—by determining transport costs—is also likely to influence the extent and structure of trade, and these in turn can have distinct implications for volatility. Remote countries generally tend to have a limited exposure to trade. This may reduce vulnerability to trade-related shocks and result in lower output volatility. On the other hand, distance can also have an effect on trade structure, in the sense that by raising transport costs distance tends to reduce possibilities for export diversification. One of the great penalties of distance thus seems to be concentrated on export structures and, consequently, higher terms of trade volatility.

Since the effects of distance on trade volumes are quite well known, the principal focus of this section is on mapping links between distance and trade structure. But, for the sake of completeness, we will begin by providing a brief sketch of the effects of distance on trade flows.

Distance and trade flows

One of the most well-established finding in international economics relates to the negative relationship between distance and bilateral trade. In other words, distance results in lower trade volumes. The quantitative effects of distance on trade flows are widely documented. A few stark illustrations are sufficient to make the general point:

- The transport costs of the representative landlocked country are 50 per cent higher, and trade volumes are 60 per cent lower, than the representative coastal economy.

- The elasticity of trade flows with respect to transport costs was -3: a 10 percentage point increase in transport costs reduces trade volumes by approximately 20 per cent. A doubling of transport costs (from the median value) reduces trade volumes by 45 per cent.

- Doubling distance from 1,000 km to 2,000 km reduces trade flows by more than half; at 4,000 km trade volumes are down by 82 per cent, and by 8,000 km, down by 93 per cent.

- In 1995, landlocked countries had a meagre import share in GDP standing at 11 per cent compared to 28 per cent for coastal economies. Of the top 15 non-primary export performers between 1965-1990, none were landlocked.

- A 1 per cent improvement in a country's market access has the effect of increasing its exports by 1 per cent.[3]

A striking aspect of the role of distance is its continuing importance in predicting trade volumes despite the fall in trade costs in the wake of advancements in communication technology. In fact, the impact of distance on trade is shown to have increased significantly over time (Disdier and Head, 2003). Brun et al. (2002) suggest that the impact of distance on trade has increased by 11 per cent over the past 35 years.

Distance and trade structure

The main argument advanced in this sub-section is that distance can serve as a structural barrier to trade diversification. There is a strong tendency for countries that lack market access to specialize in a narrow range of commodities, often primary commodities. This is confirmed in Figure 3 which shows a positive association between coastal distance and export concentration. What can be attributed to such a relationship?

An important reason is that distance imposes high trade costs which can in turn shape patterns of export specialization. Labour-intensive manufactured exports are increasingly subjected to competitive pressures, forcing them to rely on small profit margins, high import content and efficient supply chains. There is a growing dependence of manufactured exports on intermediate goods or trade in tasks. Trade in components and geographical fragmentation of these production processes increase the importance of transport costs.

[3] Limao and Venables (2000) and Redding and Venables (2004).

In fact, as Radelet and Sachs (1998) demonstrate, value added is particularly sensitive to transport costs in a vertically fragmented industry. For export items, such as electronics, where production processes involve a high import content, shipping costs can reduce the potential value added dramatically. For example, for a typical landlocked country (with a CIF/FOB band of 18 per cent), value added in electronics would only be half the value added in a coastal economy (Radelet and Sachs, 1998).

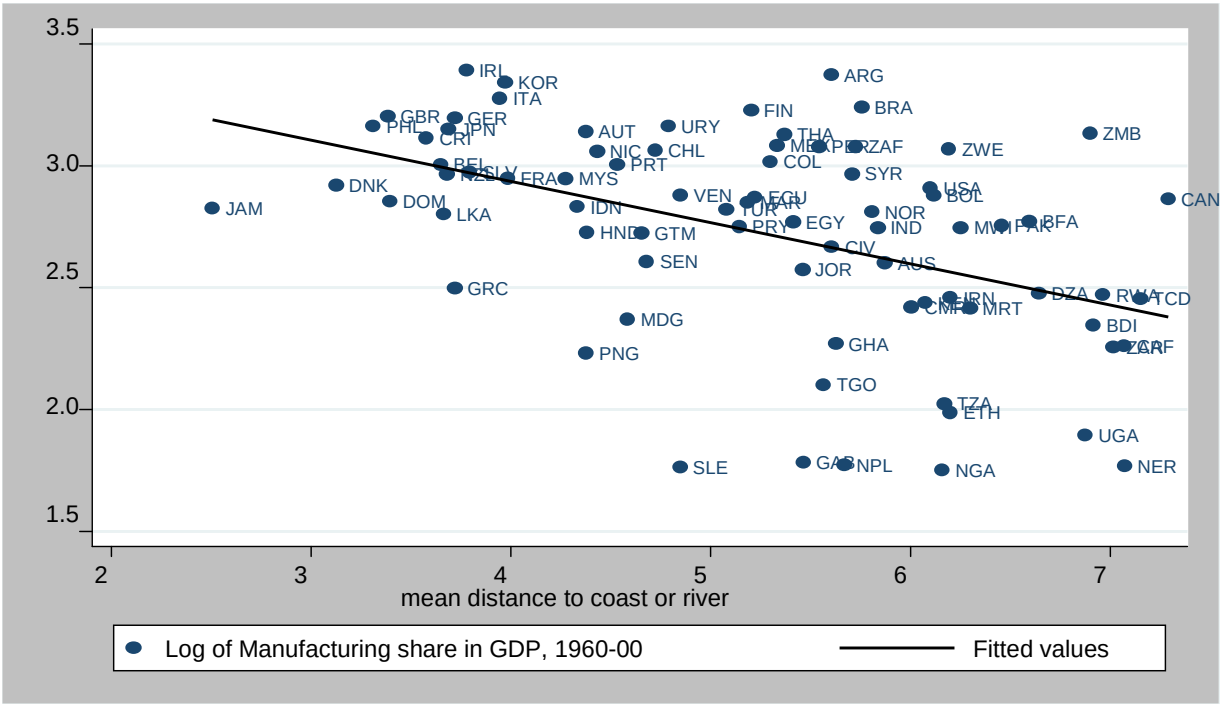
Due to high transport costs, countries that are geographically isolated are placed at an immediate cost disadvantage, and will find it harder to develop manufacturing exports. Distance can therefore make domestic manufacturing production uncompetitive, limiting possibilities for export diversification. Figure 5 plots the log of manufacturing share in GDP averaged over the 1960-2000 period against the log of mean distance from coast or navigable river. The plot suggests a strong negative correlation between the two variables: countries situated farther from the coast are likely to have small manufacturing sectors relative to their GDP levels.

The importance of transport costs and the tendency for industries to emerge and grow along coastal regions was noted by Adam Smith, who wrote that:

> "As by means of water-carriage a more extensive market is opened to every sort of industry than what land-carriage alone can afford it, so it is upon the sea-coast, and along the banks of navigable rivers, that industry of every kind naturally begins to sub-divide and improve itself, and it is frequently not till a long time after that those improvements extend themselves to the inland part of the country"— Smith (1776).

A wide range of evidence suggests that remote countries are indeed less likely to export manufactured goods. Landlocked countries export 60 per cent less value added per capita than their maritime transit counterparts (Snow et al., 2003). Breinlich (2005) suggests a positive correlation between market access and the relative size of the manufacturing sector in poor countries. Similarly, Radelet and Sachs (1998) argue that high shipping costs are associated with slower growth of manufactured exports. Redding and Venables (2003) blame geography of market access for the poor export performance of sub-Saharan Africa. These contributions all point in the same direction, namely, that adverse geography can influence patterns of specialization.

Figure 5. Coastal distance and size of the manufacturing sector



Source: Author's calculations.

3.1. Anecdotal evidence from Africa

How plausible is the link between distance, trade structure and volatility in practice? It will be instructive to consider some informal evidence from sub-Saharan Africa. The significance of coastal access for developing countries was recognized long ago in Book I of *The Wealth of Nations* where Adam Smith wrote:

> "All the inland parts of Africa, and all that part of Asia which lies any considerable way north of the Black and Caspian Seas, the ancient Scythia, the modern Tartary and Siberia, seem in all ages of the world to have been in the same [economically underdeveloped] state in which we find them at present ... There are in Africa none of those great inlets ... to carry maritime trade into the interior parts of that great continent."—Book I, The Wealth of Nations

It is well-known that economic activity has often developed fastest in coastal regions. The surge in China's foreign trade in the late eighteenth century and its concomitant industrialization was much facilitated by the development of Treaty Ports (Eastman, 1988). In the United States, much of the economic activity has been concentrated close to the ocean and Great Lakes coasts, and this concentration increased over the twentieth century (Rapport and Sachs, 2003). In the case of Western Europe, proximity to navigable rivers may have aided economic development, as in the concentration of industry around the Rhine.

Africa provides a stark illustration of the importance of geography of market access. The link between geography and export performance is arguably most evident in Africa. Many African countries belong to the hinterlands, situated at long distances away from coasts, and poorly connected with the outside world. Landlocked countries rely on neighbouring transit countries, which sometimes have poor transport networks, and this often results in a cost disadvantage for exporters. Administrative costs in the form of transit and customs charges, and the hidden costs of bribes and administrative delays, further compound the overall costs of transportation.[4]

These trade costs are not just limited to higher costs of transportation, but include costs imposed by such motley dimensions as politics, infrastructure and conflict. This is best illustrated by considering the example of landlocked countries, whose trade connection with the outside world is through transit facilities in neighbouring countries. Landlocked countries face a double penalty because of distance: their exports are as much dependent on conditions of neighbouring transit countries as on their own.

Access to transit countries is limited both by poor infrastructure and the disruptive influence of civil conflict. When transit countries have a poor transport network, exporters face a severe cost disadvantage. Administrative costs in the form of transit and custom charges further escalate overall trade costs. Such direct costs of accessing facilities in transit countries can amount to as much as 26 per cent of the direct freight costs (Anyango 1997; Snow et al., 2003). The implicit cost of cumbersome paperwork, bribes, and administrative delays are yet another burden. In much of Africa, the average delay in border crossing is about 24-48 hours (Snow et al., 2003). Administrative delays alone are estimated to impose an annual cost of US$48 million.

Politics can be a hindrance too. Landlocked countries often need to negotiate rights for accessing transit countries' facilities. Poor political relations with a transit neighbour tend to limit such access, with external war being an extreme case. Even with good neighbourly relations trade could be inhibited by civil strife—both at home and in surrounding countries.

Civil war can render existing transport networks unusable, which is likely to result in a redirection of trade and a further escalation of transport costs. The civil war in Mozambique has forced a large part of the South African Development Community's (SADC) trade to the port of Durban in South Africa. Malawi's cheapest access to the coast was via Mozambican ports of Beira and Nacala, which remained closed during the two decades of civil war in Mozambique. Malawi was therefore forced to reroute its trade to the twice-expensive ports of Durban and Dar-es-Salaam. As a result, insurance and

[4] These various charges could include port fees, rail charges, road tolls, cost of customs verification, posting of security bonds, etc. See Anyango (1997) and Snow et al. (2003) for more on freight costs when transit countries are involved.

freight costs shot up from "20% of the import bill in the early 1980s to 40% by the latter half of the decade" (Snow et al., 2003).

What does all this add up to? The cost of an inherent geographical disadvantage coupled with dilapidated infrastructure, and internecine political conflicts are broadly manifested in higher transport costs. Nowhere is this more evident than in sub-Saharan Africa where ad valorem freight costs are about 20 per cent higher on average (Ng and Yeats, 2003). Such costs have actually increased recently.

> "In 1960, for example, net freight payments to foreign nationals absorbed 11% of Africa's export earnings; that ratio had increased to 15% by 1995. And for landlocked African countries, the freight cost ratios exceed 30%, as exports must transit neighboring countries" (Amjadi and Yeats, 1995).

These high transport costs can provide one explanation for Africa's poor export performance, especially its continuing inability to diversify exports. The region has a high degree of export concentration, with primary commodities typically contributing over 90 per cent of total exports in these countries (Ng and Yeats, 2003). A selective overview of individual country experiences can put these links between geography and export performance in a broader perspective.[5]

Zambia

Situated at about 992 kilometres from the coast, Zambia has one of the highest export concentration indices in the world (0.84). Its exports are primarily dominated by copper and other minerals. Consequently, its terms of trade volatility are also exceedingly high. Zambia has one of the worst transport infrastructures in the region: about 50 per cent of the paved roads were considered to be in poor condition. Owing to its rundown infrastructure, Zambia faces high transport costs—in some cases it could be as high as 60-70 per cent of the total cost of production.[6] To make matters worse, ongoing civil war in Angola prevents Zambia from transporting its goods westward. Instead, it relies more heavily on the South African, Tanzanian and Mozambiquan transit networks.

[5] These examples draw on Snow, Faye, MacArthur, and Sachs (2003).
[6] Estimate based on Economist Intelligence Unit's Country Report.

Ethiopia

Ethiopia is another example of a country where large coastal distance (about 500 km) tends to coexist with high export concentration. Primary commodities are the mainstay of its economy, with the agricultural sector providing 9 per cent of total exports. Coffee exports, for instance, account for about 60 per cent of total export earnings—and this makes Ethiopia particularly vulnerable to global coffee price shocks. Like Zambia, Ethiopia also suffers from inadequate transport facilities. It has one of the lowest road densities in the world, with only 20 per cent of its land area within 10 km of an all-weather road and 70 per cent of its farms being more than a half-day's walk from an all-weather road. During much of the 1990s, Ethiopian trade relied on the Eritrean port of Assab, which allowed the transport of over 75 per cent of its international trade. Since the 1998 border conflict with Eritrea, Ethiopia has shifted its trading route to the port of Djibouti.

Rwanda

Rwanda is a landlocked country situated at an unusually high distance of 1,500 km from the nearest port. It has a narrow export base: traditional agricultural exports primary goods account for over 90 per cent of export share. Some 74 per cent of total exports come from exporting only three products (Ng and Yeats, 2003). The transport system is dilapidated, with only 2,662 km of paved roads. Rwanda has experienced internal conflict among competing ethnic groups. Ethnic conflict which sprung in the Great Lakes region has spread to Burundi, Democratic Republic of the Congo and Rwanda.

Uganda

With a coastal distance of about 970 km, Uganda is another country that is conspicuous for its high levels of export concentration. In 1995, more than 66 per cent of Uganda's export earnings came from coffee exports—and a large proportion of these (63 per cent) were directed to the European Union in 2001. Such a narrow concentration of exports—by products and destination—can help to explain the excessive volatility of Uganda's terms of trade.

Uganda has only two key passages to the sea: the Northern Corridor to the port of Mombasa and the Central Corridor to Dar-es-Salaam. Although transport improvements are in progress, the existing road network remains inadequate, with only some 7 per cent of the total highway system paved.[7] Net transport and insurance payments amount to more than 70 per cent of export value (Amjadi and Yeats, 1995). Local violence and prolonged civil war has adversely affected the Gulu and Kitgum districts in northern Uganda. Strong rebel movements are also present in the western Uganda. This internal strife, combined with the outpouring of refugees from neighbouring States, has increased internal displacements and suffering from drought conditions.

[7] CIA World Factbook (2002).

4. Empirical implications

The anecdotal evidence discussed so far indicates a systematic tendency for remote countries to have more concentrated export structures. However, it raises two pertinent questions. First, are these examples pure accidents or a systematic association between geography and export specialization? Second, can these examples be described as an isolated Africa effect, or do they apply more generally to a wider cross-section of developing countries?

A formal empirical analysis can yield more definitive conclusions on the relationship between geography, trade and volatility. However, existing empirical research on the causes of output volatility has tended to ignore geography as a potential explanation. In particular, there is little systematic evidence on the possible link between distance and trade structure.

Malik and Temple (2006) have attempted a systematic investigation of the determinants of output volatility, focusing mainly on structural explanations of volatility. Empirical analysis in this paper inspects the importance of geography relative to other competing explanations conventionally put forward in the literature. These include, among others, the role of mismanagement of macroeconomic policies, lack of financial sector development and the absence of strong political institutions.

The sources of output volatility are explored in a robust empirical setting using the recently introduced model selection approach, the Bayesian model averaging. It is employed as a first step in the model-building exercise. The intention is to identify a set of robust correlations of volatility that could inform our final choice of models. Precise details of our empirical approach can be perused from the CEPR working paper: http://www.cepr.org/pubs/dps/DP5516.asp

Focusing on the empirical results, we confirm the strong explanatory power of indicators measuring a broad cluster of institutions. Some of the institutional measures included in our analysis are: the aggregate governance index developed by Kaufmann et al. (1999), the Henisz (2000) political constraints index and POLITY IV's constraints on the executive. Consistent with previous studies, we find strong institutional quality, especially a higher degree of constraints on the executive, to be associated with lower levels of output volatility.

Perhaps more importantly, we find a robust effect of geography even after conditioning for institutional indicators. This contributes to the growing literature on the comparative importance of geography, trade and institutions in determining long-run economic performance (Rodrik et al., 2004; Sachs, 2003b). Remote countries are systematically more volatile. Coastal distance seems to have a non-linear effect on output volatility: "conditional on whether or not a country is landlocked, volatility increases with distance from the sea". In concrete terms, our results imply that volatility is lowest for

countries with a higher proportion of land near the coast, intermediate in landlocked countries and highest in countries that are not landlocked but where coastal distance is significant.

However, the effect of coastal distance on volatility is substantially weakened after the inclusion of terms of trade volatility. A one-standard deviation change in terms of trade volatility translates into a change of around 0.30 of a standard deviation of our measure of output volatility. This suggests that the "association between coastal distance and output volatility works partly through exposure to world price shocks".

This is explored more systematically by estimating models where the dependent variable is a measure of export concentration.[8] Controlling for a number of relevant dimensions we find that geography increases export concentration. We also show that existence of road infrastructure (percentage of paved road network) is negatively associated with export concentration, hinting at the mitigating effect of infrastructure.

Overall, our empirical analysis highlights the importance of both geography and institutions and provides strong empirical evidence on the possible link between remoteness and lack of export diversification. These effects are robust to the inclusion of a variety of different volatility determinants that include but are not limited to: financial development, policy mismanagement, initial level of real per capita income and initial population.

5. Concluding remarks

Summarizing the main arguments in this paper, various forms of remoteness, especially lack of access to the sea, imply that some countries face significant natural barriers to trade. These barriers may be especially important in constraining the development of the manufacturing sector, and lead to specialization in a narrow range of goods, often primary commodities. As a result, there is a strong association between remoteness, export concentration and exposure to world price shocks, all of which help to explain why remoteness and output volatility are so closely linked in the cross-country data.

What does the association between geography and volatility imply for policy? This paper is not intended to advance geography as an end in itself. It would be wrong to conclude from these results that countries with geographical disadvantage are condemned to higher levels of output volatility. On the contrary, it suggests a more nuanced intervention in developing countries that is based on a better appreciation of the structural constraints of these societies. After all, as Dani Rodrik powerfully

[8] Here the precise measure by UNCTAD is used.

argues, each country has its own set of binding constraints, and policy must be tailored to account for these.

Countries facing a systematic geographical disadvantage require a conscious policy effort to mitigate the effects of adverse geography. To give a concrete example, there may be significant payoffs to improving the transport infrastructure in landlocked countries. As evidenced in Limao and Venables (2000) "Moving from the 75th percentile to the 25th in the distribution of infrastructure quality more than halves the cost penalty for being landlocked, and more than doubles the volume of trade." Moreover, a well-developed infrastructure in a neighbouring or transit country is likely to be as important as improving domestic infrastructure.

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IV. Trade Facilitation as a Development Tool: What Can We Learn From a Decade of Quantitative Research?

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1. Introduction

Trade facilitation has become an integral part of the policy package aimed at building the supply-side capacity and trade-related infrastructure in developing countries and is at the centre of discussion in the aid for trade agenda. Reductions of tariff barriers in subsequent rounds of international trade negotiations and changes in supply chain management practices, such as greater reliance on just-in-time deliveries, have resulted in a relative increase in the importance of border procedure-related trade transaction costs for international commerce and triggered keen public interest in trade facilitation efforts (OECD, 2003). Recognizing the importance of trade capacity-building and to enable developing country members to benefit more fully from multilateral trade liberalization, the WTO's 147 members commenced negotiations on trade facilitation in July 2004.[2] The Doha Work Program agreed to 'clarify and improve relevant aspects of Articles V, VIII and X of GATT 1994'. These articles take up *Freedom of Transit, Fees and Formalities connected with Importation and Exportation,* and *Publication and Administration of Trade Rules.*

Trade facilitation is generally understood to involve reducing the transaction costs associated with the enforcement, regulation and administration of trade policies, and reforms in this area are designed to reduce the costs involved in the cross border movement of goods and services (Staples, 2002). In a narrow sense, the definition of trade facilitation reform measures is limited to the logistics of moving goods through ports or more efficiently moving documentation associated with cross-border trade. A broader definition includes the environment in which transactions take place, transparency and professionalism of customs and regulatory environments, as well as the harmonization of standards and conformance with international or regional regulations (Wilson et al., 2004).

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[2] Trade facilitation, along with competition policy, investment and government procurement, was part of the so-called Singapore Issues, as these themes were first discussed at the WTO's Ministerial Meeting in Singapore in 1996. Since then all issues, with the exception of trade facilitation, were dropped from the Doha Development Round which highlights the emerging consensus importance of both developed and developing countries.

It has been argued that trade transaction costs, which trade facilitation efforts aim to decrease, are a major factor in explaining the patterns of international trade and investment flows (Deardorff, 2001; Obsfeld and Rogoff, 2000). Estimates of the share of directly incurred trade transaction costs range from 2 to 15 per cent of total trade (OECD, 2005). The costs stemming from customs and related import formalities are of the order of 2 to 5 per cent of the value of merchandise trade. Trade facilitation, defined in the narrow sense, is therefore potentially a very cost effective way of reducing the costs of trading.

The past decade saw an emergence of research literature that attempts to quantify, in both partial and general equilibrium frameworks, benefits arising from trade facilitation reform. The literature generally shows that there are significant welfare gains from trade facilitation reform and that developing countries stand to gain most from that reform. This finding reflects that, on average, developing countries have less efficient customs and logistics and hence a bigger potential for improvement.

Despite the high expectations of gains from trade facilitation, empirical estimates of the impact of reforms on trade performance have been limited and it has proved difficult to provide strong supporting evidence of a causal link between trade facilitation reforms and trade performance. The complexity of international trade procedures makes it very difficult to put exact figures on the monetary gains from trade facilitation. This paper critically surveys recent literature on the impact of trade facilitation reform and shows that although gains from this type of reforms can be considerable, such gains are not immediate. The success of trade facilitation reforms depends on a host of country-specific factors as well as comprehensiveness and coordination of the reform's execution. Furthermore, in the absence of any conclusive, comparative cost measures of the implementation of such reforms, a reliable cost-benefit analysis has so far been impossible to implement.

The paper is structured as follows: Section 2 provides a review of the recent literature relating to trade facilitation reforms, particularly in developing countries. Section 3 gives an indication of the policy implications arising from the quantitative literature on trade facilitation as well as shows further research directions. Section 4 concludes.

2. Overview of recent quantitative research on trade facilitation:

Quantitative assessments of trade facilitation reforms generally use two methodological approaches: gravity models and computable general equilibrium (CGE) models. Recently, the impact of trade facilitation was also analyzed at a microeconomic level using firm-level surveys.

2.1. Gravity models

A standard gravity model[3] applies regression analysis that assumes that the volume of trade between two countries is positively related to the size of their economies, as measured by GDP, and negatively related to the trade costs between them. A number of variables are normally used to capture trade costs. These include whether a country is landlocked or an island economy, the distance between the exporter and importer, as well as various dummy variables that indicate whether both countries belong to a regional trade agreement, or share a common language, border or colonial heritage with its trading partner. Studies that aim to assess the impact of trade facilitation reform on trade flows usually augment the standard gravity model with variable(s) that proxy the efficiency of trade facilitation environment and assess the impact of that variable(s) on bilateral trade flows.

Wilson, Mann, Okuki (2004) were among the first to estimate the impact of trade facilitation on trade flows within a gravity model methodology. The authors apply a broad definition of trade facilitation and construct four indicators—port efficiency, customs environment, regulatory harmonization, and what they call service-sector infrastructure (Internet access and use). Their results indicate large potential increases in trade and growth rates from trade facilitation reform, which they define as bringing the below average countries, half way to the average of trade facilitation indicators for all the countries in the sample. They find that global trade flows receive the biggest boost when exporter port efficiency and service sector infrastructure improve. Customs environment and regulatory harmonization are also important for trade flows, but have a smaller impact. According to this study, the total gain in trade flows in manufacturing goods from improved trade facilitation measures amount to US$377 billion. In their earlier study Wilson et al. (2003) show, using estimates of the effects of trade on GDP per capita, from Dollar and Kraay (2004), that the facilitation-related expansion of trade has the potential to increase average GDP per capita by 4.3 per cent in APEC countries.

Iwanow and Kirkpatrick (2007a) show, also within a gravity model approach, that trade facilitation reforms can indeed contribute to improved export performance. The study finds that both importing and exporting countries would benefit from a better trading environment, but the country that improves its customs procedures benefits most, which underscores the value of unilateral action. The authors extend the gravity model with a measure of regulatory quality and basic transport and communications infrastructure and find that other behind-the-border reforms are also needed and are often more important than on-the-border trade facilitation reforms in facilitating export growth. The authors show that welfare gains from trade facilitation reform are highest if the reform is implemented

[3] See Piermartini and Teh (2005) for a discussion on theoretical underpinnings and research questions analyzed in a gravity model framework.

along with other reforms designed to relax the supply side constraints that inhibit an economy's response to changing trade incentives. Iwanow and Kirkpatrick (2007a) conclude that:

> 'Trade facilitation reform on its own is unlikely to induce an immediate and sustained upturn in export performance in developing countries. For this to be achieved requires an integrated programme of 'second generation' reforms aimed at improving the quality of the institutional and physical infrastructure that will complement the necessary improvements in trade facilitation, and thereby enhance the economy's capacity to respond to the export market opportunities provided by trade liberalisation.'

Iwanow and Kirkpatrick (2007b), applying the version of the gravity model designed in their previous work, find that improvements in on-the-border and behind-the-border policies yield a higher return in terms of increasing manufacturing export performance in African countries than in the rest of the world. As shown in table 1, Africa's trade facilitation and business environment are below that of other continents, implying that improvements in these two areas could have a significant impact on relaxing the supply-side constraints on Africa's manufacturing sector.

Other studies that apply the gravity model methodology, examine how time delays affect international trade. Djankov et al. (2006) find that, on average, each additional day that a product is delayed prior to being shipped reduces trade by at least 1 per cent. Put differently, each day is equivalent to a country distancing itself from its trading partners by 70 km, on average. Nordås et al. (2006) analyze the relation between time for exports and imports, logistics services and international trade. In this study, time is found not only to reduce trade volumes, but more importantly lengthy procedures for exports and imports reduce the probability that firms will enter export markets for time-sensitive products altogether.

2.2. Computable general equilibrium models

Computable general equilibrium (CGE) models are simulations that combine the abstract general equilibrium structure formalized by Arrow and Debreu with realistic economic data to solve numerically for the levels of supply, demand and price that support equilibrium across a specified set of markets. That method, usually, consists of multi-market, multi-regional models that account for all linkages in the economy (for example, the link between the steel and automotive sectors) and represents a fully calibrated picture of an economy (Walkenhorst and Yasui, 2005) CGE models are a standard tool for empirical analysis, and are widely used to analyze the aggregate welfare and distributional impacts of policies whose effects may be transmitted through multiple markets, or contain menus of different tax, subsidy, quota or transfer instruments. In these models, trade

facilitation is generally represented as technical progress in trading activities, following the approach pursued by Hertel, Walmsley and Itakura (2001).

On a worldwide basis, Francois, van Meijl and van Tongeren (2004), using a modified version of the GTAP model[4] that allows for imperfect competition in the manufacturing sector and assuming a uniform 1.5 per cent reduction in trade transaction costs, estimate the benefits of trade facilitation to amount to US$72 billion. Hertel, Walmsley and Itakura (2001), likewise, use the GTAP model to show that greater standards harmonization for e-business and automating customs procedures between Japan and Singapore increase trade flows overall, between these countries as well as their trade flows with the rest of the world.

Fox et al. (2003) also using the GTAP model conclude that a removal of frictions in border crossings (delays) between Mexico and the United States would lead to a US$7 billion increase in trade, with southbound trade estimated to increase by US$6 billion and northbound trade by US$1 billion. Welfare would also increase by US$1.8 billion in Mexico and by US$1.4 billion in the United States.

Walkenhorst and Yasui (2005) also use the CGE model to quantify economy-wide gains in various regions from trade facilitation efforts in specific sectors. Importantly, the authors distinguish two kinds of effects. They argue that indirect trade transactions costs, such as longer border waiting times, are best thought of as resulting in a wasting away of the product being shipped. But direct transactions costs, such as form-filling, while being a cost to the exporter or importer, are a source of income for the form fillers. To account for this distinction, the authors model indirect transaction costs partially as a technical improvement to trading activities, while direct transaction costs are modelled as a 'tax' reflecting traders' expenditure on logistics services. Accordingly, they argue that previous CGE results of the effects of trade facilitation that have not taken account of this distinction may have been overstated. Two scenarios are considered: trade transaction costs fall worldwide by 1 per cent of the value of traded goods, and the reduction varies across countries and sectors. The scenarios produced estimates of global income gains of some US$40 billion. The largest share of these gains is attributed to indirect costs, received by developing countries.

Walkenhorst and Yasui (2003) attribute this to the fact that developing countries have, in general, less efficient border procedures and, hence, bigger potential for improvements through trade facilitation. Furthermore, the authors argue that since a larger part of developing countries' trade is in agro-food products, and a larger number of their traders are small and medium-sized enterprises, for which trade

[4] Global Trade Analysis Project (GTAP) is a global network of researchers and policy makers conducting quantitative analysis of international policy issues. The network creates a global database of economic variables which are used to construct CGE Models. For details on the GTAP model please consult Hertel, 1997.

facilitation is more important, developing countries would benefit more from trade facilitation improvements.

2.3. Microeconomic (firm-level) studies on trade facilitation

At the microeconomic level, Clarke (cited in OECD, 2005) has studied factors that affect the export performance of manufacturing enterprises in African countries using a cross country manufacturing survey. The author finds that manufacturing enterprises in countries with poor customs administrations and restrictive trade and customs regulations are less like to export. For instance, a reduction in trade and customs regulations from the level observed in the second most restrictive country (that is, the United Republic of Tanzania in his sample) to the level in the second least restrictive country (Zambia) would increase exports as a share of production by approximately 4 per cent for an average enterprise. This represents an increase in overall exports by one third, since most production is for domestic consumption.

Yoshino (2006), in a study of African exporters, finds that trade facilitation as well as other behind-the-border factors not only characterize how much manufacturing firms can export, but also characterize the geographical orientation in exports. Compared with exports within Africa, the analysis find that exports to the global market increased substantially, with electricity services, improvements in product and service quality, new capital affecting productivity, internet access, foreign ownership and trade credits contribute to reducing trade-related costs.

3. What do we learn from a decade of research on trade facilitation?

Quantitative studies seem to indicate that very few countries would lose from global trade facilitation and that developing countries have the most to gain from implementing trade facilitation measures.

Econometric studies might, however, overestimate the potential gains from trade facilitation occurring to developing countries for two reasons. First, these models assume that potential gains from trade expansion, due to trade facilitation reform, will occur to developing country exporters. This finding reflects the fact that developing countries have, in general, less efficient border procedures and, hence, a bigger potential for improvement through trade facilitation. In a highly competitive market, however, an across-the-board decrease in trade transaction costs might result in price declines and welfare gains to consumers that are often in developed countries. Second, no empirical studies provide a cost-benefit analysis of implementing trade facilitation reform as there is no comparable cross-country database related to the costs of implementing such a reform. In most studies, a reduction in trade transaction costs is simply assumed to occur as a result of implementing trade facilitation

reforms. Since some of the requirements of trade facilitation—such as, human capital capacity in the form of computer literate work force, computerized systems, functioning telecommunication system, use of IT solutions, harmonized payment system and standardized transport facilities—are partly the outcome of a country's overall level of development, costs of implementing such improvements would be highest in low-income developing countries.

The recent World Bank report '*Doing Business in 2006*' documents the wide diversity among countries in their trade facilitation and other behind-the-border policies such as business environment (table 1). It also highlights a clear positive correlation between GDP per capita and the quality of trade facilitation environment and other behind-the-border policies. For example, in sub-Saharan Africa, on average, it takes 35.6 days and 8.2 signatures from regulatory agencies to export a standard container of goods, whereas in OECD countries the same takes only 18 days to export and requires only three signatures. Similarly, in terms of business regulation, it takes 9.8 procedures and 68.3 days to start a business in Latin America and the Caribbean, as opposed to 6.2 procedures and 14.9 days in OECD countries.

Table 1. Trade facilitation and business environment in comparative perspective

Region	Trade Facilitation		Starting a business		GDP p/c $
	Time for exports	Documents to export	Duration (days)	Procedures (number)	
East Asia *	24.3	6.9	43.8	8.3	6051
Europe and Central Asia*	29.2	7.0	26.1	8.8	9290
Latin. America and the Caribbean*	22.2	7.0	68.3	9.8	8409
MENA*	24.8	7.1	38.5	9.7	6125
South Asia*	32.0	8.1	42.6	8.8	3136
OECD	9.8	4.5	14.9	6.2	33786
Sub-Saharan Africa	35.6	8.2	56.3	10.8	1993

Source: *World Development Indicators (September 2006, Edition);*
Note: ** - excludes high-income economies.*

Some indication of the cost of implementing trade facilitation reforms is provided by case studies of reforms around the world. OECD (2005) has conducted a series of case-studies that generally concluded that the costs of even the most technically demanding measures were by no means large, and observed inter-linkages between various trade facilitation measures demand the need for a coherent implementation plan. However, the study notes that overall implementation costs of specific

measures will be affected by the current level of infrastructure development in each country, which may need to be improved before a particular measure is effectively implemented.

Duval (2006) undertook a quantitative survey of trade experts on the costs and benefits of implementation of 12 specific trade facilitation measures. This study confirms that long-term savings/benefits exceed the perceived implementation costs for all measures considered. Experts ranked the adoption and use of international standards, establishment of enquiry points, trade facilitation committees and on-line publication of trade regulations and procedures as priority measures. In the field of standardization and modernization of customs procedures, the process can draw on internationally-based standards, such as the new Kyoto Convention. Furthermore, there are a number of administrative reform measures that would likely not require large-scale investments or new infrastructure projects. These include, for example, more explicit rules on payment of fees for imports and exports, and more rapid response mechanisms to adjudicate customs disputes, among others.

Despite the apparent benefits of trade facilitation reforms, implementing them in isolation is unlikely to bring significant increases in export performance in developing countries. For this to be achieved, an integrated programme of strategic interventions is required, aimed at improving the quality of the institutional infrastructure, thereby relaxing the supply side that inhibits the economy's response to changing trade incentives. To illustrate this point, it is important to note that decreases in trade transaction costs arising from trade facilitation can be analyzed as ad valorem tariff equivalents. Economic analysis describes two main types of effects of such tariffs: price and efficiency effects. Price effects can be either direct, as in payments of customs fees, port fees, rents to corrupt officials, etc., or indirect, as in costs resulting from delays and unreliability of customs clearance. Price effects increase the price of traded products over what they would otherwise be, with a generally dampening effect on the level of trade and a potentially positive effect on domestic production (OECD, 2005).

From the perspective of a trader, however, a business agreement starts with the placing of an order and ends when the buyer receives the goods and the seller receives the payment. It ultimately does not really matter for a trader if the delay and cost of his goods/monetary is caused by transport, customs or bank formalities (Hellqvist, 2003). Thus, for trade facilitation reforms to be successful in enhancing export performance, complementary policies that boost the efficiency of the whole export supply chain are vital. Efficiency effects arise due to a reduction in trade transaction costs which enables each country to specialize in the production of those goods and services which it can produce most efficiently. However, if the structure of economic activity is rigid then trade only has a modest impact on the allocation of resources across and within industries and prevents resources from moving into the most productive sectors and to the most efficient firms within sectors. Thus, as noted by Iwanow

and Kirkpatrick (2007a, b), reduction in trade transaction costs resulting from trade facilitation reforms might have a relatively small effect on export performance if not implemented along with other reforms designed to relax the export supply capacity constraints.

Walkenhorst and Yasui (2005) argue that trade transactions costs seem to be higher for agricultural and food products, fish, forest and wood products (since these products are subject to additional border procedures due to sanitary and phyto-sanitary (SPS) requirements).

These are products for which many developing countries have a comparative advantage. Quantitative studies generally show that trade facilitation improvements in agro-food industry would yield particularly high benefits. However, as previously noted, these studies do not take into account the potentially high cost of introducing certified laboratories, improving product standards etc. for demonstrating compliance with SPS standards, and also, for changing production methods throughout the industry in order to comply with food safety standards. Studies also reported that small and medium enterprises suffer most from poor trade-related practices. Since poorer developing countries have a larger share of such enterprises, trade facilitation improvements should have a disproportionably large effect on developing countries. The effects of trade facilitation improvements on exports have a strong sector-specific dimension as, for example, in some sectors customs clearance can often be conducted by intermediaries in the supply chain. Thus the key for implementing successful trade facilitation reforms lies in understanding how the supply chain works for different products and countries.

The above discussion suggests that depending on the structure of the economy as well as other country-specific characteristics, the effects of trade facilitation will diverge. The 'growth diagnostics' literature, for example, emphasizes the need to focus on policy reforms that are essential for growth, as distinct from those that are merely desirable because of efficiency gains (Hausmann, Pritchett and Rodrik, 2005; Hausmann, Rodrik and Velasco, 2006).[5] Similarly, for enhancing export performance and in order to achieve maximum efficiency gains, each country needs to identify the key binding constraints on exports and focus policy reform on lifting these key constraints. Trade policy reforms should thus be aimed at identifying possible bottlenecks in the export supply chain, which can arise not only in the custom environment, but also in transport and communication infrastructure or in access to finance. Therefore, reforms need to focus on facilitating regulation environment conducive for the entire trading activity.

[5] 'Presented with a laundry list of needed reforms, policy makers have either tried to fix all the problems at once, or started with reforms that were not crucial to their country's growth potential …. By focusing on the area that represents the biggest hurdle to growth, countries will be more likely to achieve success from their reform efforts' (Hausmann, Rodrik and Velasco, 2006:12)

Further research on the impact of trade facilitation reform should be carried out at the individual country level, in order to identify the key constraints on export growth. These studies should possibly be in the form of value chain analysis, or use a case study approach, paying special attention to the costs of implementing such reforms. The findings of these studies should be integrated into the national strategies for economic growth and poverty reduction.

4. Summary and conclusion

The policy implications arising from quantitative studies on trade facilitation reform in developing countries are many. First, all the surveyed studies confirm that trade facilitation reforms, which form the key element of the current 'aid for trade' negotiations, can increase the short- to medium-term supply elasticity of manufactured exports. Second, there is a need for complementary longer term regulatory and infrastructure reforms that will improve the quality of the institutional and physical infrastructure, thereby enhancing an economy's capacity to respond to export market opportunities. In order to achieve maximum benefits from reforms, trade facilitation improvements should be accompanied by other trade reforms that aim at relaxing export supply capacity. Thirdly, perceived benefits of trade facilitation reforms as well as necessary costs of such reform implementation will vary depending on country- and sector-specific characteristics. Thus increased aid for trade flows that are being allocated to developing countries should provide for diagnostic trade studies to be carried out in order to identify the key constraints on export growth, and the findings of such studies should be integrated into the national strategies for economic growth and poverty reduction.

The magnitude of the benefits implied in the quantitative studies on trade facilitation should be seen as the upper boundary of the actual gains that might be achieved, as investment needs, in the absence of cross-country data on the costs of implementing trade facilitation reform efforts, have not been incorporated in the quantitative analysis.

The literature indicates that developing countries can expect to benefit from trade facilitation reforms more than developed countries. This finding reflects the fact that developing countries have, in general, less efficient border procedures and, hence, a bigger potential for improvement through trade facilitation. In a highly competitive market, however, an across-the-board decrease in trade transaction costs could result in price declines and welfare gains to consumers that are often in developed countries.

Furthermore, since many of the requirements of trade facilitation—human capital capacity in the form of computer literate work force, computerized systems, functioning telecommunication system, use of IT solutions, harmonized payment system and standardized transport facilities—are likely to be

inversely related to the country's overall level of development, and costs of implementing such improvements will be higher in low-income developing countries.

Thus, unless trade facilitation reform is implemented in a comprehensive and coordinated manner as well as preceded with diagnostic trade studies, the cost of the actual implementation of the reforms might, in some countries or regions, be so high that they will rule out potential benefits.

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V. Trade Reform and Wages: A Case Study of South Africa's Manufacturing Sector[1]

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Abstract

The empirical literature examining the impact of free trade policies on economic performance is inconclusive. This paper contributes to this open debate by examining the trade reform experience of South Africa. Using annual industry-level data covering the entire reform period from 1994 to 2004, we investigate the impact of the reductions in nominal tariff rates (NTR) on the growth rates of productivity and wages in the manufacturing sector. Our results suggest that the cuts in NTR were associated with increases in both growth rates. We show that these findings are robust to employing a number of productivity measures resulting from different estimation techniques. Additionally, we control for concerns regarding the endogeneity of protection, as suggested by theories of the political economy.

1. Introduction

In recent decades and in the context of deepening globalization, many developing countries adopted increasingly liberal trade policies. The latter entailed lowering protection on domestic industries by reducing trade barriers, such as tariffs, quantitative restrictions (QR), customs and other non-tariff barriers (NTB). The widespread claimed was that trade openness will boost production efficiencies by exposing local industries to international competition, and consequently stimulating higher growth rates. Following this view, many international organizations have prescribed globalization as a remedy for the developing countries' chronic economic depression. In accordance with this prescription, several countries embarked on free trade policies during the 1980s and 1990s.

[1] Gratitude is expressed to Edwards Lawrence for making the detailed tariff data available.
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There is extensive literature which examines the effect of trade liberalization on economic welfare and income distribution. The bulk of these studies are characterized by two main features. First, trade policy outcome variables, such as trade volumes of exports and imports, are used to measure the changes in trade policy orientation. A prime shortcoming in this setup is that trade flows are affected by variables other than a country's trade strategy. For instance, a country's ability to export and import also depends on its geography, institutions and infrastructure. Second, the majority of this work favours Latin American countries, with limited work on Africa. The latter can be attributed to the lack of micro data for African countries or to the fact that South America experienced earlier reforms, which started in the 1980s, relative to Africa, in the 1990s.

In this paper, we examine the economic performance of South Africa's manufacturing sector during a period of intensive trade reform. After joining the World Trade Organization in 1994, South Africa witnessed considerable reductions in tariff rates. Average NTR, which measure the rate of protection on final output, declined from 23 per cent in 1994 to 9 per cent in 2004, with large dispersions across the different manufacturing sub-industries. Using annual industry-level data covering the entire reform period from 1994 to 2004, we investigate the impact of reductions in NTR, our trade policy instrument on the growth rates of productivity (efficiency) and wages. Our results suggest that reductions in NTR were associated with increases in productivity growth rates. We show that our findings are robust to employing a number of productivity measures from different estimation techniques. Our results also support a rise in the growth rate of wages due to the witnessed tariff cuts.

In our empirical estimation, we account for concerns regarding the endogeneity of protection, as theories of political economy suggest that labour and product market concerns can influence a country's trade policy orientation. We argue that our results do not suffer endogeneity bias, as we consider the effect of one-period lag tariff rates on growth in productivity and wages, as opposed to contemporaneous tariffs. Additionally, we use industry fixed effects as another means to address this endogeneity bias, as they control for the unobserved time invariant industry characteristics that may affect productivity, wages and tariffs.

This paper is divided into seven sections. In the next section, we describe South Africa's trade policy history. In Section 3, we outline the theatrical literature that relates trade policy to productivity, wages and employment. Section 4 describes our empirical methodology, while Section 5 presents the data used in the paper. Section 6 discusses our results and finally, Section 7 concludes.

2. South Africa's trade history

Until the 1970s, South Africa was firmly oriented towards import substitution industrialization. The first shift away from this trade regime came in 1972 with the relaxation of QR and the introduction of an export development assistance scheme. However, the overall trade policy remained protectionist.

In the mid-1980s, South Africa faced balance-of-payment pressures arising from a debt crisis, which led to the implementation of import surcharges that offset the effects of the QR relaxation that continued into the 1990s and were discontinued in 1994. Moreover, in 1990, the general export incentive scheme (GEIS) was introduced granting subsidies to exporters based on their export value. Belli et al. (1993) find that by the end of the 1980s, the coefficient of variation of South Africa's tariffs was the second-highest among 32 developing countries.

In April 1994, the first post-apartheid government led by the African National Congress (ANC) party was democratically elected. This coincided with the initiation of multilateral trade reform, with the WTO agreeing on the phase-down tariff plan offered by South Africa in the GATT/WTO Uruguay Round (1994). Consequently, during the period starting 1 January 1995, South Africa experienced considerable reductions in protection rates.[3] Additionally, the same period was associated with the decision to phase out the GEIS, and by 1997 the export subsidy provided under this programme was terminated.[4]

3. Literature review

3.1. Trade openness and productivity

Tybout and Westbrook (1995) summarize the theoretical arguments predicting the relationship between trade openness and productivity. They outline three channels through which the positive impact of increased import competition on productivity can be felt, namely: scale effect, share reallocation effect, and residual effect. Productivity gains under the former channel take place when trade openness improves scale efficiencies which occur when trade openness raises foreign competition, which in turn increases the price elasticity of demand, forcing domestic producers to reduce their average costs. Additionally, increased competition under free trade policies can boost industrial productivity through the share reallocation effect. An industry-wide increase in efficiency is witnessed if trade reform leads to an increase in the market share of the more efficient firms and the exit of the less efficient ones. Finally, a residual effect can occur if trade policy positively affects firm productivity through unobserved channels, such as innovation, spillovers, reducing agency costs or technological progress.

[3] A more detailed characterization of the tariff schedule will be provided in Section 5.
[4] See Bell (1997) for a more detailed description of South Africa's Trade Policy.

Examining the empirical literature studying the relationship between productivity growth and tariff reductions provides no consensus on the nature of the relationship. Harrison (1994) finds an insignificant effect of tariff cuts on productivity growth in Côte d'Ivoire, while Tybout and Westbrook (1995) find that tariff reductions decreased productivity growth in Mexico by worsening scale efficiency. Results from Currie and Harrison (1997) suggest the opposite as they find a significant positive effect of tariff reductions on productivity growth in Morocco. This effect is also confirmed by findings from Ferreira and Rossi (2003) and Muendler (2004) for Brazil. The evidence of the effect of tariff cuts on productivity levels seems more consistent, as Pavcnik (2002), Topalova (2004) and Fernandes (2007) find that tariff reductions were associated with significant increases in productivity in Chile, India and Colombia.

3.2. Trade openness and workers' wages

In this section, we start by outlining trade theories which predict a relationship between trade openness and wages under the assumption of perfect competition. The conventional Heckscher-Ohlin (H-O) model predicts that owners of a country's abundant factors of production gain from trade, whereas owners of the country's scarce factors lose. In the context of developing countries, which have an abundance of unskilled workers relative to skilled labour, the former group are thus the ones expected to benefit from trade reform. Accordingly, the H-O model predicts a heterogeneous effect of trade policy on wages based on workers' specific characteristics (skill level). These predictions, stipulated by the H-O model, can subsequently affect industry wages if sectoral differences in worker-specific characteristics persist.

In contrast to the H-O model, which constitutes a long-run framework by assuming perfect factor mobility, a more short- and medium-run context is provided by the specific factor model (SFM) and the Ricardo-Viner model, respectively, which assume labour immobility. In these models, wages become relatively more depressed in sectors which face more severe liberalization measures. As imports increase in the liberalized sector, the demand for labour decreases, and given the underlying assumption of labour immobility, workers face either reduced wages or layoffs. In this set-up inter-industry wage differentials can be explained as transitory differentials due to labour immobility in the short and medium run.

Abstracting from a world of perfectly competitive markets, models with imperfect competition, namely, the efficiency wage theory and models of rent-sharing with collection bargaining, offer alternative mechanisms through which free trade policy can affect industry wages. Under the former set of models, trade reforms positively affect industry wages if trade-induced productivity enhancements are channelled to workers in the form of higher wages. Under the rent-sharing models,

firms experiencing higher protection are able to accrue more profits. In this framework, industries with stronger union representation can capture portions of these rents in the form of higher wages for their workers.

Currie and Harrison (1997) are among the first ones who attempted to empirically test the relation between tariffs and industry wage premiums. Focusing on Morocco, they find that tariffs had an insignificant effect on wages. Revenga (1997) shows that the Mexican tariff reductions were associated with significantly lower wages. Goldberg et al. (2005) and Pavcnik et al. (2004) also examine the evolution of industry wage premiums following the nominal tariff cuts in Colombia and Brazil. Goldberg et al. (2005) find that industries facing higher tariff cuts experienced larger reductions in wages in Colombia, while Pavcnik et al. (2004) find instead tariffs to be insignificant in explaining period variations in wage premiums in Brazil. Similar work is conducted on India (Mishra and Kumar, 2005; Vasudeva-Dutta, 2004) and Mexico (Feliciano, 2001). With respect to India, results from the former work support that trade liberalization induced higher firm productivity leading to higher wage premiums. Vasudeva-Dutta (2004), using a different dataset, finds the opposite. Results on Mexico reported in Feliciano (2001) are similar to those reported for the Brazilian experience, suggesting an insignificant tariff-wage relationship.

4. Empirical methodology

4.1. The effect of tariffs on productivity growth

In this section, we outline the empirical methodology employed to investigate the effect of tariff reductions on productivity growth. We implement the commonly used two-stage estimation procedure. In the first stage, we estimate a measure of productivity growth and in the second stage, we regress the latter on NTR. Given the widely documented challenges associated with estimating productivity, we present results from a number of econometric models from which we obtain different productivity estimates. These methodologies are outlined as follows:

To estimate productivity, we start by assuming a production function for gross output in an industry *j* at time *t* of the following form:

$$Y_{jt} = A_{jt} F\left(K_{jt}, L_{jt} M_{jt}\right) \qquad (1)$$

Kjt and *Mjt* are the quantities of capital and intermediate input, respectively, used to produce output *Yjt. Ljt* is the number of workers, and *Ajt* represents the industry-specific productivity, also known as

total factor productivity (TFP). Taking logs of both sides[5] and then differentiating with respect to time, we can re-express (1) as:

$$dy_{jt} = \frac{K}{Y}\frac{dY}{dK}dk_{jt} + \frac{L}{Y}\frac{dY}{dL}dl_{jt} + \frac{M}{Y}\frac{dY}{dM}dm_{jt} + da_{jt} \quad (2)$$

$$dy_{jt} = \varepsilon_k dk_{jt} + \varepsilon\iota dl_{jt} + \varepsilon_m dm_{jt} + da_{jt} \quad (3)$$

where *dyjt*, *dkjt*, *dmjt* and *dljt* denote the growth rates in the real output, real capital, real intermediate input and employment in an industry *j* at time t. *εz* is the elasticity of output, *Y*, with respect to an input *Z* where *Z* = *K*, *L* or *dajt* is the growth in productivity. The common approach to estimate *dajt* is to treat equation (2) as a regression equation, estimate the three elasticity parameters and compute *dajt* as the regression residual which captures the variation in output growth that is not explained by the variations inputs. We refer to this measure of productivity growth as OLS-Productivity. Despite the attractiveness and the simplicity of this procedure, it involves estimating three parameters for output elasticities using data that is subject to differing degrees of endogeneity. The latter stems from the fact that inputs and outputs are simultaneously determined by the firm, accordingly the technical change term, *dajt*, is correlated with the choice of inputs. Ignoring the latter concern leads to biased estimates.

The common technique to overcome this problem is to use the instrumental variable approach and find instrumental variables (IVs) that are exogenous to the error term, *dajt*, meaning that these IVs are correlated with inputs but independent of any demand or productivity shocks that affect the firm. It is not easy to find IVs that satisfy such conditions. Accordingly, we resort to panel-data estimation methods. We use the Arellano and Bond (1991) difference-GMM estimator which employs lagged levels of inputs as IVs for the changes in inputs. We refer to the productivity growth estimate from this technique as DIFF-productivity.

A more traditional approach to estimate productivity growth is to use the growth accounting procedure and compute what is known as the Solow residual, Solow-productivity. The latter approximates output elasticities by factor shares:

$$dy_{jt} = \alpha_k dk_{jt} + \alpha\iota dl_{jt} + \alpha_m dm_{jt} + da_{jt} \quad (4)$$

where *αl* and *αm* are the shares of nominal labour remuneration and intermediate inputs, respectively, in the nominal value gross output, computed from the data. Regarding the share of capital, *αk*, it is

[5] Lower case letters indicate log the variable. y = log(Y).

computed as the ratio of the return on nominal capital to nominal gross output. To compute the latter ratio, one needs to estimate an unobserved return to capital, *r*. In line with other work (Aghion et al., 2006; Fedderke et al., 2006; Ferreira and Rossi, 2003) we approximate *r* by the long-run nominal interest rate less expected inflation plus depreciation.[6] On the one hand, this procedure is superior to the previous approach as it entails a simple computation of productivity estimates, so that it overcomes concerns regarding the endogeneity bias associated with the regression estimation technique. On the other hand, a prime shortcoming to this accounting decomposition is the underlying assumption of perfectly competitive markets which implies that under this empirical specification, producers are assumed to have no market pricing power, that is, accrues no economic rents.

Finally, we report results using an alternative productivity measure based on the growth in labour productivity as opposed to the previously discussed measure of TFP growth. We construct this measure as the change in *ln* gross output (at constant prices) per worker, and refer to this productivity estimate as labour productivity.

Having estimated a number of productivity growth measures, we proceed to the second stage estimation in which we estimate the relationship between the latter and NTR:

$$da_{jt} = \gamma_{\tau}\tau_{jt} + \gamma_{ID}ID + \gamma_{T_D}TD + \eta_{jt} \qquad (5)$$

dajt is our measure for productivity growth: (1) OLS-productivity, (2) DIFF-productivity, (3) Solow-productivity, and (4) labour productivity. *τjt* refers to one period lag of NTR in an industry *j* at time *t.* In line with Fernandes (2007) and Topalova (2004), we estimate the effect of lagged tariffs rather than the contemporaneous values. The latter specification accounts for the possibility that productivity adjustments may not occur instantaneously. Furthermore, it partially alleviates concerns regarding the endogeneity of protection, as suggested by theories of political economy. If productivity growth increases due to tariff reductions then we expect our estimate of $\gamma\tau$ to have a negative sign. We control for industry fixed effects by including industry dummies, *ID*, which also serve to control for the endogeneity of tariffs as they capture the unobserved time invariant industry characteristics. We also include time-fixed effects, *TD*, to capture the period-related macroeconomic factors, such as privatization, foreign currency fluctuations or any other stabilization plans.

[6] For the interest rate, we use 10-year government bond yields. Expected inflation is based on the CPI and is computed using the Hodrick Prescott filter. The depreciation rate is set to 10 per cent, which is equivalent to an average service life of 10 years. Our results are also robust to using a rate of 5 per cent.

4.2. The effect of tariffs on the growth of wages

$$d\omega = \theta_\tau \tau_{jt} + \theta_{ID} ID + \theta_{TD} TD + \varsigma_{jt} \quad (6)$$

To estimate the effect of tariffs on the growth in worker wages, we estimate equation (6). $d\omega jt$ is the change in log -- the ratio of real worker compensation to the number of workers employed in an industry *j* at time *t*. Similar to equation (5), we use one-period lagged tariffs as our dependent variable and we control for industry and time-fixed effects.

5. The data

In this paper, data on NTR, which measure protection on final output, was derived from Edwards (2005).[7] The data covers 28 manufacturing sectors at the ISIC-3 digit level, for the period 1988 to 2004. For our purpose of investigating South Africa's performance during the trade reform period, we only consider data from 1994 to 2004. Table 1 summarizes the tariff data. Simple average NTR decreased from 23.07 per cent in 1994 to 9.39 per cent in 2004. Figure 1 plots the yearly simple average tariff rates. Notably tariff rationalization was intense at the start of the reform period, but by 1999 protection rates were as low as 50 per cent of their initial 1994 pre-reform levels. Tariff cuts were not uniform across sectors. For instance, the wearing apparel industry experienced the highest tariff reductions of 44 percentage points, whereas the paper products industry witnessed the lowest cuts of 5 percentage points. Figure 2 plots the yearly standard deviations of NTR, and the declining trend, which started in 1994, indicates the decreasing dispersion in the cross-industry levels of protection as they all approach commonly low levels.

[7] We use the tariff data computed using scheduled tariff rates and inclusive of surcharges. A detailed description of the methodology adopted for the tariff calculations is provided in the paper.

Table 1. Tariff data (Percentage)

		Nominal tariff rates			
ID	**Industry**	**1994**	**1999**	**2004**	**Δ**
5	Food	22.80	13.53	11.19	-11.61
6	Beverages	36.38	13.94	12.29	-24.10
7	Tobacco	46.15	33.27	29.66	-16.49
8	Textiles	41.20	29.57	16.53	-24.67
9	Wearing apparel	75.07	52.38	31.02	-44.04
10	Leather and leather products	25.85	13.13	11.36	-14.49
11	Footwear	47.87	25.34	22.40	-25/48
12	Wood and wood products	14.77	8.93	8.67	-6.10
13	Paper and paper products	11.42	7.11	6.46	-4.96
14	Printing and publishing	16.12	4.89	4.69	-11.43
15	Coke and refined petroleum	12.62	4.60	3.37	-9.24
16	Basic chemicals	8.30	1.97	1.67	-6.63
17	Other chemicals	16.40	5.09	4.35	-12.05
18	Rubber products	19.04	12.53	10.57	-8.48
19	Plastic products	19.85	12.00	9.65	-10.20
20	Glass and glass products	17.23	7.51	7.31	-9.91
21	Non-metallic minerals	15.55	5.31	5.57	-9.98
22	Basic iron and steel	8.96	4.32	3.89	-5.07
23	Basic non-ferrous metals	8.80	2.58	1.98	-6.82
24	Metal products	18.52	8.05	7.84	-10.68
25	Machinery and equipment	10.46	3.99	3.44	-7.02
26	Electrical equipment	18.48	8.12	7.15	-11.33
27	Communication equipment	24.13	3.51	2.73	-21.40
28	Professional and scientific equipment	12.45	0.33	0.33	-12.12
29	Motor vehicles	26.12	18.28	14.64	-11.49
30	Other transport equipment	12.35	1.47	0.85	-11.50
31	Furniture	32.18	17.60	17.37	-14.82
32	Other manufacturing	26.89	6.61	5.82	-21.07
	Mean	*23.07*	*11.64*	*9.39*	*-13.68*
	Standard deviation	*14.97*	*11.53*	*7.98*	

Source: Author

To estimate productivity and wages per worker, we use industry-level data on gross output, capital, employment, intermediate input and worker compensation from the input-output table provided by QUANTEC. The data is also provided at the 3-digit ISIC classification and is available at both current and constant 2000 prices. In Figure 3, we plot the evolution of labour productivity. The latter is computed as the simple average of *ln* the fraction of real gross output at 2000 prices to total employment for each of the 28 manufacturing sub-industries. The graph shows an evident increase in worker productivity. Moreover, Figure 4 demonstrates the period rise in the year simple average of real compensation per worker.

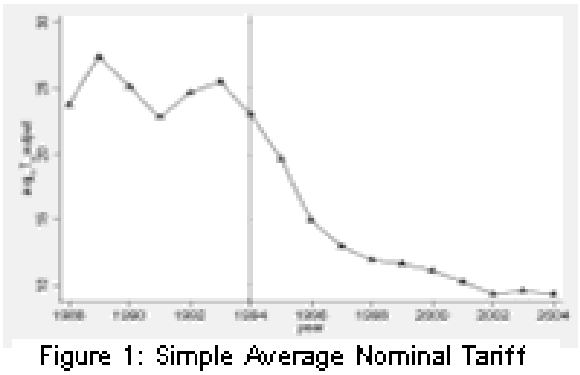

Figure 1: Simple Average Nominal Tariff Rates

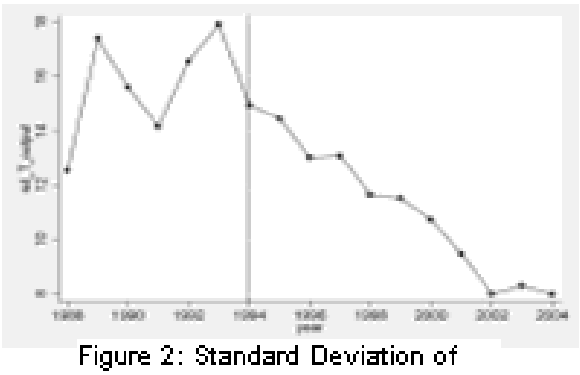

Figure 2: Standard Deviation of Nominal Tariff Rates

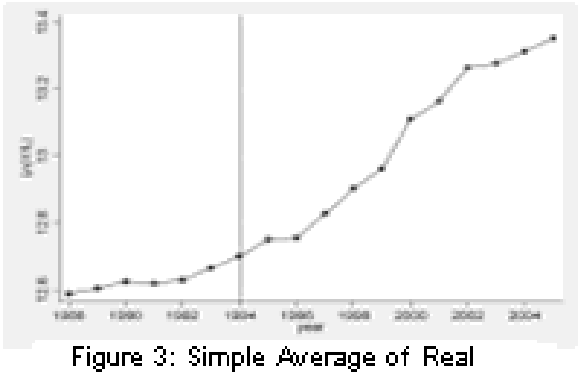

Figure 3: Simple Average of Real Output per Worker

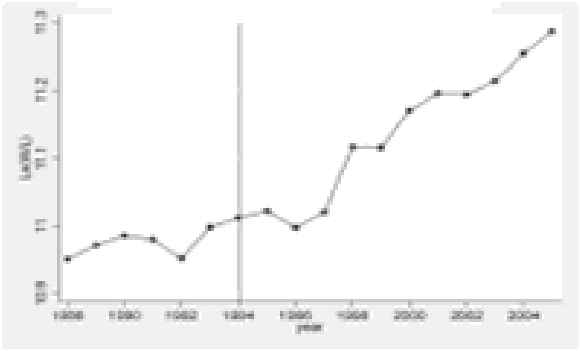

Figure 4: Simple Average of Real Compensation per Worker

$$L_n\left(\frac{\gamma}{L}\right)$$

$$L_n\left(\frac{\omega}{L}\right)$$

Source: Author

6. Results

Table 2 displays the results from estimation equation (5) where we regress our four productivity growth measures on the lag of NTR. As noted in Section 4, we include both industry and fixed-time effects. We also control for trade flow variables where in columns (1-a) to (4-a) we control for the lag of real values of exports and imports. Alternatively, in columns (1-b) to (4-b) we control for the lag of the ratio of trade openness, measured as the fraction of imports and exports to GDP. The latter trade flow controls ensure that our tariff variable does not capture an omitted variable bias. The negative and significant coefficient on the NTR variables is confirmed under all specifications, indicating the negative relationship between protection and productivity growth. To interpret these findings and based on the results in column (3-b), a one percentage point reduction in NTR translates to an approximately 0.085 per cent increase in productivity growth. This negative relationship between

protection and productivity is also confirmed in columns (4-a) and (4-b) in which we relate NTRs to growth in labour productivity. A one percentage point reduction in NTR raises the growth rate of output per worker by 0.336 per cent.

In table 3, columns (1-a) and (1-b), we report our findings from regression equation (6) in which we estimate the impact of NTR on the growth rate of wages per worker. The negative association between protection and wages is confirmed by the negative coefficient on NTR. Based on column (1-b), a one percentage point reduction in tariff rates raises the growth rate of wages per worker by 0.340 per cent. In light of our previous results, regarding the effect of NTR on productivity, this finding supports the efficiency wage hypothesis under which higher wages result from increases in efficiency. To elaborate the magnitude of our findings, based on our results, the 13.7 percentage point period reduction in average NTR in the manufacturing sector translates to a 1.16 per cent (-0.085*13.7) increase in productivity growth rate, a 4.6 per cent (-0.336*13.7) increase in the growth rate of output per workers, and a 4.6 per cent (-0.340*13.7) increase in the growth rate of worker wages.

Table 2. Impact of NTR on productivity growth
Dependent variable: Productivity growth

	(1-a) OLS	**(1-b) OLS**	**(2-a) Diff**	**(2-b) Diff**	**(3-a) Solow**	**(3-B) Solow**	**(4-a) Labour**	**(4-b) Labour**
Lag NTR	-0.035+	-0.042*	-0.097*	-0.114*	0.091	-0.085*	-0.384*	-0.0336*
	(0.020)	(0.020)	(0.046)	(0.049)	(0.038)	(0.039)	(0.165)	(0.166)
Lag in exports	-0.005		-0.003		0.002		0.036	
	(0.003)		(0.007)		(0.006)		(.0027	
Lag in imports	0.001		0.009*		0.007		).030	
	(0.003)		(0.004)		(0.004)		(0.020)	
Lag openness		-0.006		-0.008		0.011		0.077*
		(0.004)		(0.007)		(0.008)		(0.030)
Observations	308	308	3080	308	308	308	308	308
R-squared	0.26	0.27	0.12	0.11	0.18	0.18	0.18	0.20
Adjusted R-squared	0.23	0.24	0.06	0.08	0.14	0.15	0.14	0.16
IV:	No	No	Yes	Yes	No	No	No	No

Source: Author.
Notes: Robust standard errors in parentheses; + = significant at 10 per cent; * = significant at 5 per cent;
** = significant at 1 per cent.
Exports and imports are trade volumes at 2000 constant prices.
Openness = (export + imports)/GDP.

Table 3. Impact of NTR on the labour market

Dependent variable	Change in *Ln* *(1-a)*	Compensation per worker (1-b)
Lag NTR	-0.327*	0.340*
	(0.139)	(0.140)
Lag in exports	0.007	
	(0.024)	
Lag in imports	0.012	
	(0.022)	
Lag openness		0.002
		(0.026)
Observations	308	308
R-squared	0.11	0.11
Adjusted R-squared	0.07	0.07

Source: Author.

Notes: Robust standard errors in parentheses; + = significant at 10 per cent; * = significant at 5 per cent; ** = significant at 1 per cent.
Exports and imports are trade volumes at 2000 constant prices.
Openness = (Export + imports)/GDP.

7. Conclusion

In this paper, we examine the performance of South Africa's manufacturing sector during a period of intensive trade reform. Using industry-level data for 28 manufacturing industries and covering the entire trade reform period 1994 to 2004, we investigate the effect of the witnessed sizeable reductions in NTR on the growth rate of productivity and wages. In line with the new empirical literature, we use tariffs as our measure of changes in trade policy, as opposed to the more traditional approach of employing trade flow variables. Our findings support increases in both the growth rates of productivity and wages due to the witnessed cuts in NTR.

To account for the widely documented challenges regarding estimating productivity, we show that our findings are robust to the use of four different productivity estimates. We also argue that our results are not driven by endogeneity bias as we control for the latter by employing the lag of tariff rates in our estimation procedure. Furthermore, we use industry fixed effects to control for the unobserved time invariant industry characteristics that may affect both productivity and tariffs.

Finally, we note a couple of limitations to our work. First, our use of industry level data does not enable controlling for firm and worker-specific characteristics in our estimations, which is better addressed using micro-level data. This might give rise to some omitted variables bias. Secondly, this work focused on one side of the trade debate, as it only addresses the impact of import competition on the product and labour markets in South Africa's manufacturing sector. Another important channel

that should be examined is the economic gains attributed to increases in export capabilities. Investigating this issue would be an interesting avenue for future research.

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VI. Determinants of Export Performance in the Philippines[1]

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Abstract

This paper determines the factors affecting the export performance of firms in three main manufacturing sectors in the Philippines. Specifically, firm-level characteristics, such as firm size, firm age and foreign affiliation, are identified and statistically tested to determine whether or not they affect a firm's capability to export. The paper uses a novel econometric model, which specifically addresses fractional response behaviour, and estimates the said model using a modified quasi-maximum likelihood procedure. Among the firm-level characteristics tested, foreign affiliation plays a highly important role in a firm's propensity to export in the Philippines.

Key words: export determinant, firm-level characteristics, technology factors

1. Introduction

The importance of exports as an economic activity and a driver of growth has long been established in various research endeavours. Issues addressed in these studies include quantifying the contribution of exports to economic growth, designing appropriate trade and industrial policies, and identifying macroeconomic factors that affect trade performance.

As international competition became more innovation- and knowledge-based, understanding trade performance went beyond the parameters of the comparative advantage paradigm and stressed the role of technology in affecting international competitiveness (Mytelka, 2000). Focusing on the role of entrepreneurs in shaping international competition, a critical observation made is that all firms face the same macroeconomic condition, yet these firms respond and perform differently in their export activities. This suggests that there must be firm-specific characteristics that significantly influence a firm's capability to perform in the world market. Hence, research direction shifted towards understanding the different forces that influence firm-level performance. This research interest was

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further facilitated by the increasing availability of large micro-datasets but is unfortunately limited to developed countries (Wagner, 2001; Sterlacchini, 2001).

This objective of this paper is to contribute to the meagre but growing literature on firm-level export performance of developing countries using the Philippines as the empirical platform. As most trade-related studies in the Philippine setting are conducted against a macroeconomic setting, this research paper focuses on firm-level behaviour and poses the question "what are the factors affecting the export performance of local firms?" The analysis is based on a firm-level dataset culled from the Investment Climate Survey conducted by the Asian Development Bank in 2003. The paper is outlined as follows: Section 1 provides a brief introduction and rationale of the paper. Section 2 outlines the theoretical underpinnings of export performance, while Section 3 presents the empirical model and the results of the analysis. Section 4 concludes.

2. Theoretical underpinning of trade and technology

2.1. Evolution of concepts

The trade pattern is largely explained by comparative cost advantages and relies on cost or price competitiveness. Early trade theorist David Ricardo emphasized the relative labour productivity differentials as the basis of trade and proved that each country has a comparative advantage—the ability to find some good it can produce at a lower relative cost, and thereby trade with other countries. This notion was extended in the Hecksher-Ohlin model where countries focus on two factors of production—labour and capital—and employ the same production functions but have different factor endowments. The difference in relative factor endowment generates trade activities. Both models treat technology either as a costless activity, or as being irrelevant in the production and trading process. The recognition of human capital as the "third" factor of production becomes a significant contribution to the neo-factor trade theory, but still maintains the static view of the Hecksher-Ohlin model.

As the conceptualization of trade theories has become more rigid, some of the assumptions adopted in traditional trade models, such as constant returns to scale and product homogeneity, have been relaxed. This resulted in the development of strategic trade models, where scale economies and oligopolistic competition have become important factors for determining trade patterns. This view was modified and embraced by the proponents of neo-technology trade theory where the emphasis is placed on the role of innovation in creating new markets and conferring cost advantages on the innovating nation. Moreover, although technology has become a crucial determinant of international trade and differences in technologies, today it is tastes that form the basis of trade. Using the ideas espoused by Posner (1961) and Vernon (1966), exporting activity is currently determined by technological differences, which constantly evolve. A major prediction of the model is that

technologically-advanced nations will export new products and import standardized ones. However, its limitation lies in failure to account for a catch-up process between rich and poor countries. Moreover, since learning modes are not incorporated, technology cannot be treated appropriately.

As the industry-level approach failed to take into consideration the different market conditions and the capabilities of firms within the same industry, this became the starting point for the proponents of the capability framework, as influenced by Austrian economist J. Schumpeter. Schumpeter places great value on the capitalist business enterprise and regards it as his core economic agent. He stresses the importance of the monopolistic and oligopolistic market structures believing that large firms are engaged in more innovative activities than small ones. He also underlines the importance of non-price factors in competition, claiming that when these factors are incorporated in models, which solely use price as a competitive leverage, the results can be significantly different. Dynamic changes are the expected outcome that are able to raise competition to the level of new products, new source of supply, new process and new type of organization. Ultimately, it is the firm, not the industry, that decides if it should trade or not.

The presentation of Porter's five-forces model supplements the paucity of concepts in understanding industry-level competitiveness (Porter, 1980). The model developed by Porter provides a framework for understanding competition at industry level and identifies five factors that drive industry competitiveness. These include potential entrants, buyers, substitutes, suppliers, and industry rivals. Based on knowledge of these forces, the model provides an extensive understanding of an industry and identifies factors that interrelate and influence the market participants. The model suggests that firms wishing to gain competitive edge over their rivals need a clear understanding of the industry where they operate. However, it is partly misleading to use an industry-level approach for understanding export performance. It must be noted that competitive advantage is a necessary condition to export and become a global market participant. However, acquiring such knowledge does not necessarily lead a firm to export. Further, it has been observed that some firms perform badly in attractive industries, while others do well in declining industries. This merely stresses the point that understanding export performance needs to extend beyond the industry-level approach.

The literature on capability highlights the importance of the firm as the core player in the acquisition and assimilation of new technology. Technical change is regarded as an activity that can be generated by firms involved in a continuous search and learning process that could have varying results, ranging from the adaptation and improvement of chosen technology to the generation of an entirely new technology. These skills and knowledge are firm-specific and necessary in order to acquire, assimilate, adapt, change and create technology. Enabling the firm's performance is a network of economic actors, such as other firms, suppliers, institutions and the government.

2.2. Determinants of export performance

Firm characteristics have been identified as possible determinants of export performance. Some studies have shown that from these characteristics, competitive advantages are built and economic rents are realized. There are also other studies which show that firms of the same industry differ in their performance, enactment of technology policy and corporate strategies, or use of technology (Lefebvre and Lefebvre, 2001). These studies simply point to one significant implication—analysis of trade performance cannot be restricted to country or industry level, but has to include firm level, where the importance of firm-specificity in affecting export activities cannot be neglected or underestimated.

The relationship of ***firm size*** and exports is traditionally considered positive, that is, "to compete globally, you have to be big" (Chandler, 1990) as cited by Lefebvre and Lefebvre, 2001). Larger firms are generally regarded as more capable of coping with the large investments and high risks associated with exporting. Several studies support this view empirically (Aitken, Hanson and Harrison, 1997; Roberts and Tybout, 1997; Hirsch and Adar, 1974; Bernard and Wagner, 1996; Wignaraja and Ikiara, 1999; and Lall and Kumar, 1981) as cited by Dholakia and Kapur (1999). However, some researchers observed a negative or no relationship between firm size and exports. An explanation for this kind of relationship is the possibility that a non-linear relationship might exist between firm size and exports. Above a certain threshold, size no longer plays a significant role, as empirically observed in Germany (Wagner, 2001). Another explanation offered regarding the non-linear relationship between size and exports is that the advantages of exporting may not be totally attractive for large domestic firms that might be oriented towards the domestic market and capitalize on domestic monopoly (Wakelin, 1998).

Firm age and exports may similarly produce conflicting relationships. As the firm matures, it may have accumulated knowledge stock from which to build its capabilities and provide it better leverage to compete in the world market. However, core capabilities can become more rigid and younger firms may be more flexible, aggressive and proactive when catering to world demand (Lefebvre and Lefebvre, 2001).

Human capital is strongly related to technological capabilities—an aspect that needs to be developed by firms to remain competitive in the export market. This is usually represented by the share of skilled employees to total employment and/or the number of employees with degrees in either mathematics or science. The neo-technology model suggests a strong and positive relationship between human capital and export propensity because educated and skilled manpower possesses certain abilities that make it easier to establish and maintain certain contacts with foreign markets. On the other hand, the Hecksher-Ohlin model predicts that for countries with abundant unskilled labour, investment in

skilled labour would be costly and have negative effects on exports. This is empirically tested and shown for Brazilian and Indonesian firms, where the human capital variable yielded a statistically negative relationship with export performance (Willmore, 1992; and Ramstetter, 1999) as cited by van Dijk, 2002.

Research and development (R&D) expenditure is the often-used proxy variable for technology and is expected to influence export performance positively, as empirically tested in Brazil (Willmore, 1992) and Germany (Wagner, 2001). However, some studies yielded negative results between R&D and export performance, specifically in India (Lall and Kumar, 1981) and Canada (Lefebvre and Bourgault, 1998). The mixed empirical results could be traced to the fact the R&D is simply a partial measure of technology and does not account for incremental improvements in products and processes. Further, the importance of R&D on export intensity differs across sector and country; hence, it may have a strong influence on Germany, but a weak impact on Canada.

Training of workforce is a proxy measure of technological capability and is expected to have a positive relationship with export performance. Skill training enhances learning and accumulates additional skills which can improve productivity and export propensity.

Foreign interest in a local firm and export activities are expected to have a positive relationship, mainly because of the multinational's (MNE) access to superior production, technology and management know-how, which a local firm can acquire. Further, MNEs have sophisticated international networks which facilitate the export process. The studies on Indonesian firms validate this hypothesis (Ramstetter, 1999; and Willmore, 1992) as cited by van Dijk (2002).

Capital intensity is often included as a determinant of a firm's export performance. The Hecksher-Ohlin model predicts that capital-intensive industrialized countries export more, while the opposite is expected for labour-intensive developing countries. Another explanation why a more capital-intensive firm may have a higher propensity to export is due to past innovations and knowledge that capital embodies, reflecting economies of scale (van Dijk, 2002).

3. Empirical analysis

3.1. Model estimation

Using the concepts guided by the capability literature and stressing the importance of the firm as a core economic agent, the firm-level export function is specified as

$$EXPORTP2 = \mathrm{F}(\alpha_0 + \alpha_1 RSIZE + \alpha_2 RSIZE2 + \alpha_3 SKILLED + \alpha_4 RNDSALES00 + \alpha_5 TRAINING + \alpha_6 MNC + \alpha_7 CAPINTENSITY + \alpha_8 AGE + \alpha_9 AGE2)$$

where

Variable	Definition
EXPORTP2	Export performance
RSIZE	Relative firm size
RSIZE2	Square of relative firm size
SKILLED	Skilled manpower
RNDSALES00	R&D expenditure
TRAINING	Skill training
MNC	Foreign affiliation
CAPINTENSITY	Capital intensity
AGE	Firm age
AGE2	Square of firm age

EXPORTP2 represents the export performance of the firm, defined as export/sales. This value ranges from 0 to 1.

RSIZE represents the relative firm size, defined as the number of employees in a firm *j*/total number of employee in sector *I*, where firm *j* belongs. A larger firm, relative to the industry where it belongs, is expected to influence export performance positively since a big workforce is indicative of the firm's capability to produce a high production level and meet international demand.

SKILLED represents the share of skilled workers to total workers in firm *j*, where skilled workers include management, professional and skilled production workers. A large pool of skilled workers is expected to have a positive impact on export performance across all sectors due to higher labour productivity associated with skilled manpower.

RNDSALES00 is the share of R&D expenditure to total sales. A higher proportion of sales allotted for R&D activities is expected to influence export performance positively. Investment in R&D is also expected to improve the knowledge and skill base of firms, and thus make them more capable of withstanding the pressures of international competition.

TRAINING is a dummy variable where *1* represents the firm offering formal training to permanent employees, while *0* otherwise. This partly measures the quality of human capital where regular training of employees improves the quality of work and subsequently, export performance.

MNC is a dummy variable representing the foreign affiliation of local firms. A value of *1* is assigned if the firm has foreign equity participation of more than 50 per cent, while *0* otherwise. A high degree of foreign affiliation among local firms is expected to influence export performance positively, where foreign participation is regarded as an important source of knowledge and technology in developing countries.

CAPINTENSITY is defined as capital stock/labour cost, where capital stock is the sum value of machinery and equipment, land, building and leasehold improvement, while labour cost is the sum of wages and salaries, allowances and bonuses. Higher capital intensity is expected to affect export performance positively assuming that technology and knowledge, favourable to local firms, are embedded in machinery and equipment.

AGE represents the years of operation. A mixed effect is expected for the age variable. The exports of an older firm are expected to be better since it takes years to learn about the market it caters to. A young firm, on the other hand, may be able to penetrate the export market as effectively as an older firm because it is better able to keep up with the fast pace of technology change. Further, a younger firm may enjoy production flexibility, such as drastic changes in production lines and concepts, which an older firm cannot afford.

3.2. Data and methodology

The research uses data from the firm-level survey carried out by the Asian Development Bank in collaboration with the World Bank and the Philippine National Statistics Office (NSO). The survey was conducted in 2002 to analyze the investment climate and productivity performance of local firms during the period 2000-2002. A total of 716 firms were surveyed across key urban areas using stratified simple random design. Firms belonging to the following four specific industries were the focus of the survey: food and food processing, textiles, garments, and electronics and electrical

machinery. A frequency weight, determined by the NSO, is applied to make the survey sample representative across the population size.

The Asian Development Bank survey was conducted to obtain information to better understand and improve the investment climate in the Philippines, and also to explore its effect on business performance. Key questions regarding company profile, finance, technology, relations with other businesses, government regulation, contract enforcement, labour relations and international trade were raised in a two-part questionnaire.

For the purpose of this paper, information on sales, export level, foreign equity and the like were extracted from the survey. Some business units, however, failed to fill out the survey form appropriately and completely. Garment and textile firms were combined to form the clothing sector, hence the three major sectors classified here include food processing, clothing and electronics.

3.3. Empirical procedure

Studies on the determinants of export performance use either ordinary least squares (OLS), a two-step model, or a one-stage model, as estimation procedures. However, some criticisms arise from the use of these estimation procedures (Wagner, 2001). The OLS estimation is not appropriate when dealing with export performance behaviour, since it does not take into account the restriction, by definition, of export performance, that is, $0 \leq EXPN \leq 1$ where EXPN is defined as export/total sales. Studies by Wignaraja (1998, 2002) use this methodology. The second methodology involves the use of the two-step model where export behaviour is analyzed in two stages. In the first stage, the firm decides whether it will export or not. If yes, the model goes on to the second stage and determines the proportion it will export from the total sales/production (Wakelin, 1998; Sterlachinni, 2001; and Nassimbeni, 2001) as cited by van Dijk (2002). A major criticism of this approach is that a profit-maximizing firm does not make any distinction between the two stages, and simultaneously decides if and how much to export.

In the one-stage model, export behaviour (with one equation) is analyzed using both exporting and non-exporting firms, and estimations are based on the Tobit procedure (Wagner, 1995; Kumar and Siddharthan, 1994; Lefebvre et al., 1998**)** as cited by Sterlacchini, 2001). A criticism of this procedure is the failure of Tobit to recognize the endogenous variable that is bound by *0*, or positive by definition. Although, the Tobit estimation is more appropriate, if the value of the variable is below the lower limit, such values are not detected due to data censoring.

Recent developments in econometric literature experimented with estimation procedures dealing with fractional response, of which export performance is qualified (fraction of sales that is exported). The model of Papke and Wooldridge (1996) was specifically developed to deal with percentage variables bound by *0* and *1*. By expanding the literature on generalized linear models and quasi-likelihood estimation, they were able to obtain robust methods for estimation and inference with fractional response variables. The model addresses the limitations encountered in the OLS estimation (failure to recognize the limit definition), and the Tobit estimation (censoring and variables bound by the limits). It consists of the quasi-likelihood method, using Bernoulli's quasi-maximum likelihood estimator, with asymptotically robust inference for the conditional mean parameters and is relatively efficient.

The paper adopts the Papke-Wooldridge model for determining factors that affect the export performance of Philippine firms. The often-used OLS procedure is not appropriate for this type of estimation because of its failure to recognize the restrictions in the data definition (bound by 0 and 1), while the Tobit estimation is used for censored variables. The Asian Development Bank's firm-level dataset provides full information (0 < export performance < 1) on the export propensity of firms and censoring the dataset (that is, filter export performance = 0) could yield biased results. The same estimation procedure was used by van Dijk (2002) for determining the export performance of Indonesian firms. The Papke-Wooldridge model can be estimated using the statistical package STATA 9.0 under generalized linear model with Logit as the link function and robust estimators.[3] Regression analyses were conducted at industry-level, stressing the significance of sectoral variation. This means that for the same firm characteristic, it is possible that it may have a different influence on the export behaviour depending on which sector the firms belongs. Results of the econometric tests are presented in the Appendix.

3.4. Empirical results

3.4.1. Food processing sector

Using the general model, where all the possible determinants were included in the estimation, only SKILLED and MNC show a positive and significant influence of export performance, as expected. Foreign affiliation appears to be the primary source of knowledge and technology for local firms, while technical skills improve the quality of production, thereby increasing the demand for goods in world markets. Size and export performance exhibit an inverted U relation, but the z-tests are insignificant, rendering the non-linear effects of size inconclusive. Similarly, the RNDSALES00, AGE and CAPINTENSITY variables yield signs contrary to expectations, but are not significant.

[3] See Wagner (2001) for the details in estimation procedure and Papke and Wooldridge (1996) for the fractional response modeling.

An alternative, or reduced-form, model is estimated by eliminating RNDSALES00 from the original function. The rationale behind this model is the belief that most local firms hardly engage in R&D activities. While the results are similar to the general model, the level of significance of SKILLED and MNC variables increases only slightly. Obtaining the marginal effects, the results indicate that by increasing the proportion of skilled workers in the work force by 1 per cent, export performance increases by 12 per cent assuming all things are constant. Similarly, a 1 per cent increase in foreign equity participation, improves the proportion of exports to sales by 12 per cent.

3.4.2. Clothing sector

The variables MNC, RSIZE and AGE are significant with the expected signs. This means foreign interest in clothing firms is an important determinant of export performance, and firm maturity matters reflect scale economies and vintage effects. The square for AGE and RSIZE were included to test for possible non-linear effects of firm age and firm size. The z-test turns out significant with a negative sign for both squared variables. This means that the effect of age and size can be depicted by an inverted U-shape implying that at a certain threshold level, the positive effect of firm maturity and size diminishes. It implies that advantages of size and age can only be felt at a certain point, beyond which, further expansion is no longer profitable.

SKILLED, TRAINING and CAPINTENSITY did not yield significant results, while RNDSALES00 is significant, but contrary to expected signs. The result of the latter variable is similar to the one conducted by Lall and Kumar (1981) for Indian engineering firms. A possible explanation offered for the significant, yet negative, effect of R&D is that the variable is only a partial measure of technology and does not take into account incremental improvements in processes which the industry is more prone to experience. This is generally the case for developing countries where R&D is low, due to the adaptive nature of technical change (van Dijk, 2002). In the Philippine setting, a possible explanation is that clothing firms source their technology and knowledge from the capital goods they import and from suppliers of materials. Investment in R&D activities is likely to affect their core activity, given the limited financial resources.

3.4.3. Electronics sector

The variables RNDSales00, TRAINING, MNC, and CAPINTENSITY yield highly significant results, with expected signs. The paper empirically confirms that a local firm that invests in R&D and provides regular skill training to its employees, has considerable foreign influence. Moreover, a high capital per employee ratio has a higher propensity to export. Similarly, a higher R&D expenditure to sales ratio suggests that firms reinvest in learning and thus improve their performance. Also complementary training of its employees further boosts its productivity performance. Accordingly, the

foreign affiliation becomes the local firm's primary source of knowledge and network advantage. This knowledge source deepens with the accumulation of capital goods where technology is embodied. The statistical results partly confirm capital-labour complementarity, where higher capital intensity requires better-trained employees.

RSIZE, AGE, and SKILLED variables have the expected signs but are not statistically significant. Although the non-linear effect of size is also incorporated, it does not yield significant results. The variable age squared $(age)^2$ was included and turned out significant. This means that as the firm ages, the effects of cumulative learning and training improve firm performance, but after a certain age threshold, returns decline suggesting that firm experience only matters up to a certain point. Considering the rapid pace of technological change occurring in the sector, this is not surprising, since firms must continually adapt to these changes in order to grasp the profit opportunities available in the world market.

4. Summary and conclusion

This paper analyzed the different factors that could affect the export performance of firms in selected Philippine manufacturing industries. The factors identified are basically firm-specific, such as size, percentage of skilled labour to total labour, training activities, foreign affiliation, R&D activities, capital intensity and firm age. Based on the information-rich survey conducted by the Asian Development Bank in 2002, the classification of the selected manufacturing sectors stresses the importance of sectoral variation in determining the influence of these firm-specific factors on export performance. The possible relation between export performance and firm-level characteristics was tested using a novel econometric model by Papke and Wooldridge, which was specifically developed for fractional response-modelling.

The main findings of this paper are summarized as follows:

The influence of foreign affiliation is similar across all sectors—positive and strongly influential in improving a firm's export performance. The variable MNC is the only factor that tested statistically significant in all three major sectors with the expected signs. The strong positive influence of MNC on a firm's export behaviour confirms the beneficial effects of foreign participation in locally-initiated endeavours. R&D activity influences science-based firms to a great extent and confirms the belief that it is a necessary ingredient for propelling export propensity.

Development of human capital through training strongly influences the export performance for science-based sectors. This magnifies the importance of learning-by-training to improve the performance and productivity of firms (Bell, 1984). The effect of training on clothing and food-processing firms, together with the share of skilled workers across all sectors, is not conclusive.

A higher capital per worker positively influences the export performance of electronic firms, but not that of clothing and food-processing. This is reflective of the capital-intensive nature of the sector and the possibility of knowledge and technology embodied in the capital goods used by these firms.

Firm size across all sectors reveals an inverted U-shape, suggesting a non-linear relation between size and export performance. This relationship is most significant for the clothing sector. An inverted U-shape relation means that as a firm expands its operation, as measured by the number of employees relative to the industry, there is a beneficial outcome from its export activities. However, beyond a certain level of expansion, any increase in the number of firm employees will have a less-than-preferred outcome on export performance.

Firm age is an important factor in the export performance of electronics and clothing sectors. For the clothing sector, a firm's length of operation is suggestive of gains in scale economies and beneficial effects of deep knowledge in its customer base. For electronic firms, however, maturity in operations is only beneficial up to a certain point. Beyond the threshold age, experience becomes insignificant. This is a possible outcome of rapid technological changes in the sector, where a younger and more flexible firm may be able to adapt quickly to changing consumer tastes and preferences for technological advancement.

In terms of policy initiatives, the importance of local firms to be affiliated with foreign firms should be stressed. Be it in the form of foreign equity infusion, joint ventures, licensing agreements or direct investment, foreign firms carry strong network linkages with the international community which may be beneficial to local firms. This in turn better equips local firms and helps them build their capacity to trade and improves their competitiveness. As productivity and firm profits are realized, wages of workers can increase. This helps to improve their standard of living and alleviate poverty.

Investments in R&D activities and training of employees significantly improve the export propensity of electronic firms. The merits of R&D activities have long been established in various studies, even though some studies say otherwise. It is stressed, however, that R&D activities are not limited to innovative activities but can be applied to improve technological capabilities that are necessary for firms in developing countries.

Intensive acquisition of capital goods relative to increases in employment is a necessary ingredient for export performance in science-based sectors. With knowledge and technology embodied in these capital goods, local firms could benefit through improvement in productivity and efficiency.

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Appendices

Appendix 1. Estimation results for the food-processing sector

Variable	Estimation 1 General model	Estimation 2 Alternate model	Marginal effects
Constant	-4.70 (-5.56)	-5.04 (-6.39)	
Rsize	18.06 (0.25)	4.73 (0.06)	0.165
(Rsize)^2	-147.52 (-0.32)	-181.70 (-0.15)	-6.329
Skilled	**3.42*** **(2.20)**	**3.50*** **(2.31)**	0.122
RNDSales00	-54.77 (-1.14)		
Training	1.11 (1.24)	0.76 (0.90)	0.034
MNC	**1.24*** **(2.10)**	**1.64*** **(2.71)**	0.123
Capintensity	-0.00 (-0.29)	0.00 (0.26)	0.000
Age	-0.56 (-1.15)	-0.04 (-0.87)	-0.001
(Age)^2	0.00 (1.73)	0.00 (1.23)	0.000
AIC	1.82	1.81	
No. of firms	189	189	

*Note: z values are reported in parenthesis; * means significant at 95% interval.*
Source: Author's estimates.

Appendix 2. Estimation results for the clothing sector

Variable	Estimation 1 General model	Estimation 2 Alternate model	Marginal effects
Constant	-1.82 (-3.02)	-1.84 (-3.15)	
Rsize	**295.29*** **(2.55)**	**232.09*** **(2.65)**	53.93
(Rsize)^2	**-9885.13*** **(-2.46)**	**-6162.76*** **(-2.66)**	-1431.91
Skilled	-0.34 (-0.57)	-0.17 (-0.29)	-0.041
RNDSales00	**-10.11*** **(-1.88)**		
Training	0.47 (0.71)	0.38 (0.64)	0.091
MNC	**5.81*** **(4.98)**	**5.01*** **(5.60)**	0.741
Capintensity	-0.00 (-0.02)	-0.00 (-0.08)	-0.000
Age	**0.08*** **(1.80)**	**0.07*** **(1.80)**	0.015
(Age)^2	**-0.00*** **(-1.88)**	**-0.00*** **(-2.01)**	-0.000
AIC	4.06	4.04	
No. of Firms	238	265	

*Note: z values are reported in parenthesis; * means significant at 90 per cent interval.*
Source: Author's estimates.

Appendix 3. Estimation results for the electronics and electrical machinery sector

Variable	Estimation 1 General model	Estimation 2 Alternate model	Marginal effects
Constant	-8.31 (-3.70)	-5.05 (-2.79)	
Rsize	372.80 (1.68)	304.61 (1.41)	65.63
(Rsize)^2	-3734.93 (-1.43)	-3010.30 (-1.18)	-657.58
Skilled	1.29 (1.16)	1.54 (1.16)	0.23
RNDSales00	**275.56*** **(3.43)**		48.52
Training	**2.77*** **(3.31)**	**1.99*** **(2.75)**	0.48
MNC	**2.94*** **(4.06)**	**2.43*** **(2.95)**	0.52
Capintensity	**0.24*** **(3.05)**	**0.13*** **(2.29)**	0.04
Age	0.91* (2.12)	0.22 (1.15)	0.07
(Age)^2	**-0.01*** **(-2.65)**	-0.01 (-1.83)	-0.00
AIC	1.52	1.79	
No. of Firms	78	95	

*Note: z values are reported in parenthesis; * means significant at 95 per cent interval.*
Source: Author's estimates.

VII. How can we turn Ghana into a Second Republic of Korea? Technology and Skills

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1. Introduction

Over the past few decades, growth rates of Asian and African economies have diverged markedly, with important consequences for development and living standards. Prior to 1964, gross domestic product (GDP) per capita was higher in Ghana than in the Republic of Korea, whereas in 2000, the situation had reversed to the extent that the GDP per capita in the Republic of Korea was 10 times higher than that of Ghana (Heston et al., 2002). This dramatic divergence can be seen in Figure 1. Extensive literature at both the macro and micro levels has tried to identify factors that can help us to understand the huge differences in income levels across countries.

Figure 1. GDP in Ghana and the Republic of Korea

Source: Penn World Tables 6.2.

This research note argues that a large part of the differential lies in technology and, in particular, in the way in which skills are used by firms in the two economies. Firms in Ghana do not receive many benefits from employing workers with more years of education. Hence, the demand for education is low. On average, in the case of a Ghanaian worker, an extra year of education will increase output by 2 per cent, whereas in the case of a worker in the Republic of Korea, an extra year of education will increase output by 12 per cent. As wages are linked to changes in a firm's output induced by hiring extra workers, this difference in turn reduces the incentive to invest both time and money for acquiring education. Understanding why and how Ghanaian firms use production techniques and how these techniques link to the return on skills is a critical issue.

Technology does not only have consequences for the way in which skills are used in the production process. A detailed comparison of firms in Ghana and the Republic of Korea also demonstrates that intermediate inputs, such as raw materials, are used very differently. The share of intermediate inputs in total inputs, is much higher in Ghana than in the Republic of Korea–85 per cent as opposed to just under 50 per cent. This means that, for every unit of output produced, Ghanaian firms spend relatively more on raw materials and relatively less on payments to workers and capital owners. These technological differences in the material intensity of production and the return on skills are much more important than any differences in efficiency. In understanding how we can transform the Ghanaian economy to look more like the Republic of Korea, we need to consider why these two elements differ so much and what we can be done to address it.

2. Background

There has been a wide variety of hypotheses put forward to explain differences in output, or output per worker, across countries. Some of the major theories have suggested that the answer may lie in education, technological progress, capital accumulation, the scale of firms and economies, characteristics of firms, or characteristics of the investment climate (such as the rule of law and political stability).

Much of the research seeking to explain the global distribution of income is conducted at the macro level. The most familiar of this vein of research is the plethora of cross-country growth regressions. This research seeks to link changes in GDP to various country characteristics. However, it has a mixed record in successfully identifying explanatory factors. This approach is based on the idea that there are two channels through which countries can increase the level of output per worker: by increasing the level of inputs, or by increasing productivity. Much of the difference has typically been ascribed to 'productivity'. The precise economic meaning of productivity is the amount of output per unit of input, but it has been used to capture a huge range of ideas. In fact, anything that cannot be

explained is typically put down to mysterious ‘productivity’ differences. While it is very likely that levels of productivity vary by country, it seems unsatisfactory to conclude that this imprecise concept is really the reason why Ghanaian firms produce 20 times less output per worker and 40 times less value-added per worker than those in the Republic of Korea. This paper investigates a third channel: the way in which inputs are used. This analysis shows that, at the level of the firm, differences in the production structure can explain a large proportion of the total difference.

Many countries have successfully made their transition out of poverty over the past few decades, and many more are on the path. As alluded to earlier, the Republic of Korea is an example of a country that has moved from being a poor agricultural economy to a sophisticated industrial economy, with one of the world’s highest levels of per capita income. While every circumstance differs slightly and has some idiosyncrasies, a general pattern becomes apparent when such successful countries are considered. Poorer countries are characterized by a large agricultural sector and a small manufacturing sector. Wages are low due to the lack of jobs in the formal sector and low agricultural productivity. Countries that have been able to make a transition out of this state have typically done so first, by modernizing their agricultural sector and attracting labour-intensive basic manufacturing (usually textiles and garments initially) and exporting the output. Then, as wages and living standards rose, more sophisticated manufacturing moved in. Wages are certainly low in the African formal employment sector, yet there has not been large-scale migration of labour-intensive manufacturing firms there. In a global sense, there has been substantial migration of manufacturing to low-wage economies, but the recipients have been the low-wage economies of East Asia rather than those of Africa.

Why do manufacturing firms decide against setting up in Africa? Is it that African firms are inherently less efficient, the workforce is not as well educated, the poor investment climate, instability, or other issues? Of course, it is unlikely that a single magic bullet exists that can bring African living standards up to those of East Asia. This research note argues that the single most important aspect is raising the returns to education in Africa. By looking at manufacturing firms in the two countries, this research note hopes to identify the key differences between them which will in turn shed light on policy interventions that might assist in raising the level of per capita income in Africa.

3. Firms

Firms are the ultimate source of output and income in the industrial sector of the economy and, thus, also the ultimate source of productivity. Movement from the informal and agricultural sectors of the economy into the wage sector is the driver of rising incomes and more secure wage employment, and this has been key to East Asia’s rapid growth.

The data used for the cross-country comparison are unbalanced panels of 863 manufacturing firms in the Republic of Korea observed for three years, and 312 Ghanaian manufacturing firms observed for up to 12 years. Both data sets were collected in a similar manner through interviews with firm management. The data on Ghana cover the period 1991-2002 and that for the Republic of Korea, the period 1996-1998. Söderbom and Teal (2004) use the Ghana data over the period 1991 to 1997 and the present paper extends the data set but retains the definitions used in that paper. The data for the Republic of Korea are described in Hallward-Driemeier (2002). More details on the data used can be obtained from these sources or from Baptist and Teal (2007). The key variables that are used here are the quantity of output, value of physical capital stocks (land, buildings, equipment, and machinery), number of weekly employee-hours, raw material inputs, indirect costs (mostly rent, electricity and energy purchases) and average number of years of education of employees in each firm.

The key data problem is making outputs and inputs comparable both across firms within a country and across countries. This is done in three stages. First, the variables are constructed so the definitions are consistent across countries. In the second stage, the values of outputs and inputs are deflated by firm-specific domestic prices to render them comparable within the country. Finally, they are converted into international prices by means of the purchasing power parity price indices available from the PENN World Tables (Heston et al., 2002). The result is a series of comparable values which enable the comparison of productivity across the manufacturing sectors of the Republic of Korea and Ghana.

Table 1 presents the results of these calculations. As can be seen, the median output per employee is 20 times higher in firms in the Republic of Korea than in Ghana, while median capital per employee is 46 times higher; median indirect inputs per employee are less than three times higher, and median materials per employee are 15 times higher. These differing ratios are a strong indication that firms use inputs differently across the two countries. Average weekly hours worked is similar. Remarkably, average years of education do not differ substantially; 10 years in Ghana, as opposed to 12.7 years in the Republic of Korea. This is smaller than the difference at the country level, indicating that employees in Ghanaian manufacturing firms have more years of education than the national average.

Table 1. Descriptive statistics for variables used in estimation

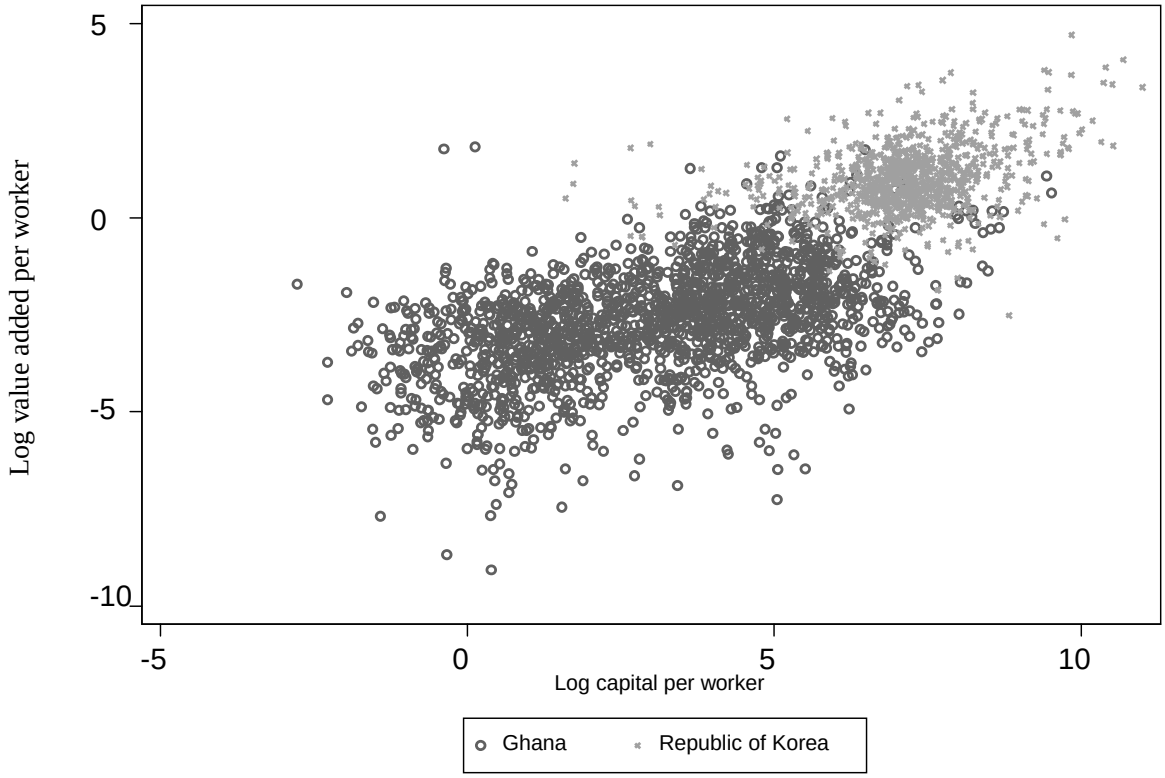
Variable	Ghana		Republic of Korea	
	Mean	**Median**	**Mean**	**Median**
Output (Y)	2,753	179	40,992	16,210
	(10,003)		(74,530)	
Capital (K)	1,180	21	21,771	4,798
	(5,729)		(66,583)	
Employment (L)	73	22	122	84
	(155)		(125)	
Indirect inputs (I)	651	15	648	216
	(2,677)		(1,890)	
Materials (M)	1,183	82	14,005	4,719
	(4,969)		(27,630)	
Y/L	20.3	9.8	290.5	192.8
	(35.3)		(355.4)	
K/L	7.77	1.32	115	61
	(29.4)		(207)	
I/L	3.21	0.85	4.50	2.32
	(7.31)		(8.41)	
M/L	10.0	4.1	98	60
	(20.0)		(132)	
V/L	7.1	3.1	188	116
	(16.7)		(303)	
Hours	46	45	46	46
	(9)		(2)	
Education (years)	10.0	10.1	12.7	12.7
	(2.5)		(1.2)	
Firms	**257**		**358**	
Observations	**1,884**		**919**	

Source: Author's calculations from CSAE and World Bank data.

Notes: the monetary values are expressed as '000 – 1996 dollars PPP. Standard errors are shown in parenthesis.

Figure 2 is a scatter plot of value added per worker against capital per worker. Value added is calculated by taking the value of output of the firm and subtracting the amount that is spent on materials and indirect costs. Thus value added is the amount of firm revenue that is available for wages and as payment to owners of capital. Firms from the two countries form two distinct clusters, with very little overlap. Even when levels of capital per worker are similar, firms in the Republic of Korea produce more value added per worker. How can one explain this gap?

Figure 2. Value-added and capital per worker



Source: Author's calculations from CSAE and World Bank data.

A production function is used here to investigate these issues more fully. The following discussion draws on the results derived in my doctoral thesis, and more detail is available in Baptist and Teal (2007). A production function specifies a mathematical relationship between inputs, firm characteristics and outputs enabling the researcher to understand how changes in the former affect output. The relationship is derived by taking real data from a large number of firms and finding out which relationship best fits the observed data. The key result of this analysis is that the apparent productivity difference between Ghana and the Republic of Korea can be explained through the use of different technology. Technology difference has two dimensions: skills and physical inputs. The returns to skills are much higher in the Republic of Korea and this is the source of a large part of the productivity differential. Firms in the Republic of Korea also differ in the way in which they use physical inputs: capital and labour are relatively more important than intermediate inputs. These two elements of technology difference are discussed in turn.

4. Skills

The mean years of education do not differ markedly between the two countries (10 years versus 12.7 years) and hence cannot explain the productivity differential. What differs markedly, and can explain much of this differential, is the shape of the (firm-level) returns to education function derived from the estimation of a production function. In Ghana, this is a very flat convex function, while in the Republic of Korea it is a concave function. The returns to education vary according to the number of years of education a worker has, as can be seen in Figure 3. In the Republic of Korea, the returns are higher for the first years of education but diminish as more years of education are accumulated. An extra year of education will be more beneficial to a firm, the lower the average level of education of its workers. The average return in the Republic of Korea is 10-12 per cent. In Ghana, the shape is convex. Education becomes incrementally more beneficial to the firm, the higher the average level of education of its workers. However, the absolute returns in Ghana are much lower: even with the convexity, returns do not reach 10 per cent until the fifteenth year of education, while the average return over the observed range is 1-2 per cent. A firm in the Republic of Korea will be most productive when its workers have completed 15.8 years of education, while those in Ghana begin to experience increases in productivity once it their workers have completed 7.4 years of education.

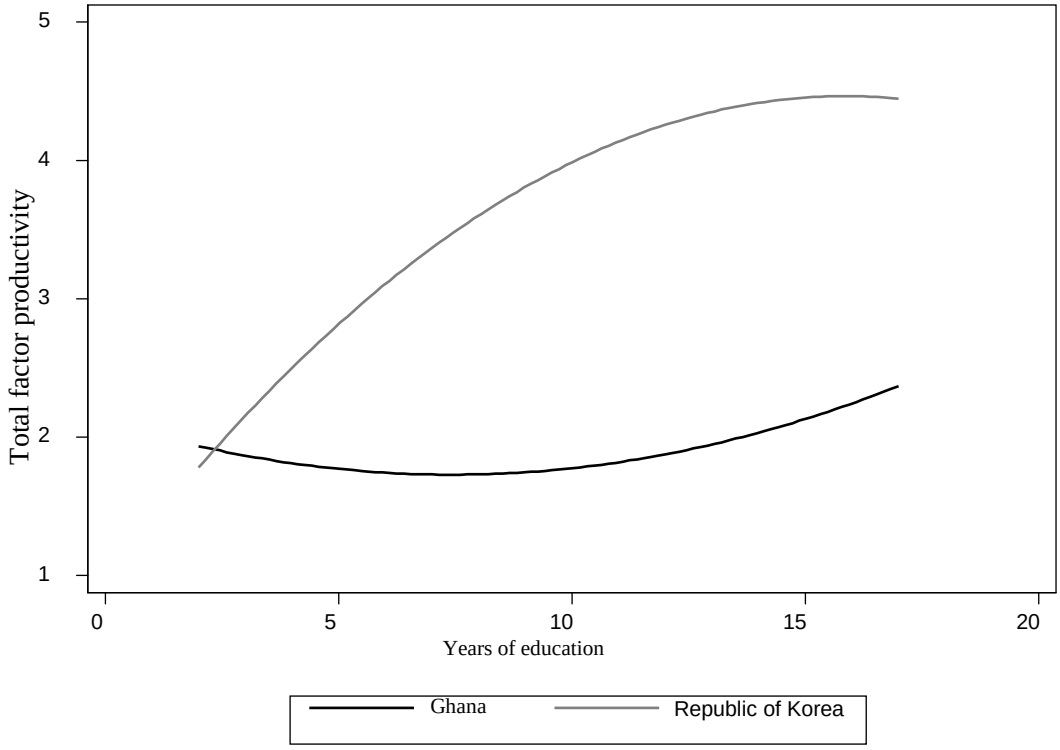
This difference in the coefficients of education is a part of what we have termed a technology difference between the two countries. If workers in a firm in the Republic of Korea receive an extra year of education, the firm can harness this to increase output. Apply the same increase to workers in a Ghanaian firm and output barely changes. An implication of this is that giving Ghanaian workers more education does not help, as the key difference lies in the way educated workers are used within the firm. Why are Ghanaian firms unable to capitalize on more educated workers?

One explanation could be that Ghanaian education is a completely different input to that in the Republic of Korea and a year in a Ghanaian classroom does not have the same marginal effect as a year in a classroom in the Republic of Korea. This is undoubtedly true. But even if the returns to education function could be compressed in Ghana (so that education moves workers along it more rapidly) there is still a big gap to close. Lower quality of education cannot be the reason.

A second explanation is that Ghanaian firms need to change the way in which they use education. These results suggest that education is not that useful in the material-intensive type of technology used by Ghanaian firms. The returns to education in Ghana and, therefore, the potential for gains in observed productivity or output per worker, could be substantially higher if more capital-intensive ‘Korean’ technology were used. This will require investment in physical capital stocks as well as the acquisition or development of external intellectual property. Therefore, understanding barriers to

technology adoption and investment are vital for understanding differences in output per worker. Investment in physical capital and sophisticated production processes would raise the returns on education and therefore the demand from firms and the incentives of individuals to acquire it.

Figure 3. Returns to education

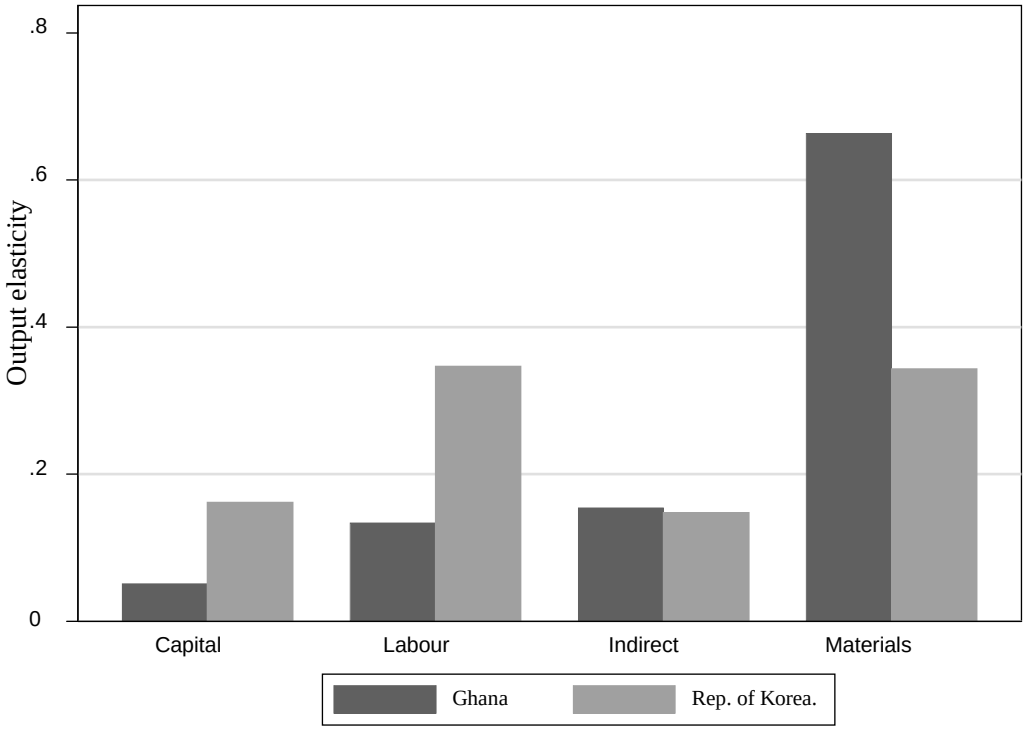


Source: Author's calculations.

5. Production processes

When I use the term "technology", I refer to the way firms produce output: the production techniques they employ or, to use another phrase, the blueprints they use to combine inputs to produce output. The use of skills is one dimension in which technology differs. The combination of physical inputs used, is another. The numbers in Figure 4 can be interpreted in two ways. First, they can be interpreted as output elasticities, that is, they tell you the percentage expansion there will be in an output if the quantity of the input increases by 1 per cent. An alternative way to interpret these numbers is to think about them as the relative share of each factor out of total inputs. For example, a 1 per cent increase in capital will increase output by 0.05 per cent in Ghana and by 0.17 per cent in the Republic of Korea. If we were able to express all inputs in a common unit, then capital would comprise 5 per cent of the Ghanaian inputs and 17 per cent of those in the Republic of Korea.

Figure 4. Production technology



Source: Author's calculations.

Why does it matter if inputs are used in different ways? The most important consequence relates to income. If materials make up a bigger share of inputs, then this leaves less money available to compensate workers and capital owners. Firms in Ghana are not willing to pay workers higher wages; an extra worker does not add too much to production but the firm will need to purchase relatively more raw materials in order to be able to incorporate the extra worker in the production process. If technology evolved, to the extent that the share of raw materials in production could be reduced, then a greater share of income would be available for workers and capital owners and, hence, for consumption. This would also have the effect of raising the returns on capital and labour which would stimulate investment in plant and equipment and in human capital.

These results have shown that the technology used is different in the Republic of Korea and Ghana, but what about more general relationships? There are three further questions relevant to the discussion of technology and industrial development in Africa that are addressed here. First, what is the picture if we consider Africa more broadly? Secondly, is there technological heterogeneity within countries? Thirdly, is there an expansion path implied by African technology that will eventually lead to Korean-style parameters being observed? I investigated these questions using a similar methodology with firm-level data on manufacturing firms not only from Ghana, but also from Nigeria, United Republic of Tanzania, Kenya and South Africa.

The conclusions from this investigation were that manufacturing firms within Africa are relatively homogenous with respect to their use of technology. Both within African countries and between them, it is not possible to find firms that use the same technology as the Korean ones. There was a small variation in the quantitative description of technology across countries, but nothing remotely close to the magnitude of the gap with the Republic of Korea. Technology does not differ significantly by country, manufacturing sub-sector, foreign ownership or export status. Even large, foreign-owned, exporting firms in South Africa exhibit a production structure fundamentally similar to other African firms. The manner in which the term is used here, technology is relatively similar across Africa, but substantially different from that used in the Republic of Korea. Of course, the particular circumstances of firms across Africa differ greatly and there may be some countries, not included in this analysis, that do not conform to this pattern. However, based on the evidence currently available, the conclusion is that the differences between Africa and other regions are much more important than differences within Africa.

These facts provide some clues as to the possible reasons why a different technology is used by African firms. Consider some of the reasons why technology may differ between firms, countries and regions. There may be legal barriers, such as patents, restricting the use of some technologies. For most production processes, and particularly for manufacturing, a range of available techniques has been developed over time, thus giving the individual firm a menu of technologies from which to choose. Given that factor prices and other local exogenous conditions will differ between countries, it would not be surprising if firms in some countries chose to use a different technology. Of course, the use of a country as the level of discussion is somewhat arbitrary although, to the extent that legislative frameworks impose binding exogenous constraints on the firm, it may be the appropriate level of analysis.

6. Technology choice

As part of the transition from a low-skill economy, such as Ghana's, to a high-skill economy, such as the Republic of Korea's, it appears that the technology used by firms needs to change. The way in which production is organized and inputs are used will require different sorts of firms to be formed in Ghana if the economy is to make this transition. It follows that we need to understand the process by which firms make choices on their production structure, how this may be influenced, and the possible consequences of adopting different technologies. An important question is whether this is through choice or constraint. Given that manufacturing is a globalized industry, hence intellectual property is widely available, and that foreign firms are more-or-less free to set up in Africa, the most likely scenario is that African firms use a different technology because they choose to do so.

If one technology produces more output than another for all levels of inputs, then clearly a rational unconstrained firm will always choose to use it. The more interesting case, and consistent with the previous quantitative investigation, is where technologies cannot be unambiguously ranked. Here consideration is given to three possible reasons why technology may differ: strategic interactions, market size, and risk.

Strategic adoption

The specific form of technology choice relevant here is that of diffusion or imitation rather than of innovation. The technology in use by advanced firms is already in existence, and other firms merely need to imitate it rather than develop it themselves, either through purchasing rights to patented technology or incurring the costs of reverse engineering. Market leaders in developing countries may convert to a capital-intensive technology in order to demonstrate excess capacity to competitors. This sends a signal that they will be in a strong position if another firm tries to challenge their position, for example, by also adopting this new technology. In the data that has been explored in this paper, it is difficult to identify even a single African firm that looks like it could be producing using the technology of the Republic of Korea. It is therefore clear that this effect does not appear to be operating at the domestic level, but may be relevant at the global level. Large firms operating in the global market for manufactures may be acting to deter investment by Ghanaian firms. This is not a situation of oligopoly or of unfair competition: it is just that these other firms are large and can produce more cheaply. Collier (2007) has used this style of logic to call for African manufacturing firms to be protected from East Asian competition. The adoption of this policy may result in African firms having sufficient incentives to invest in more sophisticated production techniques. The usefulness of such a move is contingent upon other elements of the business environment including, crucially, on the ability of African firms to export effectively.

Endogenous technology choice: market size

One reason why exporting is so difficult is because African markets do not have the scale required for firms to grow. Consider a stylized model of the two possible technologies: call one technology small and characterize it by low fixed costs and high marginal costs; and call the other technology large and characterize it by high fixed costs and low marginal costs. In the context of this research note, fixed costs could consist of capital and marginal costs of materials. Firms have a choice between the two technologies, but may face different factor costs or different fixed costs of adoption (for example, purchasing licenses or training staff). To switch to large technology, firms need to pay a large fixed cost. The benefit to them is received in the form of lower marginal costs. However, they must be able to sell sufficient extra units to make up for the cost of the investment. Hence, market size needs to be above a critical level. As technology differs between countries and there is relatively little

heterogeneity within countries and no evidence of secular technological progress, endogenous switching models, such as these, may be relevant.

Market size may also have an impact through its effects on the cost of adoption. Technology adoption generally follows what is known as an S-curve shape of adoption. Imitation is initially slow, and then accelerates until it eventually slows down once saturation is reached. This suggests that there may be some network externalities in the adoption of new technology. Serven (1997) has discussed investment under uncertainty and irreversibility in an African context, and this part of the investment literature may be informative if we view technology choice as a form of investment where firms pay a fixed cost ('invest') to switch from the small to large technology. In this context, the irreversibility could result from imperfect capital markets. Adoption of large technology in a developing country is possibly deterred by the poor resale value of equipment, with irreversibility decreasing as penetration of large technology increases, thus creating the externality. African markets do not have enough potential entrants to buy physical assets of defunct firms so, when bankruptcy occurs, it generally results in dispersion of skilled workers and loss of productive power of physical equipment rather than in their transfer to a more productive firm.

Endogenous technology choice: risk

Uncertainty and risk are often cited as reasons for the low levels of investment in African economies, and uncertainty can lead to firms being less willing to commit to sunk costs. However, the effect of risk on investment is ambiguous and firms may end up with excess capital stocks in a risky environment. This is a result of market conditions deteriorating after investments have already been made, so that the firm ends up with a capital stock that is higher than it would have chosen if it were possible to foresee these events. The use of different technologies adds to the interplay between risk and investment. The fact that the output elasticity of capital in the Republic of Korea is so much higher suggests that the 'payback' time for capital investment will be longer in Ghana. This further exacerbates the potential sensitivity of Ghanaian firms to risk.

It is possible to build a simple theoretical model whereby Ghanaian firms will choose small technology. The key differentials required between firms for this result to hold are that Ghanaian firms are more credit constrained, and small technology somehow insulates the firm from large negative shocks. The idea that manufacturing firms in a developing country face greater credit constraints than those in developed countries is not controversial and is consistent with many people's prior beliefs. But how can the Ghanaian material-intensive technology insulate firms against shocks?

Ghanaian firms are relatively more reliant on inputs that are easily adjustable, and relatively less reliant on inputs that are more difficult to adjust. Firms are constantly buffeted by external shocks to their business environment. These can range from macro shocks, such as currency depreciation or a

change of government, to micro shocks, such as the development of a new product innovation or a new competitor entering the local market. When a firm using large technology receives a positive demand shock, it is able to easily expand output and increase profit. However, when it receives a negative demand shock, it cannot reduce costs optimally due to its capacity commitment and so suffers a period of loss. Conversely, small technology is able to respond to both kinds of shocks by simply adjusting purchases of materials which, unlike capital, vary easily. The downside is that they cannot increase production beyond a relatively low capacity constraint due to low levels of capital. That is, they cannot gain substantially from any upside, but limit their downside risk. Thus, for a given demand shock distribution, the resultant shocks to firm profits have a lower variance if the small technology is used. Ghanaian firms will prefer this if they are credit constrained as it reduces their chance of going bankrupt. This distinction between demand shocks and the resultant profit shocks by firms, and the channels through which they are transmitted, is the central plank of this hypothesis.

7. Conclusion

Poverty reduction through productive activities occurs mainly through the channel of wages. The wages that a firm pays are dependent on the extra output that an extra worker is able to produce (the marginal product) and the cost of the other inputs (capital, materials etc.) required to enable that worker to produce. The technology used by Ghanaian firms has a lower marginal product of labour than that used by Korean firms, and so firms using that technology will pay lower wages. The major reason for this is the lower rate of return on education in Ghana. If this could be raised to Korean levels, the productivity of Ghanaian firms and, consequently, the wages they pay, would increase dramatically.

Increasing the number of years of education is not the only answer. The rate of return can be increased partly by improving the quality of education, but, no matter how good an education the Ghanaian workers receive, they will not be compensated well unless the rate of returns that firms receive from their education increases. For this to happen, Ghanaian firms need to fundamentally change the way in which they use inputs. The issues underlying such a technology switch are numerous and complicated. Firms need access to large markets so that they can achieve the scale economies required to justify the fixed-cost investment in more capital-intensive production techniques. African governments need to ensure that exports are a focus of domestic industrial policy and that firms are not discouraged through perverse financial incentives, poor infrastructure or regulations. The investment climate must also improve. This will also have the effect of reducing risk levels which may further enhance the likelihood of a technological transition. Ultimately, it is this investment by firms that will increase the returns to education.

Firms in Africa are much more intensive in their use of raw materials than firms in the Republic of Korea, and there is also evidence that raw materials are substitutable with other inputs, including quality of labour. Thus energy and material conservation programmes are not inconsistent with poverty reduction and, in fact, may even aid the transition. There is no need for there to be a trade-off between poverty reduction and the environment. If firms are given incentives to reduce their material inputs, then they will become more reliant on labour and capital inputs which are in the interest of the workers.

Many countries, but particularly those in East Asia, have lifted much of their population out of poverty by harnessing the productive activities, industrial development and exporting. Firms are the ultimate source of output, productivity and wages in an economy, and this research paper, argues that African firms differ from those in the Republic of Korea in a number of dimensions. The returns to education are much lower in Africa, and the technology they use is much more heavily reliant on the use of raw materials. African firms need to make a technological transition and the returns to education should be increased. Transformation and growth at firm level are Africa's best chance to lift its people out of poverty in the long term.

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VIII. Multinational Presence and Technological Spillovers in Africa: Extent, Determinants and Mode of Occurrence[1]

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Abstract

Foreign direct investment is regarded as one of the driving forces integrating underdeveloped countries into the globalization process which has characterized the world economy over the past several decades. It is presumed to be an important channel through which international diffusion of knowledge and technology takes place. The purpose of this paper is to examine the spillover occurrence from multinational corporations in the African context, taking Kenya as the case study. Accordingly, firm-level survey data on two industries—food processing and machine engineering—are utilized to examine the extent and determinants of spillover occurrence. This is done based on an analytical framework developed overlapping three strands of literature, namely, literature on foreign direct investment, cluster and network dynamics and technological innovations. This enabled a reconceptualization of spillovers in terms of learning and capability-building. An empirical determinant of spillover occurrence was done using the multinomial ordered logit technique. The results generated showed that on an average, spillovers occurred. The two major forms of spillovers occurrence pertained to products and process, while the two main mechanisms of spillovers occurrence were demonstration effects and competition. Some of the main determinants of spillover occurrence included absorptive capacity, systemic embeddedness (interactions), firm training, process changes, low technology gap and trade orientation.

1. Introduction

Foreign direct investment (FDI) is regarded as one of the driving forces integrating underdeveloped countries into the globalization process that has characterized the world economy over the past several decades. It is presumed to be an important channel through which international diffusion of knowledge and technology takes place. Since the underdeveloped countries lag behind the world technology frontier, they rely considerably on inflows of foreign technology from the technically advanced countries (Lall, 1987; Pack and Saggi, 1997). This however, should not be interpreted to mean that underdeveloped countries do not generate indigenous technology. Some underdeveloped

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countries have significant packages of technical knowledge, hence there is no reason to suppose that many technologies cannot be developed indigenously.

However, the absorption of new and advanced technologies in underdeveloped countries may be problematic for firms in the short run, especially when the technology gap is wide. It would require much time to nurture research and to develop human capacity—for instance, training scientists and engineers. This calls for sustained expenditure on education and research and development (R&D). All this notwithstanding, it could also take a long time to ensure that findings from research are transferred to locally-owned firms for exploitation. This long process does, however, represent an alternative to FDI as does the import of machinery and equipment and the hiring of technical and engineering personnel with a mandate to train local personnel in its use and maintenance. Unfortunately, the scarce resources in underdeveloped countries and the amount of time this process could take before it is accomplished leads many to stress the need to import technology, and the role of FDI in facilitating this process. In this respect, we argue that FDI is not only important in the international transfer of technology and skills to underdeveloped countries, but could also act as a stimulant to the technological development process which in turn enhances industrial development and eventually long-run economic growth.

Technology transfer, irrespective of the channel through which it occurs, is not easy. It requires enormous effort and investment in various resources on the part of the recipient to facilitate the adaptation of the technology before it is implemented (Teece, 1977; Nelson and Pack, 1997). Contrary to the over-simplified assumptions accorded to technology in the neo-classical framework, the characteristics of technology are quite complex, making it different from other normal market products. The tacit nature of technology makes it difficult to define, to the extent that it becomes difficult to transact in a normal commodity market. The seller has more information than the buyer, has greater bargaining power and can exercise imperfect competition, thus making the buyer operate under a situation of information asymmetry (Arrow, 1962). It is equally difficult to judge the value of any specific technology and agree on prices and licensing costs acceptable to both parties. The benefits of technology transfer are also difficult to determine. In the short run, technology transfer benefits the recipient by increasing productivity, contributing to the development of new products and by raising profits. In the long run, the benefits depend on how much recipients learn from the technology and their ability to deepen and develop their own capabilities (UNCTAD, 1999).

This paper investigates whether technology and knowledge are transferred to underdeveloped countries through FDI and whether they contribute to learning and capability-building. This aspect has not been accorded due recognition in the spillover literature whose work, which focuses mainly on neo-classical literature, tends to naively reduce technological change to production. The production

function was considered to be the dominant framework to measure and determine the impact of technological spillovers (Caves, 1974; Globerman, 1979; Blomstrom and Persson, 1983). The effort by locally-owned firms, for instance, to learn, imitate or copy production, processing, marketing, managerial or organizational techniques demonstrated to them by foreign firms was neglected, as was the case in the understanding of dynamics and mechanisms through which specific spillovers occurred.[3] As shown later, the production function approach, which conceptualizes spillovers in terms of labour or total factor productivity rather than learning, capability-building or innovation, does not actually measure spillovers, nor does it capture their economic impact. There has been little work, if any, which directly investigates spillovers taking learning and capability-building as their point of departure in line with Schumpeterian tradition, which emphasizes the importance of learning and innovation in development.

This paper aims to fill this gap in spillover literature by taking an evolutionary perspective. The analysis is done by examining the occurrence and effects of spillovers from multinational corporations (MNCs) to locally-owned firms in the context of a technologically underdeveloped country, namely, Kenya in sub-Saharan Africa. Despite the existence of voluminous literature on FDI, spillovers in both developed and advanced developing countries, little, if anything, is known about spillovers and their effects, particularly in sub-Saharan Africa, where economies differ substantially from other developing countries. Most of these are characterized by very fragile economies where markets are small, firms are weak, capital is poor and still 'locked into' low levels of traditional skills and non-competitive techniques, and where institutions and infrastructure are weaker than in many other developing countries.

All these factors demonstrate why the case of countries in sub-Saharan Africa is unique and one that ironically failed to receive any significant attention in the spillover literature. The specific questions posed are: Does the presence of foreign firms stimulate spillover occurrence to local manufacturing enterprises in host countries in sub-Saharan Africa? If so, what are the determinants for such spillovers to occur?

This paper is organized as follows: Section 2 presents the analytical framework. Section 3 presents the methodological setting of the paper, while Section 4 provides results and discussion. Lastly, Section 5 presents summary and conclusions.

[3] By failing to examine the mechanisms through which spillovers take place, the production function approach treats them as a 'black box', denying us full understanding of the spillover process.

2. FDI and technological spillovers: analytical framework

The analytical framework employed in this paper utilizes a framework developed in Gachino (2006) for examining the spillover process. The approach overlaps three strands of literature. First, the literature on MNC spillovers pioneered by Caves (1974) employing the production function framework. This led to a plethora of other works employing a similar framework (Globerman, 1979; Blomstrom and Persson, 1983; Djankov and Hoekman, 1998). This framework, production function, has recently been advanced by studies that have introduced new methodologies taking into consideration new dimensions, instruments and dynamics, such as time variations, industry type, locational and other spatial variables (Aitken and Harrison, 1999). The spillover literature has also been advanced by proponents of the new growth theory which emphasizes endogenous technological change, accumulation of human capital and openness to international trade and investment (Lucas, 1988; Romer, 1990; Grossman and Helpman, 1995). The literature emphasizes the importance of technological spillovers in long-run economic growth and development.

Second, is the literature on clustering and network dynamics founded under the theory of industrial organization pioneered by Coase (1937), Richardson (1972) and Williamson (1985). The literature extracts elements of transaction costs and institutions economics. The transaction costs theory emphasizes that markets and hierarchies play important roles in coordinating production. According to this theory, the choice between long-term contracts and standard market transactions for exchange of goods depend on the costs and benefits of the former relative to the latter.

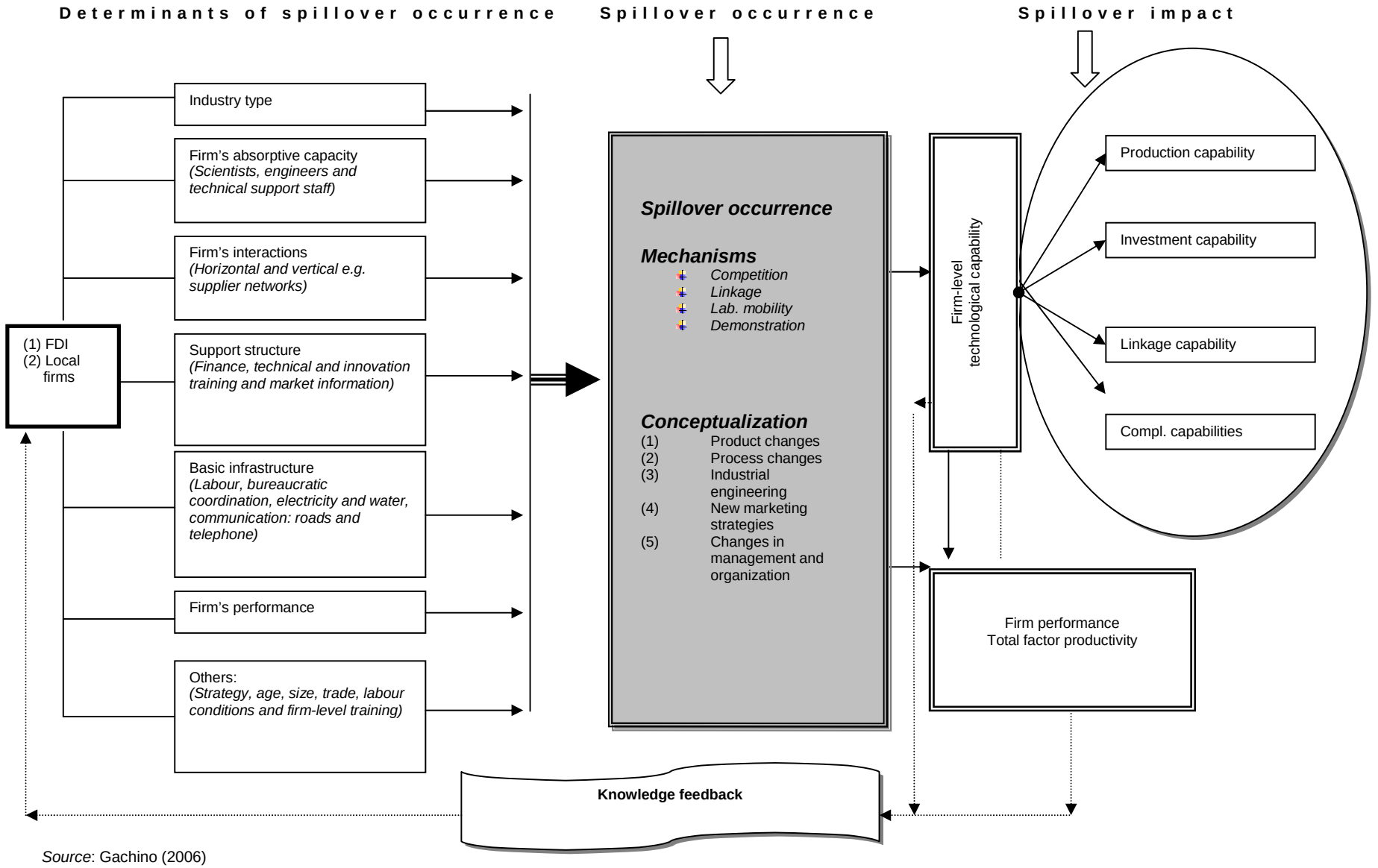
The third strand of literature relates to economics of technological innovation which emphasizes the importance of learning and capability-building in the innovation process. This literature is based on the evolutionary economics advanced by Nelson and Winter (1982), among others. Evolutionary literature has, in addition, motivated the development of the national system of innovation (NSI) framework (Freeman, 1995; Lundvall, 1992; Edquist, 1997).

The NSI emphasizes ways in which technology, social-economic agents, organizations, institutions and policies interact with each other for the purpose of fostering knowledge, learning, capability-building and innovation. It is characterized by agents engaged in formal government and education institutions, network of physical, scientific, economic and technology infrastructure. The flow of technological information within the NSI is regarded as most important for the purpose of learning and innovation. Flow of this information is highly dynamic and non-linear which makes interactions among agents vital in facilitating the flow of information.

2.1. Extent and mechanism of spillover occurrence

Contrary to the traditional technique where spillovers were conceptualized in terms of productivity gains, we conceptualize spillovers in terms of learning and capability-building. A firm's productivity largely depends on the accumulated technological capabilities over time where continuous learning results in a dynamic process of technological accumulation. It is therefore assumed that foreign presence through knowledge spillovers is likely to stimulate learning in domestic firms either by providing raw materials, or resources, or specific stimuli which trigger various forms of technological changes. This process is depicted in Figure 1.

Figure 1. A Framework model for spillover analysis: determinants, mechanisms and effects on technological learning and capability-building



Source: Gachino (2006)

However, this should not be taken to imply that spillovers are the only determinants of capability building, since a whole range of factors are involved. From Figure 1, four channels of spillover occurrence are considered, including competition, linkage, labour mobility and demonstration effects.

Firm-level capabilities can be categorized in several ways drawing from the main proponents of capability literature who include Lall (1992), Bell and Pavitt, (1993); Ernst, Mytelka and Ganiatsos (1998). Useful categorization of technological capabilities considers the functions they perform and the degree of complexity as the two classificatory principles. Thus, it is possible to single out investment, production and linkage. Other forms of capability are regarded as complimentary capabilities. Due to the magnitude and scope of work involved, this paper focuses only on production capability and then identifies the associated learning and technological changes. The following technological changes are considered as proxies for spillover occurrence; production changes, process changes, industrial engineering, new marketing strategies, management and organization changes (see Figure 1).

The degree to which each change takes place is determined subjectively in the firms on a continuous gradual ordinal scale, ranging from a minimum score of 0 representing "nothing happening" to a maximum score of N representing "very much". On the basis of this scale, an index, SPO INDEX, is computed which is then used in the quantitative determination of spillover occurrence as well as spillover determinants. A summarized format of how this index is developed and computed is presented in table 1.[4] It should, however, be acknowledged that like all other indexes, the SPO INDEX inevitably suffers some potential drawbacks as it is largely based on firms' own subjective assessment.

Spillover index is estimated for all four modes of spillover occurrence shown in the table, competition C, linkage L, labour mobility M and demonstration D. The spillover index is computed for each of these modes using the following equation:

$$SPO \quad INDEX_{Firm-level} = Composite \quad Average(C, L, M, D) \qquad 1$$

Similar results of the SPO INDEX can be computed by column average using the following equation.

$$SPO \quad INDEX_{Firm-level} = Composite \quad Average(PD, PR, RM, MS, MO) \qquad 2$$

[4] More details on this can be obtained in Gachino (2006).

Table 1. Computation of Technological Spillover Index, SPO INDEX

Spillover conceptualization	Competition (c)	Linkage (l)	Labour mobility (m)	Demonstration (d)	Average score
Product changes (Pd)	Pd_c	Pd_l	Pd_m	Pd_d	**Pd**
Process changes (Pr)	Pr_c	Pr_l	Pr_m	Pr_d	**Pr**
Repair and maintenance (Rm)	Rm_c	Rm_l	Rm_c	Rm_d	**R&m**
Marketing strategy (Ms)	Ms_c	Ms_l	Ms_m	Ms_d	**Ms**
Management and organization (Mo)	Mo_c	Mo_l	Mo_m	Mo_d	**Mo**
Average score	**C**	**L**	**M**	**D**	**SPO INDEX**

Source: Author.

The spillover index for the manufacturing industry can then be computed from any of the two equations above as sample's arithmetic mean. As an example, using equation 2, we have:

$$SPO \quad INDEX_{Industry-level} = 1/N \sum_{i=1}^{N} \{Composite \qquad Average(PD, PR, RM, MS, MO)\} 3$$

Where N is the sample size, equal to 180 in this case.

The SPO INDEX assumes an ordered framework ranging between 0 and 5 on a Likert scale as follows:

$$SPO \quad INDEX = 0, \quad 1, \qquad 2.....5 \qquad 4$$

Where SPO INDEX = 0 represents *"None"* occurrence of spillovers
SPO INDEX = 1 represents *"Least"* spillover occurrence
SPO INDEX = 2 represents *"Low"* spillover occurrence
SPO INDEX = 3 represents *"Average"* spillover occurrence
SPO INDEX = 4 represents *"High"* spillover occurrence
SPO INDEX = 5 represents *"Highest"* spillover occurrence

2.2. Determinants of spillover occurrence

From the analytical framework designed and presented in Figure 1, several determinants of spillover occurrence emerge. Each of these is discussed here, beginning with those perceived to be major ones.

One of the main determinants of spillover occurrence is absorptive capacity, which refers to a firm's ability and effort to detect external knowledge, acquire and exploit it for the purpose of production (Cohen and Levinthal, 1990; Grossman and Helpman, 1995). A firm's internal absorptive capacity can be viewed as accumulated technological knowledge over time as firms engage in routine operations such as production and R&D. In this case, R&D expenditure or staff engaged in R&D would be very good indicators of a firm's absorptive capacity. Unfortunately, only few firms undertake research. In such cases, other indicators, such as the share of technical personnel, become useful.

The analytical framework developed regards the spillover process as extremely interactive and dynamic, largely influenced by a multitude of socio-economic agents as well as existing policies which operate in a systemic manner. A strong network cohesion, which supports generation and the diffusion of knowledge, is emphasized (Lundvall, 1992). Interactions are regarded as important means through which interactive learning, information and technology can be exchanged or jointly exploited for the purpose of productive activities. This implies that interactions among firms, institutions, and government and business associations are likely to stimulate the process of spillover occurrence.

Given the tacit nature of technology, spillover occurrence is an extremely complex process influenced by many factors. Thus, a systemic approach would be important for knowledge generation, its exploitation in firm's production, its utilization for learning and innovation, and further its diffusion through a dynamic and interactive process. Consequently, the systemic support structure and basic infrastructure play a crucial role in the spillover occurrence process.

Another determinant of spillover occurrence is firm-level performance. A firm is able to perform well if it has developed a substantial amount of technological capability. Such a firm is characterized by high capacity utilization as well as high output performance in terms of sales and profits. Such a firm would be in a position to undertake dynamic strategies; perform basic R&D, recruit well-trained professionals, like scientists and engineers, undertake human resources development and other enrichment programmes. This has a direct implication, to the extent that a firm with high performance offers more room for learning, and acquisition of tacit and experiential knowledge, all of which enhance a firm's absorptive capacity.

Trade orientation is another factor believed to have an influence on the spillover process. We examine it on two fronts—exports and imports. Exports result in spillovers through different avenues. The first one is through demonstration effects by MNCs to local firms. To a local firm producing for the domestic market, participation in export markets would imply adding sunk costs, looking for new global markets, establishing international distribution linkages and networks as well as establishing overseas transport infrastructure. A tremendous amount of time and effort are required to understand the global regulatory framework and the highly dynamic consumers' tastes and preferences. Local firms benefit from MNCs existing stock of knowledge on international markets and this enables them to become exporters. MNCs will already have existing export networks abroad supported by established transport infrastructure internationally. Local firms can benefit from the export information externalities through collaboration or demonstration and penetrate export markets.

Second, participation in export markets is anticipated to stimulate a dynamic learning process in several ways. First, by introducing pressure to compete in international markets, local firms are forced to pay attention to global tastes and preferences. This can be referred to as learning-by-exporting. Secondly, by participating in the export market forces, local firms can learn to continually increase their technological effort and master techniques required for maintaining international competitiveness in the world market. As a result of these two factors, local firms are forced to learn and accumulate technological and absorptive capacity. Even at the local level, competition for foreign markets, based on the host country’s available resources by MNCs and local firms, stimulates learning and improves export performance. Export orientation is believed to relax the market size constraint, which means more MNCs and new local firms can enter. The higher the number of firms, the higher the spillover effects, as argued by the postulates of agglomeration economies.

Importation by a firm is also believed to have a positive relationship with spillover occurrence. A firm is likely to increase its level of knowledge particularly when imports are sourced from technically advanced countries. Imports of new capital and intermediate goods are viewed as some of the main channels for international transfer of technology. By importing, firms learn through imitation. They become innovative and are at the same time able to build absorptive capacity necessary to further absorb spillovers.

Another factor likely to influence spillover occurrence is firm strategy. Examples of firm strategies include process modification, product diversification, reaching new markets etc. A firm may also have a strong strategy to broaden its knowledge base through human resource development by adopting a training strategy in vocational, technical or professional education. The implication of this is that a firm with demonstrated path dependence towards absorption capacity accumulation could result in spillover occurrence.

Other factors

Others factors include firm size, age, labour market conditions and industrial specificities. To a large extent, size (big firms) may be at an advantage, in terms of spillover occurrence, primarily on account of their ability to mobilize productive resources and other services that are either external or internal to a firm. On the other hand, not all industries require high minimum scale efficiency (MSE) unit production. In many cases, scope rather than scale is important (Scherer, 1980).

To a large extent, the influence of firm age on the spillover occurrence is similar to that of size. We hypothesize that firms with longer experience enjoy greater experimental and tacit knowledge, as the older the firm, the greater the chances for spillovers to occur. With time, large firms are expected to improve their technical capacity and efficiency more than small firms, as large firms enjoy economies of scale, with ample resources to spread over learning, capability-building and innovation initiatives.

Labour market conditions often influence spillover occurrence. Studies examining this role indicate that good labour conditions can positively contribute towards industrialization by stimulating competitiveness (Piore and Sabel, 1984). The same studies also show the converse to be true, indicating a slow road to industrialization when good labour market conditions are not observed. In the current context, we argue that when a firm observes good labour market conditions, it is bound to pay high salaries and wages, offer fringe benefits, provide staff with human resources training opportunities, including enrichment programmes, etc. In such cases, however, workers' morale is motivated, thus reducing their willingness to quit their jobs.

Industrial specificity has a strong bearing on spillover occurrence. A high level of heterogeneity with significant differences in technological capabilities and capacities to learn and absorb external knowledge exists among industries. This is more so to the extent that even technologies used by MNCs within industrial sectors often differ widely in complexity. The effect of industrial differences is usually determined by the use of dummies.

3. Research methodology: data and empirical setting

In this section, we present the data and empirical setting of the paper.

3.1. Data description

The data used comes from a survey undertaken in Kenya covering two industries (food processing[5] and machine engineering industries) perceived to be the most dynamic in Kenya characterized by high productivity performance, employment and FDI levels. A sample was drawn from Kenya National

[5] For the sake of simplicity, we sometimes refer to food and beverages as just food processing sector.

Bureau of Statistics (KNBS) using proportionate probability sampling (PPS) technique. A total of 180 firms were used, where 78 (43.3 per cent) were foreign firms and 102 (56.7 per cent) were local firms. Note that a firm was defined as foreign owned if it had foreign ownership of nominal capital (equity) of at least 10 per cent, otherwise the firm was treated as locally owned. Note also that, this included stand-alone firms; 14 in food-processing and nine in machine-engineering industry.

By industry, the sample included 105 (58.3 per cent) food-processing firms and 75 (41.7 per cent) machine-engineering firms. Classification by firm ownership shows that foreign firms in food-processing accounted for 48 per cent of the total food-processing firms, while locally-owned firms accounted for 52 per cent. In the machine engineering industry, foreign and local firms accounted for 37 per cent and 63 per cent, respectively.

The data collected was representative; both foreign and local firms accounted for well over 50 per cent of manufacturing production for both sectors (in terms of output sales) and employment. Hence the results obtained enable a policy-relevant assessment.

3.2. Empirical setting

This paper adopted an ordinal scale to measure spillover occurrence, hence, examination of spillover determinants can only be done using a limited dependent variable estimation technique. In this case, we propose the use of multinomial ordered logit as follows: Assume there are institutional determinants of spillover occurrence defined by a vector *I*, structure determinants defined by a vector *S*, conduct determinants defined by a vector *C*, performance determinants defined by a vector *P* and spillover occurrence defined by a vector *SPO*. For a given enterprise, say *i*, the relationship between spillover occurrence and the determinants can be formulated as:

$$SPO_i = SPO(I_i, S_i, C_i, P_i) + V_i$$

V_i a stochastic disturbance term assumed to be independent and normally distributed across observations. The proxies used were measured and defined, as shown in table 2 below.

Table 2. Variables included in the empirical models and their hypothesized influence on spillover occurrence in Kenya's manufacturing industry

Variables	Variable description	Variable measurement	Hypothesized influence
Technological spillover (SPO INDEX)	Spillover occurrence index	5 if highest, 0 if none	Positive
Foreign presence (FORPS)	Foreign presence at firm level	Aitkens method	Positive
Firm size (SIZE)	Firm employment	1 if large, 0 otherwise	Pos. or neg.
Asian (KASIAN)	Firm owned by a Kenyan Asian	1 if Asian, 0 otherwise	Positive
Firm age (FIRMAGE)	Age of a firm	Years in absolute numbers	Positive
Firm performance (CAPUT)	Firm capacity utilization	Percentage capacity utilized	Positive
Infrastructure (INFRSPT)	Infrastructure support to firm	1 Infrastructure, 0 otherwise	Positive
Institutional (INSTSPT)	Institutional support to firm	1 Institutional, 0 otherwise	Positive
Business (BUSASPT)	Support from business associations	1 Business, 0 otherwise	Positive
Firm interactions (INTERACTIONS)	Presence of firms interactions	1 if interacts, 0 otherwise	Positive
Skilled intensity (SKILL)	Share of university and technical	Percentage share in total employment	Positive
Technology gap (TGAP)	Value of core production machinery	1 high technology gap, 0 otherwise	Pos. or neg.
Diversify products (STRTPDCT)	Diversification into new products	1 if to diversify, 0 otherwise	Positive
Process technology (STRTPRCS)	Acquire new process technology	1 if to acquire, 0 otherwise	Positive
Technological training (TRAINING)	Undertakes training	1 if to train, 0 otherwise	Positive
Exports (EXPORTS)	Exports of manufactured goods	1 if exports, 0 otherwise	Positive
Import (IMPORTS)	Imports raw materials	1 if imports, 0 otherwise	Positive
Wages (WAGES)	Wages per person in a firm	Wages per person	Positive

Source: Derived from author's survey.

4. Results and discussion

In this section, we present the results and discussion starting with a descriptive analysis.

4.1. Descriptive analysis

An important firm characteristic expected to influence spillover occurrence is firm size which was considered in terms of employment size. As expected, foreign firms were bigger in size than local firms, consistent with the literature on MNCs, which reiterates that foreign firms have ownership advantages which enable them to invest internationally.

While the average age of all firms in the two industries was 29 years, foreign firms had a higher average firm age (39 years) compared to local firms (22 years). This supports the argument that foreign firms invested earlier than local firms. However, foreign manufacturing investment declined tremendously during the 1980s-1990s following extensive institutional failure, infrastructure decay and inconsistent policies during the period of structural adjustments.

Firm performance proxied by capacity utilization showed an average capacity utilization of 64 per cent, indicating the existence of excess capacity in both industries. Foreign firms also had higher capacity utilization than local firms. This can be explained by the fact that foreign firms have a relatively high demand for their products since most of them are exporters. Furthermore, foreign firms also engage a more skilled workforce alongside efficient production facilities.

On infrastructural and institutional support, firms were asked to rate the provision of key infrastructural and institutional support. With the exception of food processing where 50 per cent of the total foreign firms rated provision of infrastructure as good, in all the other cases only a third felt they were provided with relatively good infrastructure. This is rather low but not surprising in the Kenyan context since, for a very long time, little attention has been paid to infrastructure development. A similar trend was observed in the case of institutions where, on average, only a third of the firms felt they were receiving above average institutional support. For instance, during the survey, access to capital was notably constrained by the high cost of credit. The legal system was reportedly weak, while academic institutions and industry remained largely detached.

Firms that benefited from services offered by business organizations were equally very low. Foreign firms in food-processing that benefited from business organizations were 33 per cent, while in machine-engineering, were 24 per cent. Of the food-processing firms, only 15 per cent and 20 per cent benefited from business organizations. Again, this was not surprising given the weak capacities of most business associations.

Another aspect examined was interactions, that is, with machinery and raw material suppliers, government and private institutions, universities and technical training institutions, industry and business associations, investment and export promoters, buyers and distributors etc. For both local and foreign firms, the proportion of firms that benefited from interactions was very low, below 50 per cent, on average, for the two industries. Several reasons account for that. First, the level and frequency of interactions were usually low. This links to the second reason that most agents (institutions or business associations) they interact with often suffer major drawbacks such as inadequate physical and human resources, finance and working capital. Third, there is a lack of adequate support from the Government to institutions, as such most of them remain weak and inefficient.

In order to determine the firm's absorptive capacity, the proportion of staff with university degrees, technical and vocational training was considered. In the two industries, foreign firms had the highest levels, with 39 per cent and 58 per cent in food-processing and machine-engineering, respectively. This is not surprising as foreign firms have more resources to spread over heavy capital investment and can engage technically qualified personnel.

The technology gap was considered by taking the value of a firm's core production machinery. A firm with the highest value of production machinery (obviously a foreign firm) was taken as the reference point. Firms whose value of production machinery was below the reference point but above the industry average were considered to have a low technology gap, while those below the industry average were considered to have a high technology gap. Although this conceptualization of technology gap is narrow; the approach calls for an empirical analysis, particularly to examine issues pertaining to production capability and the associated spillovers. As expected, the value of core production machinery used by foreign firms was higher than that by local firms; thus the existence of technology gap between foreign and local firms.

A high proportion of foreign firms in food processing had a strategy of diversifying their products (56 per cent) and process technology (63 per cent) compared to those in the machine engineering industry at (27 per cent) for products and (31 per cent) for process technology. The same trend was observed in local firms. It is interesting, however, to note that a higher proportion of local firms in machine engineering had a continuous strategy to change their products and processing technology than foreign firms. This is to be expected as local firms try to introduce changes to match those of foreign firms.

The proportion of firms offering technological training averaged 30 per cent in both industries, with foreign firms inevitably offering more training than local firms. Although these figures confirm that Kenyan firms offer training, the proportion is, however, low but comparable to that obtained in the World Bank RPED study (Biggs, Shah and Srivastava, 1995). It was also noted that the kind of training offered differed substantially between firms. While in the case of foreign firms, training was routine, internal and often external including internationally, most of the local firms merely offered simple in-house training, usually done on an ad hoc basis.

As expected, a higher proportion of foreign firms participated in exports than local firms. While 20 per cent and 18 per cent of local firms were exporters in the food-processing and machine-engineering industry, respectively, 55 per cent and 22 per cent of foreign firms were exporters in the food-processing and machine-engineering industries, respectively. This is expected given that foreign firms are more endowed with export capabilities than local firms. The difference between local and foreign firms in imports of raw materials was not significant.

Under labour market conditions, there was a tremendous difference between local and foreign firms, in terms of annual wages paid per person. The difference in wages between foreign and local firms was similarly noted in other studies: Aitken, Harrison and Lipsey (1996) for Venezuela and Mexico;

Mazumdar (1995) for Cameroon and Zambia; Lipsey and Sjoholm (2001) for Indonesia; Te Velde and Morrissey (2001) for Cameroon, Ghana, Kenya, Zambia and Zimbabwe.

4.2. Occurrence of technological spillovers

Employing the above framework, the spillover index for the Kenyan manufacturing industry is computed and discussed under the two sub-sections below.

4.2.1. Spillover occurrence in food-processing and machine-engineering industries – pooled

Table 3 provides the results of the spillover index computed for the food-processing and beverages, and machine-engineering industries combined. The computed spillover index was approximately 3.30, which depicted an average spillover occurrence into the two industries from both local and foreign firms. The results obtained show that technological spillovers occur in Kenya's manufacturing industry.

Among the four modes of technological spillover occurrence considered in this analysis, competition generated the highest level of spillover occurrence (3.52) followed by demonstration (3.44), labour mobility (3.16) and finally linkage (3.08). This showed that competition and demonstration effects resulted in more learning and technological changes. Linkage system and labour mobility have weaker learning effects and thus, by implication, weaker capability-building in manufacturing. Comparisons done using T-test analysis showed the difference to be statistically significant. Interestingly, the highest type of spillovers conceptualized in terms of learning and technological changes (new and/or incremental) occurred in products, changes occurred in products (3.63) and process (3.58). Marketing strategy had an index of 3.19; while both management and organization, and repair and maintenance had 3.05 each.

Examination of spillover occurrence by firm ownership revealed that more spillovers occurred in the two industries from foreign firms than from local firms. The spillover index computed from foreign firms was 3.48, while that of the local firms was 3.11. A comparative T-test analysis showed this difference to be statistically significant. By the ordinal scale developed, it can be concluded that there is high spillover occurrence into the two industries combined from foreign firms, and average spillover occurrence from locally-owned firms. The implication of this is that foreign firms generate more knowledge spillovers than local firms in both industries. In all the cases, competition generated the most spillovers followed by demonstration effects. Similarly, most of the spillovers occurring were in product, process and marketing strategy in that order.

Table 3. Occurrence of technological spillovers in local and foreign firms, food-processing and machine-engineering industries combined, Kenya

Computed index for spillover occurrence in the two industries from both local and foreign firms					
Spillover conceptualization	**Competition (c)**	**Linkage (l)**	**Labour mobility (m)**	**Demonstration (d)**	**Average score**
Product changes (Pd)	3.90	3.47	3.43	3.73	**3.63**
Process changes (Pr)	3.80	3.36	3.45	3.71	**3.58**
Repair and maintenance (R&M)	3.10	2.80	3.18	3.13	**3.05**
Marketing strategy (Ms)	3.52	2.98	2.78	3.46	**3.19**
Management and organization (Mo)	3.27	2.79	2.95	3.18	**3.05**
Average score	**3.52**	**3.08**	**3.16**	**3.44**	**3.30**
Computed index for spillover occurrence in the two industries from foreign firms only					
Product changes (Pd)	4.09	3.73	3.80	3.85	**3.87**
Process changes (Pr)	3.96	3.53	3.75	3.88	**3.78**
Repair and maintenance (R&M)	3.18	2.97	3.41	3.24	**3.20**
Marketing strategy (Ms)	3.63	3.16	3.07	3.57	**3.36**
Management and organization **(Mo)**	3.37	2.95	3.21	3.37	**3.23**
Average score	**3.63**	**3.27**	**3.44**	**3.59**	**3.48**
Computed index for spillover occurrence in the two industries from local firms only					
Product changes (Pd)	3.70	3.21	3.06	3.61	**3.40**
Process changes (Pr)	3.63	3.19	3.14	3.53	**3.37**
Repair and maintenance **(R&M)**	3.01	2.63	2.94	3.02	**2.90**
Marketing strategy (Ms)	3.41	2.79	2.50	3.34	**3.01**
Management and organization **(Mo)**	3.18	2.63	2.69	2.98	**2.87**
Average score	**3.39**	**2.89**	**2.87**	**3.30**	**3.11**

Source: Computed from author's field survey.

4.2.2. Spillover occurrence into only locally-owned firms in food-processing and machine-engineering industries

An examination of spillover occurrence to local firms from both foreign and local firms showed an average spillover index of 3.31. This index compared to that computed for both food-processing and machine-engineering industries combined (3.30). The highest spillovers generated was in product changes followed by process changes, and the marketing strategy with 3.61, 3.52 and 3.29, respectively. As noted above, spillover occurrence to local firms from foreign firms was significantly different from that of local firms. Similarly, a comparison by mode and type of spillover occurrence shows that more spillovers occurred to the locally-owned firms from foreign firms (3.44) than from local firms (3.19). The implication is that foreign firms in both industries generate more spillovers into local firms than local firms.

These findings are very interesting as they confirm two things: First, spillovers occur from foreign firms to local firms in the Kenyan manufacturing industry. Second, spillovers occurring from foreign firms were much more than those from local firms. Occurrence of these spillovers was highest through the demonstration channel, 3.66 followed by competition, 3.64. Comparison made using the T-test analysis showed that the difference between demonstration and competition, on the one hand, and linkage and labour mobility, on the other, were statistically significant. The two were followed by labour mobility (3.35) and finally linkage (3.10). All these, however, empirically support the fact that labour mobility and linkage between foreign and local firms are crucial in the diffusion of skills, knowledge and technology.

Table 4. Occurrence of technological spillover in local firms only: food-processing and machine-engineering industries combined, Kenya

Computed index for spillover occurrence in local firms (for both industries) from both local and foreign firms					
Spillover conceptualization	**Competition (c)**	**Linkage (l)**	**Labour mobility (m)**	**Demonstration (d)**	**Average Score**
Product changes **(Pd)**	3.85	3.34	3.40	3.83	**3.61**
Process changes **(Pr)**	3.75	3.34	3.31	3.67	**3.52**
Repair and maintenance **(R&M)**	3.23	2.60	3.03	3.32	**3.05**
Marketing strategy **(Ms)**	3.72	2.94	2.91	3.58	**3.29**
Management and organization **(Mo)**	3.44	2.77	2.88	3.35	**3.11**
Average score	**3.60**	**3.00**	**3.11**	**3.55**	**3.31**
Computed index for spillover occurrence in local firms (for both industries) from foreign firms only					
Product changes **(Pd)**	3.89	3.48	3.69	3.88	**3.74**
Process changes **(Pr)**	3.79	3.44	3.57	3.80	**3.65**
Repair and maintenance **(R&M)**	3.33	2.67	3.21	3.51	**3.18**
Marketing strategy **(Ms)**	3.72	3.06	3.16	3.63	**3.39**
Management and organization **(Mo)**	3.46	2.86	3.10	3.50	**3.23**
Average score	**3.64**	**3.10**	**3.35**	**3.66**	**3.44**
Computed index for spillover occurrence in local firms (for both industries) from local firms only					
Product changes **(Pd)**	3.81	3.20	3.12	3.79	**3.48**
Process changes **(Pr)**	3.71	3.23	3.06	3.53	**3.38**
Repair and maintenance **(R&M)**	3.13	2.53	2.85	3.12	**2.91**
Marketing strategy **(Ms)**	3.72	2.82	2.67	3.53	**3.19**
Management and organization **(Mo)**	3.43	2.69	2.67	3.20	**3.00**
Average score	3.56	2.89	2.87	3.43	**3.19**

Source: Computed from author's field survey.

4.3. Determinants of spillover occurrence

Table 5 presents the results of the ordered model. To avoid the problem of multi-collinearity, a backward selection procedure was employed to select the independent variables to be included in the final model. There was no multi-collinearity problem. The estimated model passed the White (1980) test for heteroskedasticity. The overall goodness-of-fit statistics—Log likelihood, the likelihood ratio LR-Test and Pseudo R^2—indicated good overall performance of the Tobit model.

For this model, the estimated backward selection was done in such a way that only variables with probability values below 0.2 would be retained. Accordingly, only marginal effects of these variables were computed and reported. With backward selection, the independent variables dropped after failing the significance test which included firm performance, infrastructure and firm's strategy to introduce product changes regularly.

Table 5 shows that as expected, most of the estimated coefficients had the a priori expected signs and were statistically significant at 1 per cent, 5 per cent and 10 per cent levels. From the empirical analysis performed, foreign presence was positive and statistically significant at 5 per cent. The data produced statistically significant results confirming the hypothesis that spillover occurrence in Kenya's manufacturing industry is stimulated by foreign presence.

Two of the proxies, experience and knowledge accumulated, were significant at 5 per cent. Firm age and age-squared had a positive influence on spillover occurrence. However, based on the magnitude of their marginal effects, the two variables do not seem to have much influence on spillover occurrence. The age results imply that spillovers were more likely to occur in old firms than in young firms. The learning process in the firm could explain the age influence on spillover occurrence. Over time, learning-by-doing effects result in experiential and tacit knowledge and consequently the accumulated stock of knowledge enhancing a firm's absorptive capacity, which in turn enables the firm to assimilate, adapt and exploit external knowledge spillovers. The estimated marginal effect of age squared was negative and significant indicateng that growth of spillover occurrence decreased with age an inverted-U shaped relationship. Age of the core production machinery was also positive and highly significant. The results showed that old production machinery was characterized by high levels of spillover occurrence compared to the relatively new production machinery.

Table 5. Determinants of spillover occurrence, ordered logit analysis: food-processing and machine engineering industries combined

Variables	dy/dx	Standard errors
LFORPS	1.366**	(0.545)
FIRMAGE	0.351**	(0.143)
AGESQRD	-4.066**	(1.660)
MACHAGE	0.270***	(0.093)
KASIAN$^{\psi}$	5.293***	(1.823)
INTERACTIONS$^{\psi}$	3.537**	(1.735)
SKILL	1.686**	(0.847)
TGAP$^{\psi}$	7.438***	(2.590)
STRTPRCS$^{\psi}$	7.306**	(3.205)
TRAINING$^{\psi}$	5.797***	(2.038)
EXPORTS$^{\psi}$	-4.199**	(1.834)
IMPORTS$^{\psi}$	2.569**	(1.312)
LWAGES	-2.166**	(0.644)
_Cut1	1.756	(6.344)
_Cut2	18.069	(8.501)
_Cut3	29.764	(10.963)
Industry dummies	Yes	
No. of observations	73	
Log Likelihood	-20.092	
LR-Test	98.100	(0.000)
Pseudo R^2	0.7094	

Note: Spillover index computed is taken as the dependent variable-proxy for spillover occurrence.

(ψ) dy/dx is for discrete change of dummy variable from 0 to 1.

, * represent 5 per cent and 1 per cent levels of significance, respectively.

Source: Computed from author's field survey.

The Kenyan-Asian variable was significant at 1 per cent with a strong marginal effect. The implication of this result is that more spillovers are likely to occur in firms owned by Asians compared to non-Asian firms in Kenya. These results support the argument that Asian firms in Kenya are more dynamic, entrenched in high value-added activities compared to the African firms. Himbara (1994) noted that in comparison with African firms, Asians firms were characterized by high entrepreneurship and commercial skills, efficiency and competitive edge, with hard working employees, who survive on modest resources, with family units and collective organizations playing a pivotal role in providing mechanisms to engender discipline and cohesion.

The data suggested that interaction was an important determinant of knowledge spillover occurrence. This finding is supported by literature on learning and innovation, which emphasizes the importance of interactions (with suppliers, customers, support institutions and industry business associations) in firm learning and new knowledge acquisition, including accumulation of tacit knowledge. Such interactions are likely to provide information on technologies and new markets and other inputs to complement the internal learning process, such as external staff training, consulting services and R&D grants.

The variables for absorptive capacity had the expected results. The first one defined as proportion of staff with university, polytechnic and vocational education was important in explaining spillover occurrence. The direction of the estimated marginal effect was positive and significant at 5 per cent. The results support the fact that skilled personnel are important for spillover occurrence in the Kenyan firms. Thus, an adequate stock of technically-qualified manpower is necessary to absorb new technologies, to modify them and create and transfer new technological knowledge and information.

The technology gap variable was positive and significant at 1 per cent. The results showed that a change from high to low technology gap resulted in an increase of 7.44 points, supporting the hypothesis that a low technology gap had a positive influence on spillover occurrence in the Kenyan industry.

A firm with a strong strategy of constant modification and upgrading of its processing technology was more likely to obtain high levels of spillover occurrence compared to a firm with no strategy on machine modification or upgrading. Accordingly, this variable had a strong positive marginal effect of 7.31 which was significant at 1 per cent. One of the ways in which technological capability is acquired is by undertaking continuous, incremental modifications that adapt new technologies to fit specific situations or production conditions. Once technological capability has been accumulated, it enables high spillovers to occur as it enhances the absorptive capacity.

The training variable in the firm was also very important in explaining spillover occurrence. The estimated marginal effect was strong, positive and significant at 1 per cent. This implies that the more a firm undertakes technological training, the higher the likelihood for spillovers to occur. Firm training results in accumulation of firm technological capability, which in turn determines the magnitude of potential knowledge spillovers. Logically, a firm that offers training and also conducts R&D is better placed to detect new external knowledge and its value than a firm that does not. Thus, when a firm invests in training as well as R&D, we can assume that in the process it increases its technological capability as well as absorptive capacity.

Contrary to expectations, the results of exports obtained showed a negative and significant (5 per cent) influence on spillover occurrence. This is possible given that exporting firms have already reached the threshold to export.[6] Non-exporting firms have a lot to learn and are thus comparatively likely to introduce more technological changes than exporting firms. Surprisingly, this result contrasted those obtained in other studies which reiterated the importance of learning-by-exporting. The results also contrasted the widely acknowledged facts regarding the East Asian miracle that exports contributed tremendously to the development of technology capability-building as a result of international spillovers occurring from interactions with more sophisticated foreign clients based abroad (Westphal, 1990). The marginal effect obtained for imports was high, positive and significant at 5 per cent. Hence, more spillovers occurred with importing firms than those that did not, supporting the literature that views imports of new capital and differentiated intermediate goods as main channels for international transmission of technology.

Wages had a negative influence on spillovers, which was statistically significant at the 1 per cent level. This implies that higher wages in a firm are likely to reduce spillover occurrence. This was not surprising in that if a firm pays efficiency wages, then its workers were not expected to leave the firm. As an example, high wages boost workers' morale and motivation and thus reduce workers' mobility, resulting in spillovers.

5. Summary and conclusion

This paper arose out of concerns to understand how FDI affects the industrialization process in Kenya, with particular emphasis on spillovers, learning and capability-building. It investigated whether technology and knowledge transferred to a host country from technically advanced countries contributed to learning and development of technological capabilities in locally-owned firms. The analysis was done by examining the effect of technological spillovers from MNC affiliates to locally-owned firms in the African context, taking Kenya's manufacturing industry as the case study.

This paper has shown that FDI plays an important role in industrial development in the country through occurrence of technological spillovers. Nevertheless, several reasons accounted for spillover occurrence levels ranging from mechanisms of spillover occurrence to type and determinants. Hence, the analysis done has generated some general lessons for policy which can be outlined as follows:

[6] This would imply that an export threshold exists below which all spillovers matter to achieve export status. Nevertheless a clear direction of causality between learning and exporting is yet to be detected.

As a first point, the paper acknowledges the need to observe consistency in policy stance. A combination of erratic policy changes (like those pursued during the structural adjustment period in the 1980s-1990s), inefficient institutions and poor infrastructure result in extremely high operation and transaction costs. In turn, this makes investors, including FDI, shy away from investing locally, thus reducing spillover occurrence. This interferes with the technological learning and capability-building process as it cannot thrive under such a policy environment.

Second, the analysis showed that linkages did not generate substantial spillovers (in the Kenyan context) implying existing linkages were less in content in terms of information, technology, knowledge, skills etc. This was a likely scenario in the broader African context, unlike in the newly industrializing countries, where industrial linkages played a vital role in spurring spillover occurrence. There is therefore a dire need to formulate more definitive policies geared towards the promotion of linkages. This would include the promotion of linkage formation between and among firms, sectors and institutions. This could also include match-making local firms with MNCs abroad sometimes promoted through foreign missions abroad and embassies. Most important, the linkages formed should be strengthened in terms of content – should be rich in information, technology, finance and knowledge flow etc.

Third, absorptive capacity was noted to be an important factor for spillovers to occur. Hence, human capital accumulation, particularly in science, technology and engineering, should be encouraged. Perhaps urgently needed in Africa are policies to promote and support a strong culture of technology development through learning and R&D. This is important if firms are to increase their ability to absorb and assimilate spillovers. Countries in the region lacked strong guiding industrial policies, for instance, to encourage R&D and innovation. Needless to emphasize that it is only through a culture of vibrant R&D and innovation that industrial development can take off and in turn dynamize economic growth.

Fourth, it was noted that the role played by institutions in the spillover process would have been much higher were it not for their weak capacity to perform. This is a common trend in Africa. When institutions are weak, understandably, this implies a reduced role in supporting technology development and hence weak industrial capability prevails. There is a need to focus on policies which would ensure sound running and performance of these institutions as this is the surest way to promote endogenous industrial capabilities necessary for catching-up. No country can claim to have long-run growth without solid industrial capabilities propagated via sound and well coordinated institutions. Consequently, the Government should provide coordination guidelines for institutions to encourage a systematic and coordinated mode of operation.

Fifth, poor infrastructure emerged as one of the biggest problems facing firm operations in the country. This causes operation and transaction costs to be extremely high, thus lowering interaction among firms. Poor infrastructure also reduces willingness to invest or expand. All these factors hinder or lower the occurrence of spillovers. As an example, bad roads and high telephone costs reduce interaction and consequently the sharing of information, knowledge etc. As a recommendation, basic infrastructure should be provided in earnest. The success story of East Asian countries shows that governments that do not offer continuous support and effective industrial facilitation often fail their entrepreneurs.

Sixth, formal and informal interactions with institutions and business associations were important factors in the spillover occurrence process. For instance, interaction created an atmosphere where local entrepreneurs share manufacturing experiences, market information, skills and technological knowledge with foreign firms. Such interaction whether formal or informal should be encouraged and facilitated where possible. Examples include the facilitation of trade and agricultural fairs which enable learning and information exchange. All these would widen the scope of spillover occurrence.

Seventh, although the findings in our paper showed that competition plays an important role in the spillover process, it is also noted that high competition from foreign firms could crowd out domestic investment. Hence, if possible, an institution should be established to deal with competition regulation in manufacturing. It should have the capacity to determine prevailing competition levels. It should assess incoming FDI so that only MNCs with high potential for generating technological spillovers of capability development without crowding out local investment are permitted to invest.

Eighth, our paper shows that imports are important in the spillover process. Imports of capital goods by NICs enabled them to strengthen their technology base. Hence, there is need to continue eliminating import barriers for capital goods, technology, machinery and equipment that could serve as sources of learning and capability development through imitation, replication and reverse engineering. Also, although exports failed to correlate with spillover occurrence in Kenya, participation in exports should be encouraged as that would force domestic firms to learn and increase their technological effort in order to compete effectively in global markets.

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IX. National System of Innovation and the Role of Demand: A Cross Country Comparison

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1. Introduction

The National System of Innovation (NSI) is a broad concept which enjoys growing popularity among scholars and policy makers. The popularity of this concept is due to its capacity to reduce some of the difficulties related to technological change. To understand this success we have, on the one hand, to recognize knowledge as the main driver of a nation's wealth. On the other hand, we have to resist simplistic ways of introducing technology into neoclassical growth models. The NSI adopts a more systematic approach which takes into account the various interrelationships between the actors of society (firms, consumers, universities, institutions).

Let us briefly comment on two ideas related to this opposition to the simplistic view of technology in the neoclassical framework. First, why demand is relevant in a systematic view and, second, the notion of complementarity among the economy's different factors as a key point for successful innovation processes. The relevance of demand in this systemic framework can be seen as a continuation of demand pull theories to explain innovation processes. In the early 1970s, Schmookler (1971) argued that society, through its market mechanism, affects the allocation of economic resources dedicated to innovation and therefore shapes the evolution of technological change. Rosenberg (1969) concentrates his argument on process innovation, by explaining how demand for new techniques emerges and evolves. Many other arguments from the supply side were suggested as being relevant. This gave rise to the debate known as demand pull versus supply push. Perhaps the systemic view could be interpreted as an eclectic position to this debate in which demand plays a role. In the words of Edquist:

> "One consequence of the interdependent and non-linear view which characterizes the systems of innovation approach is that is natural also to bring in demand as a determinant of innovation." (Edquist, 1997, p. 21).

The second idea we want to stress is the importance of complementarities. The tradition of economic research is based on trade-offs. For example, to find an optimal solution there is always some form of trade-off between spending and saving. Spending gives instantaneous satisfaction but is risky for the future, so the individual tries to take a balanced decision. The NSI approach is slightly different. This literature remarks that it is not just a trade-off between educating the population to a higher level and

doing more research, but that these decisions complement each other. Research and development (R&D) output will be much more efficient if the population is more highly skilled. This paper attempts to define four important dimensions of the NSI and to study the complementarities among them. Having done that, the paper presents a means of detecting in which dimension the system is weak, by which we mean one that is not generating the expected complementarity with the others.

From our point of view, the role of demand has still not been studied. Scholars recognize the importance of the role of human capital and knowledge in improving the country's production capacity. But how is demand affected by these factors? Are knowledge and demand complementary in any way? These are the main concerns of this research.

The literature on NSI covers very different aspects and uses very different methodologies, going from case studies to input-output tables. Recently, a quantification, based on composite indicators, of the system which permits comparisons between countries appears to be emerging from one branch of literature (Porter and Stern, 2001; Furman et al., 2002; Chang and Shih, 2005; and others). While we continue to follow this quantitative approach, this paper differs from others, because we explicitly include the role of demand into the system.

In the next section, a selective review of literature is conducted based on the role of demand and quantification methods for the NSI. Section 3 reflects on why we focus on four dimensions, while Section 4 discusses the relation between the different parts of the system and the generation of wealth. The last section concludes and offers some possible links for UNIDO's activities.

2. The role of demand in NSI literature

To review in detail all that has been said and written about NSI is beyond the scope of this paper. For a detailed introduction to the history and different approach see, for example, Montobbio (2001) and Lundvall (2005). Instead, this section first reviews the role of demand in the NSI literature and then comments on different attempts to quantify the NSI.

2.1. The role of demand

Here we review what the important demand characteristics are, as seen by different authors; we then narrow it down to the relevance and importance of demand in the concept of NSI. Some authors have focused their attention on the role of international demand, some on national demand and some argue that both are relevant. The unit of analysis is the country; therefore international demand is the demand of the rest of the world. Demand affects the system in many ways.

In one of the first articles using the concept of NSI, Freeman (1982) discusses the role of international demand. He argues that a firm that innovates and successfully exports its innovation enjoys an export monopoly that can be exploited until imitators come into the market. Posner (1961) introduced the argument that monopoly occurs because foreign demand develops faster than foreign supply, thus providing for a time a competitive advantage to the initiating country. For example, the Italian demand for mobile telephones developed faster than Italian supply; Norway, which introduced the innovation, took competitive advantage of this time lag. One might expect this monopoly to be erased by imitation sooner or later. Posner finds several arguments for this lag to continue in time. For example, he says that initially it is the new product which generates the competitive advantage in an international environment, but international leadership can be held for a long period due to the sequence of future process innovation linked with the new product. It is the time lag between the international demand and the national supply which allows a country to be more competitive. The time lag effect was further developed in relation with technical change and international trade by the literature (see, for example, Hufbauer, 1970, or more generally, Dosi et al., 1990). In these relations, as demand does not play a prominent role, we shall not discuss this here.

A different perspective is taken by Dalum (1992) when he looks at how the different export specialization patterns of 21 OECD countries affect the performance of the NSI. He implicitly gives international demand a greater weight than the national one, and he tries different specialization patterns with a sectoral focus. He notes how national sectors are present in the international distribution of exports. Even though all countries have access to international trade, they specialize in different sectors for historical or cultural reasons. Behind his arguments, we find that international demand plays a role of specialization of the national capacity.

The recognition of a different demand segment is a key factor to understanding international competition and the finding of a new demand niche. Here we argue that the study of international demand is used as a source of information. The recognition of a new need in international demand allows the country to seize an advantage. It can be the creation of a new good or a new niche within an existing demand. Perez (1985, 1988) suggests that the international advantage originates by analyzing the new technological paradigm and domestic demand and deciding where the highest innovation potential lies. She suggests using the information given by domestic demand and adjusting it to the new paradigm so that national supply can satisfy the needs of the national households. For Porter, finding a new niche can explain why some countries have leapfrogged others in particular sectors. He gives the example of competition in the copier machine industry between the United States of America and Japan. The Japanese discovered a new segment of demand, small machines, and developed a new strategy to approach the buyer. This new strategy allowed them to leapfrog the United States which was previously the principal seller in the sector (Porter, 1990, p. 36).

To summarize, we found three main roles in international demand: information, specialization and a time lag. International demand is used as a source of information to identify new needs; it affects the sectoral specialization of the country and, since it develops faster than international supply, allows the country to enjoy monopoly income during this time lag.

Some authors have centred their attention on national demand and its effects on the general overall performance of the NSI. The first interesting idea is from Porter (1990, p. 98). He points out that national needs anticipate those of the rest of the world. This fact can explain why a country first moves into an industry and how it can enjoy monopoly income, referred to by Freeman (1982). It is the time lag between national needs being fulfilled versus the rest of the world that explains the superior national performance.

The role of specialization due to national demand is pointed out by Freeman (1995). He also highlights differences in national demand as one of the reasons against globalization. He argues that the differences in some industries might not be important, but are in others. There are some national needs that, from his point of view, can never be satisfied by international supply. He highlights climate differences that affect the performance of machines, instruments, materials... and also cultural aspects that cannot be ignored without consequences in segments like food, clothing and personal services. For example, take two firms producing take-away pizzas, one Italian and the other American. The one in Italy probably produces pizzas more to the liking of Italians than ones imported from the American firm.

The information capacity of national demand is recognized as a key factor for various reasons. Lundvall (1992) points to the relations between users and producers. These strong links help producers meet the needs of different users. Out of these links the producer can find new ideas for production or to improve designs. Von Hippel goes one step further, and attributes the entire innovation process, in some specific areas, to what he calls the “lead user” (von Hippel, 1986 and 1988). This idea is also important for Porter when he says that sophisticated and demanding buyers allow firms to increase the quality of the product. Although more than information, it seems to be that demand helps national capacity-building power (Porter, 1990, p. 89). He also emphasizes the fact that a large number of independent buyers helps to increase variation, which is a major concern for many evolutionary economists. The same idea, taken from a supply side perspective, is enunciated by Metcalfe (1995).

A stream of the literature has contemplated simultaneous national and international demand dynamics as a possible explanation for differences in national capacity to compete. Fagerberg (1992) centres on testing the home market hypothesis. A strong home market means the producer's production patterns

are allowed to grow faster, building a strong competing national sector in the international market. The role of demand is information about the evolution of consumer needs, plus the capacity-building associated with this demand, which affects the international competitiveness of the supply. The capacity-building issue is also discussed by Freeman (2002) who points out that after World War II, when European research analyzes productivity gaps with the United States, the size of the domestic market is always acknowledged as one reason for the gap. However, not only the size of the demand, but also its growth seems to be important. For Porter, of even more relevance is the growth of domestic demand. But Porter also points out that the advantage of a large domestic market can be contradictory, and for some countries low demand has forced competition into the international market. Porter comments that independent of the size of the market or the growth of demand, an early saturation of domestic demand is a prerequisite for the internationalization of sales.

An interesting point regarding demand is raised when the public sector is considered as a determinant consumer. It is determinant in the sense of the proportion of the economy's consumption. Gregersen (1992) centres her attention on the public sector as a huge consumer, thereby introducing the capacity of the government to affect the innovative process from the demand side. The same point is met by Edquist (1995), where he analyzed the role of the government as a sophisticated user, and by Malerba (2004) when he recognized that demand is not one homogeneous consumer but is composed of many highly heterogeneous consumers, one of them being the public sector. This way of thinking is very much connected to another branch of the literature, military R&D, where the public sector is the main determinant and consumer.

Here, one might wonder if demand has not been sufficiently analyzed in the context of NSI. But in our view there are three principal roles that have not yet been studied:

***The importance of habit formation*.** When thinking of innovation as one of the main drivers of economic growth it is impossible to ignore this point. It is not just the fact that we need novelty, but something that is useful in the long run allows an innovation to affect the growth of the country. There is a branch of literature that has long recognized the value of this situation (for example, Duesenberry, 1949; Pollak, 1970; Ryder and Heal, 1973; and Scitovsky, 1977). But only recently, a group of economists appears to be dealing with the habit formation hypothesis and growth: Carroll et al., 1997; Alonso-Carrera et al., 2004; Alvarez-Cuadrado et al., (2004; Carroll et al., 1997; and Fuhrer, 2000.

***The causality from growth to savings*.** Opposing the formal neoclassical view that more savings generates more growth, the introduction of demand provides an argument to reverse the causality. In the orthodox framework, savings are always invested, generating more capacity to acquire new technologies, and are then translated into more output. However, this argument is biased towards

supply. By introducing demand, there is room for proposing a different causality. More consumption generates more growth and more savings. If we include this idea in a technological change framework, nobody will disagree that an environment with an active demand will favour the appearance of innovations. An interesting empirical work trying to prove this reverse causality has been presented by Carroll and Weil, 1994; and Carroll et al., 2000.

Novelty and marketing expenditure. The concept of marketing as important for innovation has been pointed out by many scholars, such as Freeman (1995). To understand why the effort a country makes in marketing is a determinant of innovation, we must understand how marketing expenditure affects individual consumers. Discarding the idea that preferences are constant, novelty plays a determinant role. In this chapter, novelty is related to the effort invested by the firm to make its innovation known to consumers. Therefore it is possible to study how marketing affects preferences. If an individual is offered two equivalent options, it is normal that the one in which a higher marketing effort is made is more likely to be chosen. If we assume that growth can be caused by an increase in consumption, a higher consumption pattern will be followed by the country where marketing expenditures are superior. The relation between growth and marketing expenditures has been analyzed by Benhabib and Bisin (2000).

Having reviewed the different roles of demand in the NSI literature, the next subsection looks at research undertaken to quantify different characteristics of the system. The main goal of this quantification is to simplify comparisons of national performance.

2.2. Attempts to quantify NSI

Although NSI was initially a qualitative approach to innovation, as Godinho et al. (2005) argued, several factors that were impossible when the idea was conceived now allow us to make a quantification of the NSI. An important generation of indices appeared after the publication of the Oslo Manual. Several new indicators have been created either by EUROSTAT or OECD statistical offices.

The first step before trying to quantify an NSI is to decide which dimensions of the system should be taken into consideration. Already Lundvall, in 1992, argued that there are five interesting dimensions that any study considering this issue should analyze: the internal organization of the firms; inter-firm relationships; the role of the public sector; the institutional set-up of the financial sector; and R&D intensity and organization. The same five dimensions are used by Montobbio (2000), though recognizing that not only the internal organization of the firm is important, but also the vertical links of the firm with clients and suppliers. Making slight variations to the original division by Lundvall,

avoiding the internal organization of the firms and studying the regulations in the sector instead, Kaiser and Prange (2004) analyze these dimensions in the German bio-technology sector. Dang Nguyen and Jolles (2005) take the division as stated by Montobbio, and add two new ones: social cohesion and access to information and communication technologies (ICT).

A different approach is taken by Furman et al. (2002) and by Porter and Stern (2001). They propose looking at three dimensions: common innovation infrastructure, national cluster conditions and the linkages between these two. Although in agreement on the same number, Nasierowski and Arcelus (1999) propose looking at the inputs of innovations, at their outputs and at the moderators between the two. Godinho et al. (2005) follow this research, but also look at the preconditions for innovation; the moderators are renamed structural organization.

An even closer division is made by Liu and White (2001). They explain that their division evolved from a detailed study of the literature concerning technical change. This is relevant for us because these are the dimensions that best fit our research. They propose taking into consideration: research, implementation, end-use, linkages and education.

After considering these dimensions, what techniques and methodologies can be used for quantified comparisons? One group comprises studies that build composite indicators. Porter and Stern (2001) use regression techniques to build up a composite indicator that measures the national innovative capacity, ranking countries according to this index. In line with this research is work done by Furman et al. (2002). But they use the composite indicator to run regressions on total factor productivity (TFP) and attempt to explain the contribution of each index in the creation of innovations. Among their concerns is the intention to link NSI and endogenous growth literature. Dang Nguyen and Jolles (2005) work with 11 variables that were initially divided among seven dimensions, before using a principal component factor analysis to reduce them to two principal components. They study the dynamics of the countries based on these two factors. Godinho et al. (2005) used 29 variables to make four dimensions from the indicators. They use these indicators to perform a cluster analysis; based on the results, they propose a taxonomy of NSI.

Nasierowski and Arcelus (1999) study the NSI in a different way. They use a set of 11 indices that they classify as inputs, moderators and outputs. Later they proceeded with different settings of a system of simultaneous equations to see how the linkages among inputs, moderators and outputs of innovations are best related. Chang and Shih (2005) use an input-output matrix to study R&D intersectoral relations and diffusion of innovations. They compared the systems of Taiwan Province of China and China. An interesting point is raised by Coombs et al. (1996) when suggesting a new way of accessing innovation performance from one branch of the literature is emerging from one

branch of the literature is emerging—that of counting innovations published in specialized journals. More oriented toward business literature, Chiesa and Manzani (1998) classify the NSI according to the various strategies that firms use when they decide to innovate.

3. The four dimensions of the system

After all the discussion introduced in the previous section, it is our belief that the interaction of the different agents of the system could be studied by looking at four main dimensions. We concentrate on two forms of knowledge: codified knowledge that can be accessed by anybody; and tacit knowledge, embodied in people. And we study how these two forms of knowledge affect the capacity to improve the production side of the economy and its demand for new innovations. These four factors are considered because we feel they are vital for the functioning of an NSI.

Human capital. The quality and quantity of human capital is fundamental for the innovation system. It is fundamental in the sense that it is through human capital that knowledge can be transformed into innovations, new processes and products. It is interesting to see what the effects of differences are across Europe's educational systems and the overall performance of the countries. We are interested not only in the capacity that the country has to educate their population, but also in its ability to spread existing knowledge. Therefore we use as ingredients for this composite indicator, the percentage of working population with tertiary education, the proportion of working population involved in life-long learning as a way to keep updated with the evolving knowledge, and the national effort made in education as a proportion of the total GDP.

Knowledge creation. We would like to assess the efforts realized by the country to push forward the frontier of knowledge and the national capacity to use this knowledge. The three variables considered here are first, public expenditures in R&D, as an indication of the national capacity to push knowledge in a more basic knowledge way than business R&D, with more profit oriented expectations. Second, the number of scientific publications as a percentage of population; an output indicator of knowledge performance of how well the resources are used to produce codified knowledge, and third, the number of internet users per capita. This last indicator is a way to see how quickly knowledge in a country is diffused. Both scientific knowledge and information on new products can be diffused much faster via the Internet.

Supply innovation capacity. What we want to understand from this dimension is not so much whether innovation is the result of a supply-push situation. We are more interested in studying what is the national capacity that the production side of the economy has to use human capital, and how existing knowledge can be used in production more efficiently. We consider here the labour productivity

index, keeping in mind the reduction of cost (increase in productivity index) as a result of the capacity of the country to take advantage of human capital and knowledge. The next variable is business R&D as a private effort to generate the specific knowledge that production needs. And the last one is the proportion of high-technology exports, to find out the degree of competitiveness of a specific country's export capacity.

***Demand innovation capacity*.** As this is a parallel concept to the previous one, we are interested in the capacity that knowledge and human capital have to increase the sophistication and needs of a country. We are also interested in assessing the impact of a more qualified society, and finding out if greater access to an increasing stock of knowledge creates a more favourable environment for the creation of innovations. To compare this dimension across countries, we use the total expenditure on cell phones per capita. The idea here is to understand how the habit of a new innovation varies across countries. As regards national marketing expenditure as a percentage of GDP, as a national effort to diffuse new products, and the proportion of GDP that goes to final consumption, the intuition behind is that a country more ready to spend is more likely to generate new products.

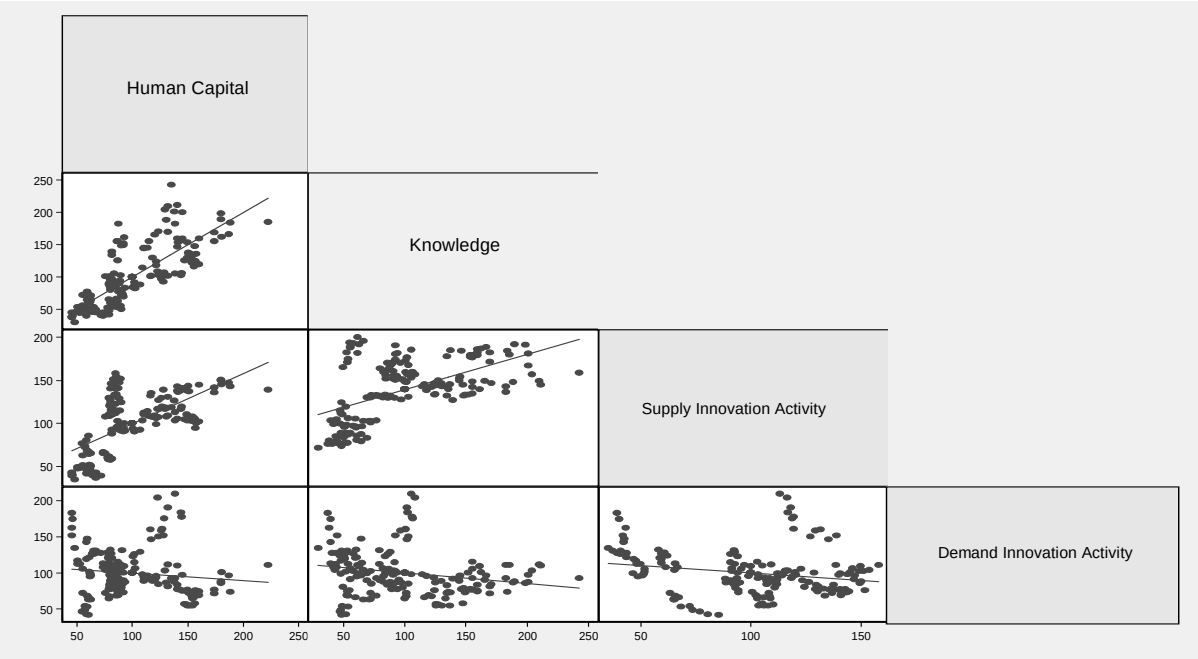
In total, we have 12 variables, which are presented in Table 1. rst, we build a composite indicator for each dimension (for a detailed discussion on how to build composite indicators, see Garcia-Torres, 2007). We study 14 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. These countries, excluding Luxembourg, comprise the EU-15 group. This country has been excluded from the sample because of the quality of the statistics provided by its statistical office. As we are interested in the evolution of the dynamics of the system, it is important to get the variables for as many years as possible. The period of this paper covers 1993 to 2003, including both years. For each variable, we have a panel data structure of 14 countries times 11 years. The data are normalized taking the European mean as a unit, and each indicator is a mean average of the three variables.

Table 1. Dimensions and variables

Dimension	Variables	Sources
Human capital	Percentage of work population with tertiary education	EUROSTAT 2005
	Life-long learning	EUROSTAT 2005
	Total expenditure in education	OCDE 2005
Creation of knowledge	Public expenditure in R&D (as percentage of GDP)	EUROSTAT 2005
	Number of scientific publications (as percentage of population)	CORDIS 2005
	Internet users per capita	WTI 2005
Innovation capacity supply	BERD (as percentage of GDP)	EUROSTAT 2005
	Labour productivity	EUROSTAT 2005
	High-technology exports over total exports	EUROSTAT 2005
Innovation capacity demand	Total expenditure in cell phones per capita	WTI 2005
	Consumption (as percentage of GDP)	WDI 2005
	Marketing expenditure (as percentage of GDP)	EUROSTAT 2005
GDP per capita WDI 2005		

The first step taken is to study the relation among the four indicators. To do this, we plotted the four dimensions, as shown in Figure 1. We plotted in a scatter graph the four dimensions against each other; the line shows a linear regression. A quick glance at the graph shows that the first three dimensions of the NSI are highly correlated, while the indicator on demand innovation capacity is not. Let us review briefly the theories behind these relations.

Figure 1. Correlation among the four dimensions



Sources: EUROSTAT, 2005; OECD, 2005; CORDIS, 2005; WDI, 2005; and WTI 2005.

The first square shows us the relation, between the human capital of the country and the capacity to increase knowledge. Here, a very strong positive relation between the two indicators can be observed. Basically, this supports the concept that a better educated population will have a higher possibility to push the frontier of knowledge. The next square shows the relation between human capital and the capacity that the working population has to improve the productive capacity of the country. Here too, it can be seen that the relationship is quite strong and positive.

If we look at the relation between knowledge and supply, it can also be seen that the relation is positive but not as strong as the previous one. So even though we find a positive relation between the increase in knowledge and the capacity to improve productivity, taking into account the previous relations, it seems to be stronger through human capital. It is possible that the impact of knowledge goes out through the human capital capacity to implement this knowledge into the production side. The most surprising part is the three last correlations. In all of them, demand is either not related to the other indicators, or there has a negative relation. In principle, we would expect that a population with higher education is in a way a group of more sophisticated consumers. Also a positive relation will be expected with the knowledge, because knowledge, in principle, should be transformed into better things, which the consumer needs in order to have a more comfortable life. But the graphs do not reveal any such relations. The relation of the last square is a bit more complex, in the sense that

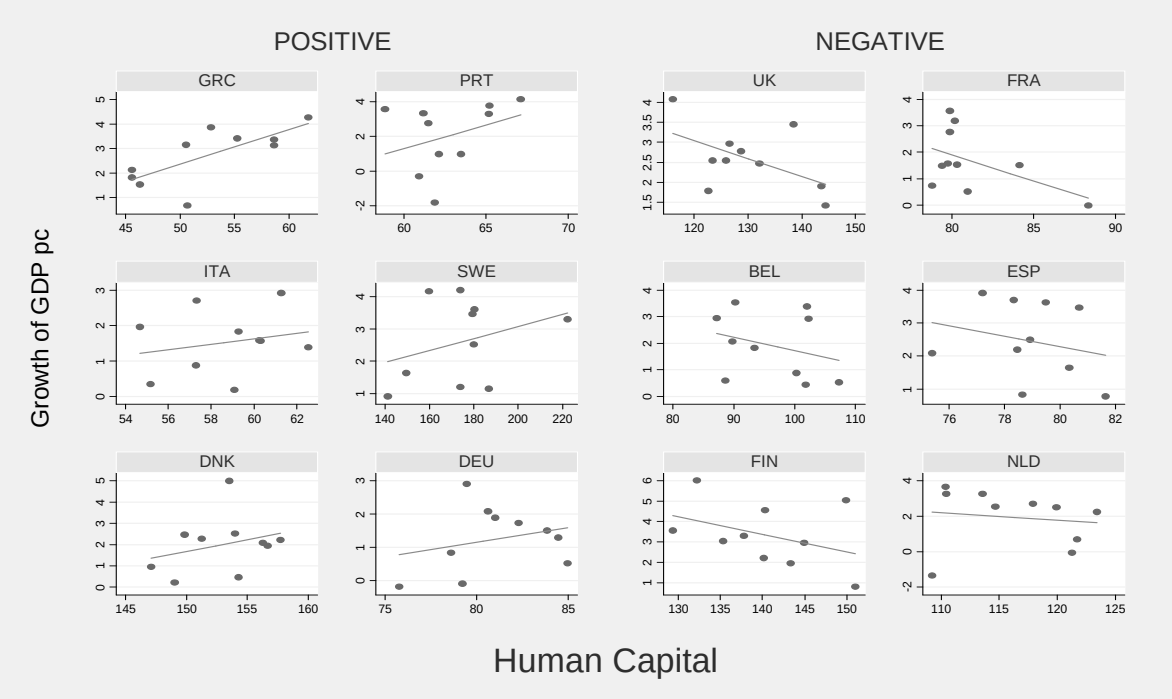
we cannot find any theoretical reason why a society able to implement the productive capacity better is also a society that is more dynamic from the demand side.

One possible explanation for these results is that, in the graphs, all the countries appear together. It could therefore be that the effect of individual countries is strengthening the relation between the indicators. Another possible hypothesis could be that the three first indicators, because they emanate from the literature base on NSI, are biased toward high-technology indicators, while none of the indices in the demand indicator bears, in principle, any direct relation with high technology. Another possible explanation is that countries are not aware of this dimension, because the scientific community has always neglected the demand side. In trying to use the information we have at hand, we go a step further; analyze the relation between the indicators and the growth of GDP per capita.

4. Knowledge and generation of wealth

Looking at the panel structure of the database, we see how countries have evolved each year. It is interesting to study the relation between the movement of the indicators and the performance of the country proxies by growth of GDP per capita. For every country, we have a total of 11 years of evolution. Now the index at each phase is the position of the country, related to the mean average behaviour. Therefore it does not necessarily have to increase constantly. The value of the index should be interpreted in relation with the mean. Hence, a country that has an index for one dimension, which is constantly increasing over time, means that its position, in relation with the mean, has been improving over the years.

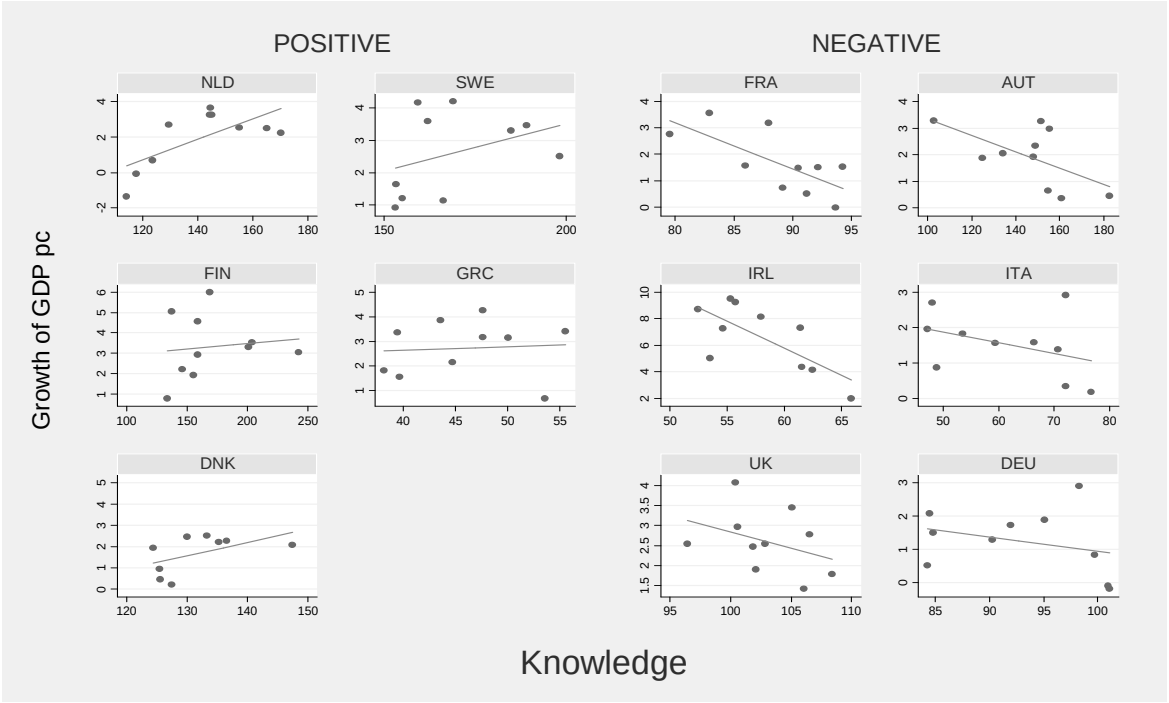
Figure 2. Relation between the economic performance of the country and human capital



Source: EUROSTAT, 2005; OECD, 2005; and WDI, 2005.

In Figure 2, we have plotted the value of the human capital index versus the growth of GDP per capita. What we are analyzing here is the position of the country in relation with the movement of the mean. And this relative movement is plotted against GDP. We can see, for example, in the case of Greece, human capital has been increasing over the years, but is still below the average value, which is 100. What we argue here is that even though the level of the index is important, we are more interested in the movement of the value in relation to the mean. The Netherlands, on the other hand, is above average over the entire period. The graphs have been presented in a way that in the left side it shows countries that manifest a positive relation between a positive movement of the index, and growth. The idea behind it is that NSI differ, and might have the capacity to perform well from different dimensions. A strong positive relation between the human capital dimension is observed, as well as an increase of wealth in countries such as Austria, Greece, Italy and Spain. A negative relation is observed in countries such as France, Ireland, the Netherlands and the United Kingdom. For the rest of the countries, it is difficult to assess whether the relation is positive or negative, as they show almost no relation between the variations of the two variables.

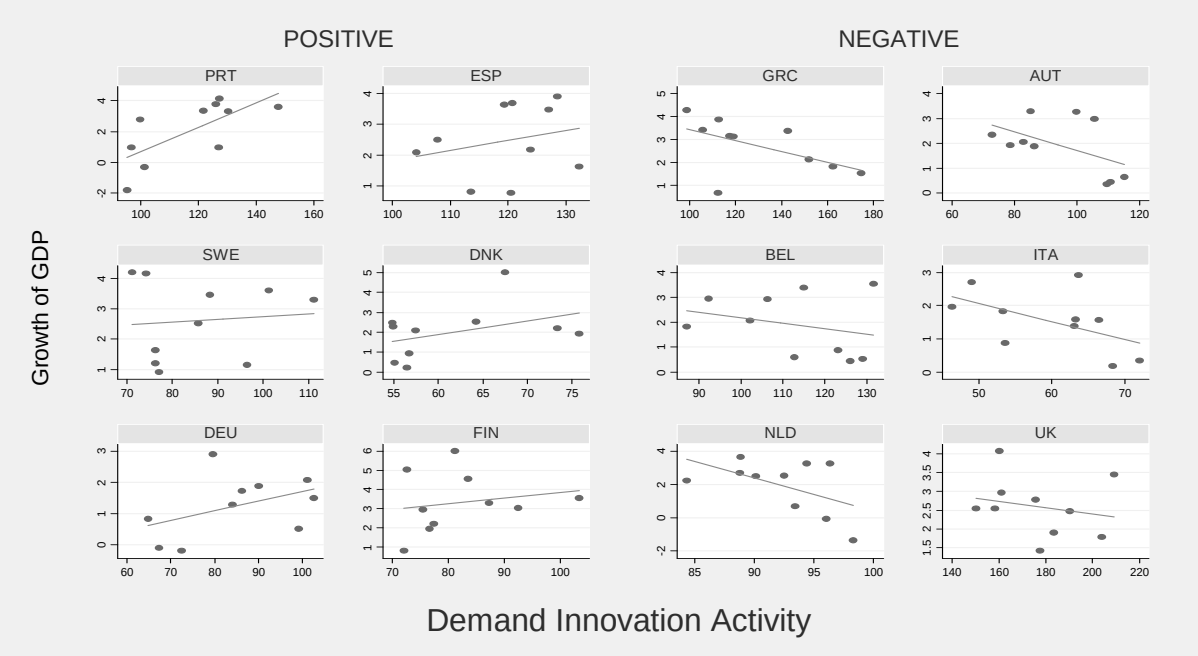
Figure 3. Relation between the economic performance of the country and knowledge



Sources: EUROSTAT, 2005; CORDIS, 2005; WTI, 2005; and WDI, 2005.

We do the same for the dimension of knowledge; the results are plotted in Figure 3**.** A similar result to the previous one is found here. Some countries have the capacity to benefit from an increase in the index, which for this knowledge index means a capacity to push forward the frontier of knowledge and use this push to increase the wealth of the country. Again, as in the previous index, there does not seem to be any relation between countries that are above the average and those that are below it. Belgium, Denmark, Greece and the Netherlands seem to have the capacity to incorporate a positive movement in this dimension, with an increase in the wealth of the country. The opposite can be said for Austria, Finland, France, Ireland and the United Kingdom. The rest of the countries, even those not presented in the graph, do not reveal any significant correlation.

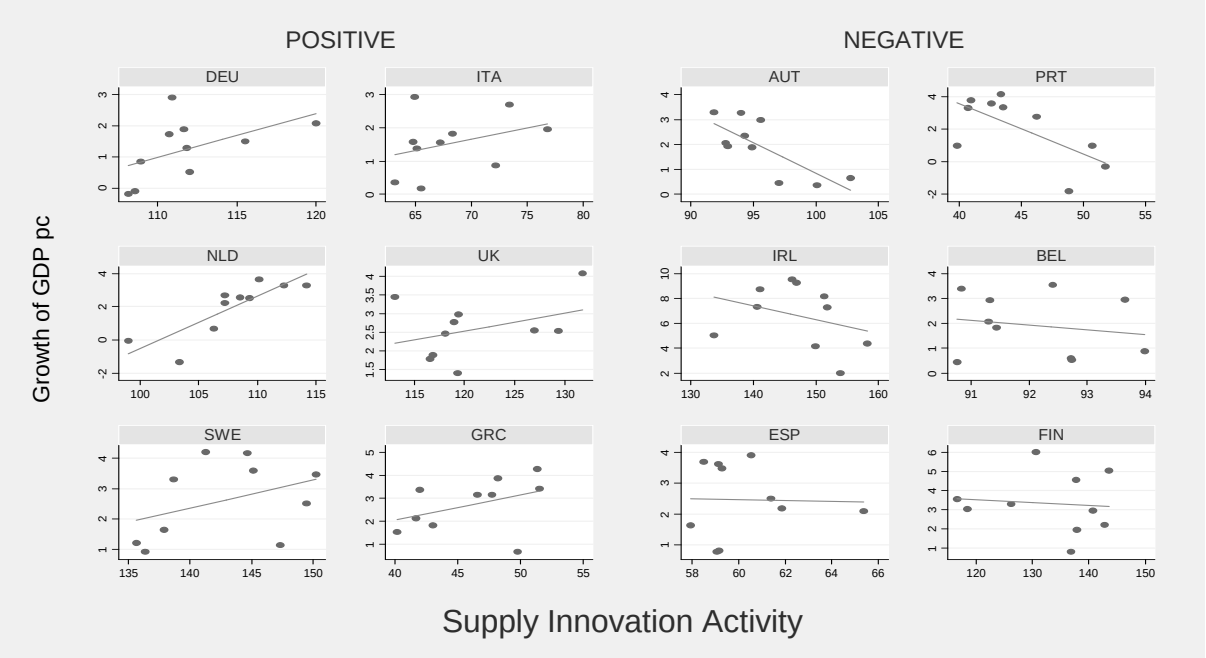
Figure 4. Relation between the economic performance of the country and demand



Source: WTI, 2005; WDI, 2005; EUROSTAT, 2005.

The next dimension studied is the dynamism of demand in relation with growth. This information is presented in Figure 4, where Belgium, Portugal and Spain show the capacity to use the movements of this index and transform them into more economical output, as seen by the positive slope of the regression line. One possible explanation for the differences in this indicator, as compared to the other three, could be that the other three indicators are biased toward the high-technology sectors. A negative relation is found for Finland, France and the Netherlands. For the rest of the countries, we find no relation with growth.

Figure 5. Relation between the economic performanceof a country and supply

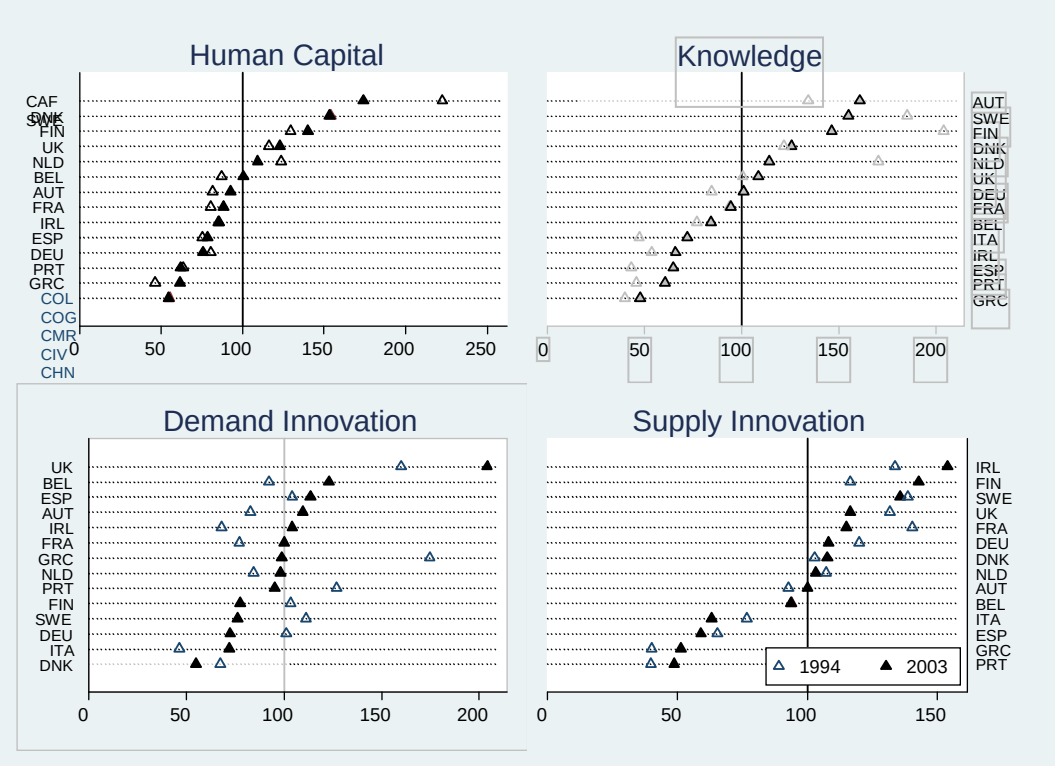


Source: EUROSTAT, 2005; and WDI, 2005.

The last dimension is the supply capacity to incorporate human resources and knowledge in production. This information is presented Figure 5. The first interesting result comes from the comparison of this figure with the previous one. Almost every country that seems to have a capacity to use demand side into growth output, seems to fail in this relation. However, the contrary is also true. The only exception, Sweden, although very mild, has a positive relation with both indicators. Greece and the Netherlands both show a positive relation between the increase of this dimension and the growth of the country; one is above the average, while the other is below. Also positive relations are present in Finland, Ireland, Sweden and the United Kingdom. Negative relations are experienced by the rest of the Mediterranean countries, Belgium and Denmark.

The general conclusion of these relations is that NSI vary across countries, and the strong and weak points of each differ according to its relation with growth.

Figure 6. Final and initial value in each dimension



Source: EUROSTAT, 2005; OECD, 2005; CORDIS, 2005; WDI, 2005; and WTI, 2005.

Before arriving at a more general conclusion, it is useful to take a closer look at the ranking and evolution of the countries over the time span being studied. This information is presented for each dimension in Figure 6.

The countries have been ranked in relation to the value they show in the year 2003. In the figure, this is presented by the dark triangle, while the light triangle shows the value at the beginning of the studied period, namely, 1993. In the human capital dimension, most of the countries remain very stable, with values at the beginning and at the end almost constant. The only exceptions are Sweden, which, in addition to being in first position, is gaining momentum in the way it is educating its population, and the Netherlands, although above the average, it is losing its position in the ranking.

As regards the knowledge indicator, Finland, the Netherlands and Sweden are still ahead in the classification, although they scored much higher values in the initial year. One possible reason is the fact that the rest of the countries are catching up in this dimension, and maybe it is the consequence of a reduction in the dispersion of this indicator across European countries. The demand dimension is one that shows more variation. First, it is interesting to see that the Scandinavian countries are below the average. This effect does not occur in any other indicator. Denmark is the last and is losing a lot of

magnitude if we compare it with its initial value. At the top is the United Kingdom, showing a higher increase. Austria, Belgium, Ireland and Spain are moving ahead, while Finland, Germany, the Netherlands and Sweden are falling behind in their consumption patterns. In the supply dimension, Ireland tops the list, and shows a capacity to increase when compared with the average behaviour. It is followed by Finland. France and the United Kingdom, even though they are still above the average they show a decrease in these indexes.

Bringing together all this information, we summarize our findings in Table 2. In the first column, the average per capita growth has been calculated for the whole period. In the next column, a positive or negative sign is shown depending on the intensity we observe from the relation with GDP growth. Then we have a number that indicates the ranking position in year 2003. Close to it, we have inserted an upward arrow if we observe an increase of this indicator in relation to its value in 1994 as related to 2003, and a downward arrow if it loses its position with respect to the average. (This information is a simplification of Figure 6.)

Let us start by analyzing the countries that show the worst performance in relation with the average growth, namely, Germany, France and Italy. Germany is only able to translate a positive impact of demand side indicator into growth, but for this indicator it is losing momentum over time. France is unable to capture any positive relation with any of the indicators. Italy shows a positive relation between growth and the human capital indicators, but occupies the last position for this indicator in the ranking, and does not show any improvement over the period. The countries above the 2 per cent average growth seem to have one corner-stone which helps them to gain comparative advantage. Spain shows a positive relation with the human capital dimension and demand, and in both indicators is gaining in position. Finland seems to rely on its capacity to reduce costs on the production side, and in this indicator it ranks second and is gaining in position. Greece is in the last position but is always increasing, and shows a very positive relation in growth with variation on three dimensions. Ireland only shows one corner-stone, the supply innovation capacity, but it ranks first and continues to gain capacity. Then we have Sweden with three positive relations, but is losing its position in some of them, due probably to the fact that the rest of the countries are catching up on these dimensions. The United Kingdom is the first on the demand side, and reveals the largest growth in this indicator, albeit with one exception, it is unable to correlate this movement to growth, even though it shows quite a high average growth over the period.

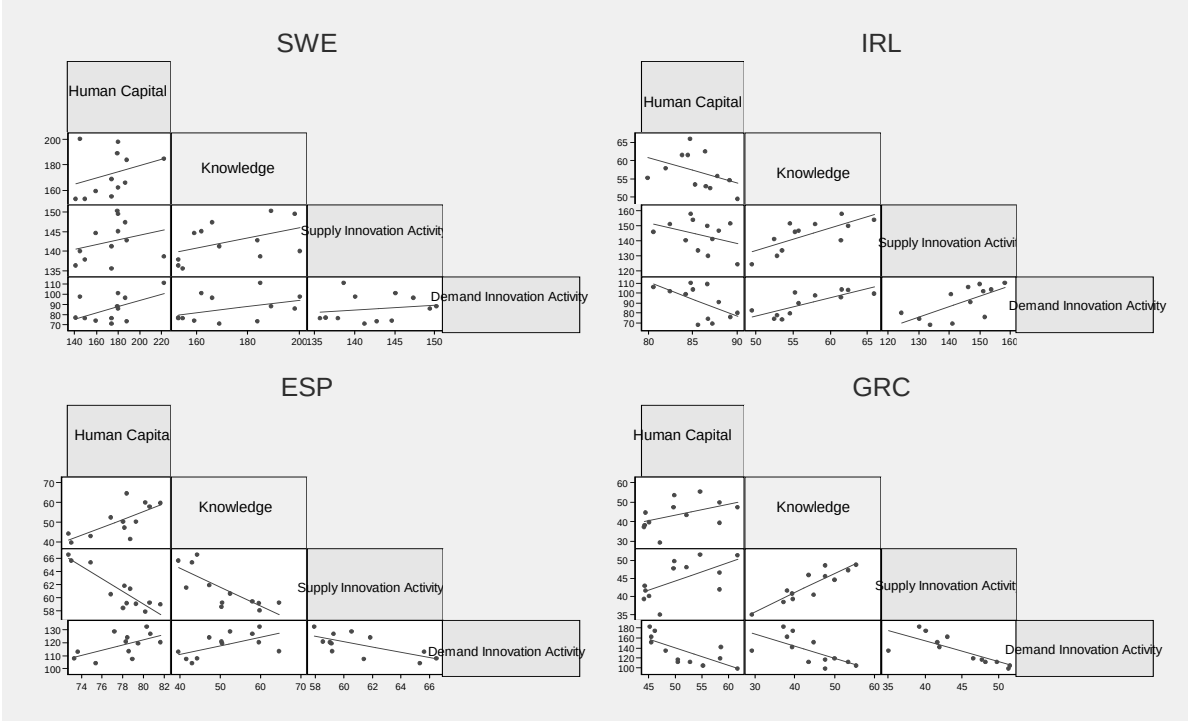
Table 2. Summarized output

	Average growth	Relation with growth				Evolution in time			
	(Percentage)	hk	kn	di	si	hk	kn	di	si
Austria	1.74	+	-			7 ↑	1	4 ↑	9 ↑
Belgium	1.63		+	+	--	6 ↑	9	2 ↑	10
Germany	.95			+		11 ↓	7	12	6 ↓
Denmark	1.78	+	+	+	--	2	4 ↑	14 ↓	7
Spain	2.1	++		++	--	10 ↑	12	3 ↑	12
Finland	2.85		-	-	+	3	3 ↓	10 ↓	2 ↑
France	1.39	--	--	-	-	8	8 ↑	6	5 ↓
Greece	2.27	++	++	--	++	13 ↑	14 ↑	7 ↓	13 ↑
Ireland	6.15	-	-		+	9 ↓	11 ↑	5	1 ↑
Italy	1.37	+			-	14 ↓	10 ↑	13 ↑	11 ↓
The Netherlands	1.74	--	+	-	++	5 ↓	5	8 ↑	8
Portugal	1.66	--	+	++	-	12 ↓	13 ↑	9 ↓	14 ↑
Sweden	2.12	+		+	+	1 ↑	2 ↓	11 ↓	3
United Kingdom	2.54	--	-		+	4	6	1 ↑	4 ↓

Sources: EUROSTAT, 2005 ; OECD, 2005 ; CORDIS, 2005 ; WDI, 2005 ; and WTI, 2005.

To complete this analysis, we have plotted the relations of Figure 1, but only for some countries. With this we would like to see if these graphs can be used as an X-Ray of the NSI of innovation. We chose four countries as clear pedagogic examples. The information on the NSI of Sweden, Ireland, Spain and Portugal is presented in Figure 7. Sweden seems to be the example to follow, as clearly evidenced by the graph. Sweden is a country which seems to be doing well in all dimensions and is also able to exploit the right links among these dimensions. And as presented in the graph, it reveals a positive relation among all the factors. This methodology could be useful to detect where the weak links of the NSI are. This can be detected easily by looking at the rest of the countries plotted in the figure. Ireland, although performing much better than the rest of the European countries in terms of per capita growth average, presents a problem with its human capital as it shows a negative relation of this dimension with the rest of the countries. It remains clear that it is this dimension where the Government should adopt more direct policies to enhance wealth. Spain, on the other hand, is a clear example of doing the right thing in three of the four dimensions, but presents a problem as regards the capacity of the society to use the knowledge and human capital to enhance productivity. Greece presents a negative relation on demand innovation capacity, so here is where more Government support could be used.

Figure 7. Individual study of some selected countries



Source: EUROSTAT, 2005; OECD, 2005; CORDIS, 2005; WDI, 2005; and WTI, 2005.

This exercise, also explains why in the first graphs no positive relation of the demand side with the other dimensions could be found. This was due to the fact that in the first graph, it was aggregated at the European level. However, the situation is different when we look at individual countries.

5. Conclusions and extensions towards UNIDO's activities

It can thus be concluded that a healthy NSI is one that is able to grow using right links among different actors of society. This paper can be used as an exercise to spot difficulties in the NSI. Once these difficulties are identified, different policy scenarios can be designed in accordance with national requirements.

The objective of this paper is to help policy makers concentrate their efforts on the weak links of the system, the differences across countries seem to vary significantly; accordingly policy recommendations for each country should also vary. The aim of this paper is thus to highlight areas on which policy makers should focus. It is also recommended that the results should be complemented by some historical and institutional analysis of the situation of the country.

With the analysis, it seems that European countries differ in their capacity to transform innovation-related activities into growth; in other words, they present very different capacities to enhance wealth. Despite the fact that the main focus of this paper is on European countries, a similar analysis could be carried out for any other group of countries. In a way, the most relevant output is a way to quantify and study the relations between the different agents of a NSI. Because our initial target was developed countries, we have mainly focused on the creation of knowledge. If we are to consider any possible extension of the work toward UNIDO's research area, we should consider variables that are more related to innovation policy and development: diffusion of knowledge, capability-building, own knowledge creation, exports, FDI and so on.

In such a globalized world, it is very important that any policy recommendation concerning industrial development considers the role of knowledge and the capacity to generate innovations from the industrial sectors. This paper offers a good way to map problems at the macro level considering the dynamics of demand and supply.

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X. Assessing the Effectiveness of Corporate Social Responsibility as a Tool for 'Poverty Reduction through Productive Activities': The Case of the Delhi Garment Cluster

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Abstract

This paper explores ways to link cluster studies and value chain analysis with efforts towards poverty reduction by investigating employment patterns in export-oriented garment clusters at the end of the Multi-Fiber Arrangement. The analysis uses the case of the Delhi garment cluster and assesses the ability and limitations of social compliance norms in facilitating poverty reduction there. Results show that the structure and characteristics of local labour markets strongly impact on poverty alleviation outcomes. While this illustrates the main constraints for the effectiveness of social compliance norms in the Delhi context, it also points to new areas for research bridging clustering and poverty reduction.

1. Introduction and rationale of the present study

So far, cluster studies have mainly addressed issues related to the growth and competitiveness of firms, overlooking the relationship between clustering and poverty reduction (Nadvi and Barrientos, 2004). This is, however, a compelling area for future research in order to assess how industrial development can actively contribute to the Millennium Development Goals (MDGs), whose main agenda focuses on poverty eradication. UNIDO is actively trying to increase its efforts in this direction; such efforts have been formalized in the elaboration of UNIDO's new key thematic area of 'Poverty Reduction through Productive Activities'. The increasing need to pay attention to poverty issues in cluster studies and initiatives must lead to a shift in focus from firms to people within the cluster (Ibid). Within this broad agenda, attention to employment generation is crucial.[2] It has been argued that, due to their labour-intensity, clusters can lead to 'sustainable employment'. However, emphasis should be put on the kind of employment clusters generate, both in terms of work practices and conditions of work, a point made by Das (2005). The recent emergence of corporate social responsibility (CSR) concerns can be a tool to improve working standards; therefore there is a compelling need to assess its effectiveness in specific contexts and sectors, especially those

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[2] Indeed, some clusters have been able to increase their labour absorption potential exponentially. Bair and Gereffi (2003) report that employment levels in the Torreon blue jeans cluster in Mexico increased from 12,000 in 1993 to 75,000 in 2000. In the Southern Indian knitwear cluster of Tiruppur employment levels grew from 20,000 to 40,000 during the 1980s (Cawthorne, 1995). By 2003 they went up to 200,000 (Singh, 2003, in Nadvi and Barrientos, 2004) and today, according to the Tiruppur Exporters Association (TEA; interview), the industry employs 300,000 people.

characterized by a high vulnerability of workers. This paper addresses these concerns by looking at the effectiveness of CSR in the Delhi garment cluster at the end of the Multi-Fiber Arrangement (MFA), indeed a crucial period for the so-called global garment industry which now faces full liberalization. The Delhi cluster is investigated through a value chain approach (VCA), which helps identify all the different activities and types of labour which are at the basis of garment production. The VCA becomes a fundamental tool to identify different locations of poverty within the Delhi cluster, and to highlight the current limitations of CSR in tackling poverty, while pointing to new research areas to further bridge cluster studies and poverty reduction.

2. Organization of the report and methodology

The rest of the report is organized in other seven sections. Section 3 sketches an overview of the birth and demise of the MFA, while Section 4 presents a brief picture of the Indian garment sector at the end of the MFA, focusing on the industrial area of Delhi. Section 5 presents an assessment of the CSR impact on the Delhi garment cluster. Section 6 analyzes further the characteristics of the value chain which defines the cluster, highlighting the leading factors which reproduce industrial fragmentation. Section 7 analyzes labour trends in Delhi, underlining how given employment practices, mainly mastered by specific agents, that is, labour contractors, represent a serious hurdle to the functioning of CSR norms in local garment factories. In Section 8, the analysis moves further, to highlight the magnitude and characteristics of the non-factory based labour force, a point completely overlooked by CSR. Section 9 summarizes the conclusions and policy implications of this analysis, while highlighting some crucial key areas for future research aiming to further bridge cluster studies and poverty reduction. This paper is based on field findings stemming from a period of intensive fieldwork conducted in India between October 2004 and July 2005, and is based on an analysis that combines quantitative and qualitative research methods. Quantitative data on export turnover was derived mainly from the archives of the Apparel Export Promotion Council (AEPC). Qualitative data, which represents the most valuable contribution of this analysis to the knowledge of the Indian garment sector, has been obtained through interviews with different tiers of key informants, such as academics and researchers studying the Indian garment sector, AEPC and other government officials, manufacturers and exporters associations (such as, the Clothing Manufacturing Association of India (CMAI)), labour organizations and unions (mainly, in Delhi, the Centre for Education and Communication (CEC), and the Centre of Indian Trade Unions (CITU)), and Delhi exporters and subcontractors (18 in total), identified thanks to the help of AEPC, and CSR managers of the two brands; Monsoon and The Gap. Delhi exporters allowed access to further key informants who work within the final segments of the garment value chain. Interviews with exporters and subcontractors

have been followed by visits to their factories, which allowed verification of the reliability of interviews.[3]

3. International policy in the textile and garment sector: is the end of the MFA an opportunity or a threat for exporters?

The textile sector is one of the most globalized industries in the world. Attempts to regulate textile trade can be traced back to the 1950s, when the United States negotiated the first voluntary export constraints on Japanese products in 1955 (Spinager, 1998). While these first attempts on regulation were dominated by bilateral agreements, soon efforts focused on ways to elaborate a structured initiative to regulate trade and production multilaterally. These efforts gave birth to the MFA, established in 1974, and aimed at allocating maximum export quotas to exporters of textile-based products (Singh, Kaur and Kaur Sapra, 2004). While initially the MFA focused mainly on raw materials and low value-added manufactures, such as fabrics, later on it started focusing on more elaborate manufactures, especially garments. In a way, it could be argued that the evolution of the MFA well reflects changes in the so-called comparative advantage of developing countries. In fact, since the end of the 1970s, the shift from import-substitution (IS) policies to export-oriented industrialization (EOI) caused a profound restructuring of the old international division of labour, where developing countries were mainly providers of raw materials, giving rise to a new division of labour where many of these countries became sites of manufacturing production (Jenkins, Pearson and Seyfang, 2002), following the formation of what authors such as Gereffi and Korzeniewics (1994) call global commodity chains (GCCs).

With the substitution of the General Agreement on Trade and Tariffs (GATT) with the World Trade Organization (WTO) in 1994, the end of the MFA was negotiated; it was meant to happen over 10 years and in five stages. By 1 January 2005, the MFA final deadline expired, leading to the full liberalization of the textile and garment sectors.

4. The Indian garment sector: main debates around the end of the MFA

In India, the end of the MFA was long awaited by garment exporters, who saw in it a great opportunity to increase their share of the global market. Indeed, India arrived at the end of the MFA in a rather privileged position. In fact, data show that, since the 1960s, when India's garment production was virtually non-existent, the country has managed to exponentially increase its share of global production.

[3] For a more detailed discussion on methodology, see Mezzadri (2007).

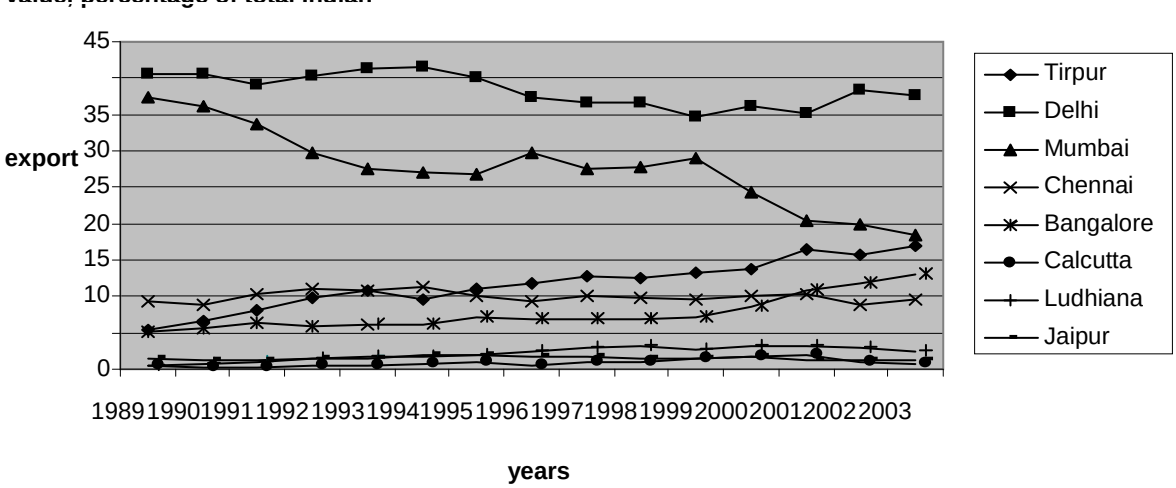
Table 1. Share of readymade garments in India's exports 1960-1961 to 2000-2001

Year	Readymade garment exports		Total textile exports		Manufactured goods exports		Total exports	
Value/ Percentage	Value (millions of Rs.)	Percentage	Value (millions of Rs.)	Percentage	Value (millions of Rs.)	Percentage	Value (millions of Rs.)	Percentage
1960-1961	10	0.16	790	12.29	2,910	45.26	6,430	100
1970-1971	290	1.89	1,450	9.45	7,720	50.29	15,350	100
1980-1981	5,500	8.20	9,330	13.90	37,470	55.83	67,110	100
1990-1991	40,120	12.32	69,260	21.28	237,360	72.91	886,690	100
1994-1995	103,050	11.6	199,450	22.5	646,830	72.90	886,690	100
2000-2001	254,780	12.52	-	-	1,607,230	78.95	2,035,71	100

Source: Author's adaptation from table 3.1 in Singh and Kaur Sapra (2007:43); based on DGCI&S data cited in Economic Survey 2002-2003, Tables 7.3 and 7.4, Government of India, various issues.

Garment production concentrates around a number of key industrial areas, which are identified by the AEPC, the Indian governmental body which, since its birth in 1978, was in charge of the allocation of quotas under the MFA, and which continues, to date, to be in charge of the export promotion activities related to that sector. These key industrial areas are Delhi, Ludhiana, Jaipur, Calcutta, Mumbai, Bangalore, Chennai and Tiruppur. These centres are characterized by a strong presence of small and medium enterprises, and they are included in UNIDO's list of Indian industrial clusters (UNIDO, 2003). In the past three decades, AEPC has registered the turnover from these centres, both in terms of quantity and value.

Figure 1. Export performance of Indian garment export centres: value



Source: Author's own elaboration, based on data by AEPC on export turnover, various issues (1989-2003); Value is expressed as a percentage of total exports from India.

As the data clearly show, Delhi is the most important centre in terms of value exported.[4] In Delhi, the end of the MFA was welcomed with great enthusiasm, and since the first months of 2005, Delhi exporters registered steady increases in their export orders (Delhi Exporters, interviews). Many of them reported they were expanding their production facilities, opening up new units and buying new machinery. The potential expansion of industrial set-ups could be crucial for India; in fact, according to the last UNCTAD report on the global garment industry, smallness of industrial premises is identified as the major constraint to the growth of the sector in the sub-continent (Appelbaum, 2005).

5. The rise of CSR norms in the garment sector: impact assessment in Delhi

Parallel to these relevant transformations in the industrial scenario, the late 1990s saw a steady rise in CSR norms in the garment industry in the form of company-based codes of conduct (Jenkins, Person and Seyfang, 2002). Codes aimed to guarantee social compliance, that is, the respect of given standards vis-à-vis labour practices. Garment exporters in developing countries had to adjust to the new global requirements towards social compliance, and adopt codes of conducts imposed by the international buyers.

In both policy-making and academic circles, CSR has been heavily criticized. Some criticisms have focused on CSR's internal contradictions and on its aim for a self-regulating business (Jenkins, 2002; Dubinsky, 2002; Justice, 2002; O'Rourke, 2002). However, the scarce implementation of labour laws (where present) in many developing countries makes it rather difficult to simply disregard CSR from the start. Instead, there is a need to assess its impact. Empirical evidence so far has been rather mixed (see, for instance, Roberts, 2002; Dent, 2002; Prieto, Hadjipateras, and Turner, 2002), highlighting the need for further studies on CSR effectiveness and limitations in specific contexts.

In the Delhi garment cluster, the end of the MFA (and the consequent pressures to consolidate production) and the implementation of CSR norms could reasonably lead to an improvement in working conditions for the hundreds of thousands employed by the industry.[5] In short, the great success of Delhi garment exporters could translate into a success for their workers as well. However, this does not seem to be the case. On 23 November 2004, during a workshop held at the Habitat Centre in Delhi, experts of the Institute of Development Studies (IDS) presented their impact assessment of CSR norms in the Delhi garment sector.

According to the assessment, codes worked well only for some, that is, for those holding permanent contracts. Codes did not work for the other two categories of workers employed by the garment

[4] In terms of quantity, Delhi is only second to Tiruppur, India's 'T-shirt town', whose export turnover rose exponentially at the end of the 1990s (AEPC, 2004).

[5] Estimated between 250,000 and 330,000 (AEPC, interviews, Delhi Exporters, interviews; CEC, interviews; CITU, interviews).

industry, namely, casual and temporary workers.[6] Unfortunately, these workers represent an astonishing 80 per cent of the total factory workforce. Codes of conduct were therefore working only for a meagre 20 per cent of workers, who were arguably already rather well protected by Indian national labour legislation as permanent employees. In a way, codes were merely replicating the failure of national legislation in protecting the most vulnerable (and conspicuous) segment of the labour force. This result can be explained by looking at the characteristics of the value chain in the Delhi garment cluster, both in terms of production activities and labour employed to carry out these activities.

The relevance of the integration of VCA and cluster analysis has already been spelled out in the literature on industrial development. Generally, the VCA is used to address the issue of external constraints that clusters face in the era of globalization (Schmitz and Nadvi, 1999; Humphrey and Schmitz, 2000). While the VCA mainly focuses on the various activities which comprise one specific production cycle, it can also be used to map the different types of labour which these activities entail, a point which was clearly made in the first conceptualization of commodity chains by World System theorists (Hopkins and Wallerstein, 1986). This way, the VCA can become a useful tool for mapping poverty nodes within the cluster, that is, those points "*where specific groups of producers and/or workers are located who are vulnerable to poverty or likely to be in poverty"* (Nadvi and Barrientos, 2004:33).

6. Pressure towards consolidation versus resilience of industrial fragmentation: sketching the value chain of the Delhi garment cluster

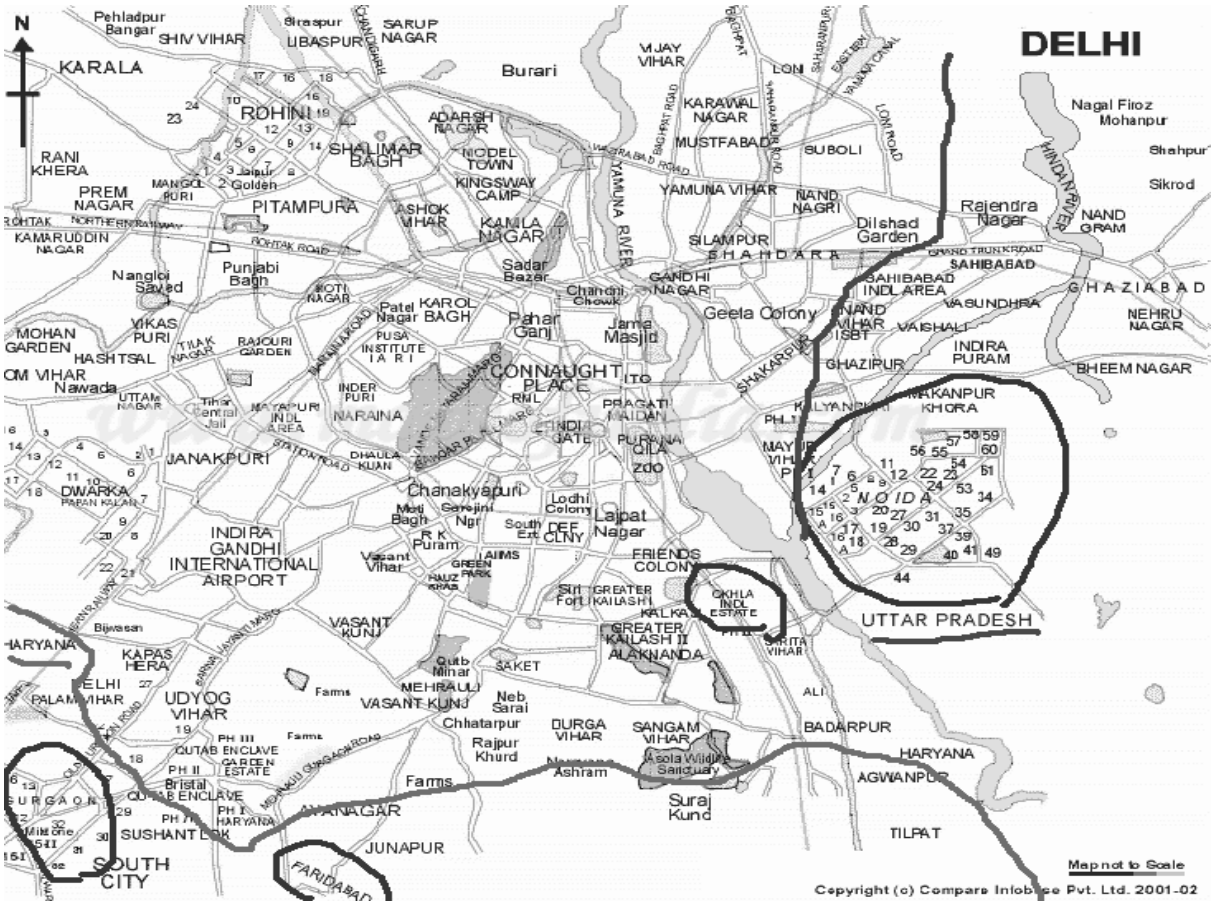
The Delhi garment cluster has been historically characterized by a high fragmentation of industrial activities, due to its artisanal heritage, which traces back to the Moghul Empire (Blake, 1993). Small tailoring units were initially organized according to the logic of the putting out system, where a core of powerful merchants, thanks to their connections with overseas importers, decentralized production to a spider-web of little artisans (Singh, Kaur and Kaur Sapra, 2004). Old reports on the Indian garment industry (Ambedkar Institute of Labour Studies, 1980) confirm that by the 1980s, the industry was still fully organized according to this logic.

The old legacy of Delhi garment production can still be traced in the current geographical make-up of the industry, which shows a highly complex and fragmented value chain, characterized by numerous production activities. From Okhla, the original site of Delhi garment production (Alam, 1992), inside Delhi city, the industry slowly moved to new areas, mainly to the neighbouring states of Uttar Pradesh

[6] Temporary workers are those who are employed by the industry only for short periods of time, while casual workers are those employed on a daily basis (AEPC, interviews, Delhi Exporters, interviews; CEC interviews; CITU interviews). Generally, these workers are employed during specific periods (for instance peak season), or to carry out specific activities, not always required within the production cycles.

(UP) and Haryana, which have since been incorporated into the Delhi metropolitan area. Today, the New Okhla Industrial Development Area (NOIDA) in Uttar Pradesh and Gurgaon and Faridabad in Haryana represent the main locations of the industry, which is further moving towards the hinterlands, towards what is known as Greater NOIDA (further down in UP) and along the Delhi-Jaipur highway.

Figure 2. Location of garment production in Delhi metropolitan area



Source: Map from http://www.airportsindia.org.in. The circles indicate the location of the main garment hubs.

It is quite common that exporters own multiple units in several of these production sites. On this point, it is worth noting that if, today, the end of the MFA represents a push-factor towards the consolidation of production, in the past it reproduced industrial fragmentation. In fact, through the ownership of multiple units, exporters could access a higher number of quotas, as up to the 1990s quota allocation was mainly based on two principles: the first-come–first-served (FCFS) principle and the past performance (PP) principle. These principles favoured those operators who were in business for a longer time; specifically, those who already had strong connections with overseas buyers, and who had a history of positive past export turnover. According to both principles, quotas were

attributed to the single industrial units, directly supporting the parcellization of production capacity. By 2004, AEPC estimates that the Delhi garment cluster was hosting between 3,000 and 4,000 units, with an average of 60 sewing machines each. The number of exporters, instead, was around 600 (AEPC, interviews).

The high industrial fragmentation of the value chain which characterizes the Delhi garment cluster is clearly reflected in the high incidence of subcontracting. On average, Delhi exporters subcontract some 60-70 per cent of their total production to smaller garment producers who may or may not have direct access to the export market (AEPC-Delhi, interview; Delhi Exporters, interview; Delhi subcontractors, interviews). These agents may specialize in full garment fabrication (in which case they are called 'fabricators') or in specific activities of the production process (such as cutting, packaging, etc).

Also, Delhi's product specialization, geared towards ladies' wear fashion products, contributes to reproducing the fragmentation of the value chain. In fact, it is based on very layered and volatile product cycles, mainly characterized by a rapid succession of small orders (Ibid; Monsoon and The Gap CSR departments, interviews). In this context, subcontracting becomes fundamental in order to maintain high competitiveness and flexibility.

Therefore, if the end of the MFA is indeed pushing towards consolidation of production, other factors are in fact countering this consolidation, supporting instead the resilience of industrial fragmentation. Such resilience explains the lack of formalization of labour relations in the sector and the dominance of temporary or casual labour across the entire chain.

7. Labour in the factory realm: the dominance of 'in-contracting' and migratory labour

Some bigger exporters are indeed responding to pressures towards consolidation generated by the end of the MFA. They are increasing their unit-size and are trying to formalize their production process, especially by increasing in-house production, and reducing the level of subcontracting. However, even in these bigger units, temporary and casual labour dominates. Big exporters manage to maintain non-formalized labour relations through the decentralization of the labour issue to specific agents, the *thekedaars*, or labour contractors. These agents organize groups of workers and provide a highly flexible workforce to the exporter (Delhi exporters, interviews). In his study on Tiruppur, Chari (2004:115) reports how the local exporters interviewed often used the expression "I own the machines, but not the work". This is exactly what happens in the Delhi context. By decentralizing labour recruitment and management to the *thekedaars*, Delhi exporters remain mainly in charge of the 'machines'. In this context, even fully formalized production can be carried out in the absence of

formalized labour relations. The *thekedaars* organize workers' groups according to exporters' production needs, both in terms of skills and export orders. This practice, which guarantees that even larger industrial set-ups are able to increase their labour force without losing out on flexibility, is generally referred to as in-contracting.[7]

The workforce which dominates the factory realm of the Delhi garment sector is mainly composed of migrants from the rural hinterland of UP and Bihar, the two poorest states of the Hindi belt. These populous states represent a huge reservoir of labour for India's manufacturing production. Generally, labour contractors have sub-agents in the villages who organize local recruitment, the journey to Delhi, and who provide for housing arrangements, generally in slums around the main industrial areas. Migrants stay in Delhi for an average period of eight months before going back to their villages (CEC, interviews; Monsoon and The Gap CSR departments, interviews). In this scenario, it is not surprising that CSR norms fail to work. Codes of conduct are elaborated as factory regulations, whereas the factory does not directly employ its labour force, which is instead organized and managed by other agents along the value chain, and functions under very precarious and temporary labour arrangements.

8. An army of labour in the non-factory realm: the case of embroidery

The spread of in-contracting explains the persistence of temporary labour relations in the factory realm of the Delhi garment sector. However, the casualization of employment in the industry appears even more pronounced when one considers the army of workers who are indirectly employed in non-factory based activities. A great share of these workers finds jobs in what can be labelled the embellishment network, which represents the final segment in the value chain of the Delhi garment cluster. This network mainly deals with embroidery-related tasks, which have a considerable importance in the local garment industry. In fact, thanks to embroidery, garments can become twice as expensive for the buyer (Lal, 2004).[8]

Delhi exporters report that the ratio tailors/embroiderers needed is 1:3, that is, for each tailor the industry needs at least three embroiderers (Delhi Exporters, interviews). AEPC sets at 3,000-4,000 the total number of units in the Delhi garment cluster, and at 60 the average number of machines per unit.[9] From this, it would follow that the industry needs between 540,000 and 720,000 embroiderers, indeed quite significant.

[7] A similar practice was described by Castells and Portes (1989) with reference to the Latin American informal economy.

[8] Lal (2004) reports that buyers pay 73 rupees to local exporters for non-embroidered garments, while they pay up to 125 rupees for embroidered items.

[9] The number of machines is used as a proxy for the number of tailors.

The embroidery network belongs to the vast world of the Indian informal economy. Although such a world is not regulated by legal institutions, it is strongly socially regulated (Harriss-White, 2003; see also Breman, 1996). Indeed, this is the case for the Delhi embroidery network. Activities are geographically placed in very strategic ways, while the employment of different social groups in different activities seems to assure cost minimization in each segment of production.

The two types of embroidery which are most needed by exporters are '*adda*' work and 'beading', also known as '*moti'* work. *Adda* work is a type of very intricate embroidery realized on a special handloom, the *adda*, traditionally used by Muslim communities, mainly based in UP, in villages around the areas of Bareilly, to realize designs on Indian sarees. Beading, instead, is the process of attaching beads onto designs already made inside the factories, generally through computerized machines. Exporters subcontract these activities to specialized agents, called 'vendors', who utilize an informal home-based workforce, which constitutes the last segment of the Delhi garment 'labour value chain' (Delhi exporters, interviews; Vendors, interviews).

When asked about where *adda* work takes place, exporters answer: "in the villages" (Delhi Exporters, interviews). The analysis of the vendors' network helps to unravel the meaning of this expression. In fact, only a small percentage of *adda* work is realized in Delhi. Here, vendors make use of various informal units situated in and around the main industrial areas, but these units alone are not sufficient to satisfy the industrial needs, besides being non-economical for both the vendor and the exporter, as *adda* work is not a typical Delhi-based skill, and as such it is quite scarce and expensive. The minimization of costs in these units is realized through the employment of a consistent percentage of child labour. Children start learning the job at the age of eight, they master it by the age of twelve, and their wage is roughly half that of an adult worker. The largest share of *adda* work is instead decentralized to artisanal clusters around Bareilly, the area in UP where this craft originally emanated. Here vendors, making use of local sub-vendors, employ household labour. Households generally own the looms; however, vendors provide them with all the necessary inputs (such as thread, beads, etc.). Often, vendors may even provide them with some form of credit, for instance, an advance on their final payment (vendors, interviews).

The combination of low child worker wages and urban-rural wage differentials guarantees cost minimization in the *adda* segment of production (vendors, interviews, sub-vendors, interviews; proprietors of embroidery units, interviews). It is worth noting how, through this particular network, the garment value chain connects the urban, dynamic Delhi garment cluster to small, artisanal clusters in rural India.

Beading, instead, is realized through the employment of female home workers, generally in and around the main industrial areas in Delhi (Ibid). As this is considered a very low-skill activity, and

therefore a female task, gender wage discrimination guarantees cost minimization. All those engaged in these embroidery-related tasks are not covered by CSR norms, as they are solely conceptualized as codes of conduct, therefore as factory regulations. This is indeed another consistent limitation to CSR effectiveness in Delhi; CSR norms do not account at all for workers who are employed in the final segments of the value chain.

9. Policy implications and areas for further research

This paper shows how a VCA of industrial clusters can indeed provide useful insights regarding the relationship between clustering and poverty reduction, empirically strengthening what is already claimed by Nadvi and Barrientos (2004) at the theoretical level. Moreover, in this specific case, the use of the VCA to map different types of labour present in the Delhi garment cluster unravels the reasons behind the CSR's limited effectiveness in ensuring improvements in garment workers' conditions. In fact, this analysis reveals that CSR limitations in this specific context are strongly dependent on the characteristics of the social division of labour and the layered structure of labour markets within the cluster.

First, within the factory-realm, the functioning of the CSR is undermined by the diffusion of local practices which aim to decentralize labour-related risks to specific agents, freeing exporters of the labour burden. The increasing casualization triggered by these practices makes CSR norms difficult to implement and monitor. Secondly, the conceptualization of the CSR as a set of mere factory-based regulations, or codes of conduct, seems inadequate to fully address poverty concerns within the cluster. In particular, in order to reach out to non-factory based workers, other CSR measures should be elaborated. By 2005, international buyers, such as Monsoon or The Gap, were exploring new ways to tackle the issue of home-based labour. In some areas, they tried to set up community centres, where home-workers could meet (Monsoon and The Gap CSR departments, interviews). The effectiveness of such initiatives is yet to be assessed, but they indeed represent one viable option to explore further.

At a broader level, the case of the Delhi garment cluster clearly shows that labour markets are indeed powerful mediators between productive activities and poverty reduction. Their structure and dynamics are fundamental in order to elaborate effective poverty reduction strategies within industrial clusters. In fact, the present analysis shows that the main limitation of the CSR in the Delhi context is due to the lack of consideration of local social structures of production and labour dynamics internal to the industry.

This paper has unravelled given areas where there is a wide scope for future research in order to further bridge cluster studies with efforts towards poverty reduction. Firstly, the VCA carried out in

Delhi has highlighted how, in the current context of global production, the dichotomy between urban or modern clusters and rural, artisanal clusters may be false.[10] In the case of Indian garment production, the fortunes of the Delhi industrial cluster seem to be strongly interconnected with those of some small artisanal clusters in rural UP. The extent to which such interconnectedness is likely to bear positive spillovers to these small rural clusters, in terms of poverty reduction, is definitely worth further exploration.

Secondly, migration flows which guarantee a consistent reservoir of labour to the factory-realm of the Delhi garment cluster deserve closer attention in future. In fact, these migrants' livelihoods seem to cross the usual boundaries which differentiate between urban and rural employment, and urban and rural poverty. These individuals are likely to be representatives of new forms of poverty, which are worth studying further in order to elaborate more successful poverty reduction strategies.[11]

Finally, this analysis highlights the need for a deeper understanding of how forms of household, or home-based, labour are integrated into local and global value chains, again for the purpose of poverty reduction. In the case under scrutiny here, for instance, can UP-based household labour be conceptualized as self-employment? In a way it could, as households generally own their means of production (the looms). However, as they obtain inputs and often credit from the vendors, it is licit to wonder whether they may instead represent disguised forms of wage labour. This query is far from purely theoretical, as it bears strong policy implications in terms of poverty reduction.[12] In fact, if these individuals are self-employed, efforts should focus on micro credit provision and access to inputs, strengthening the current dominant rhetoric on poverty reduction in rural areas. If, instead, they could be viewed as wage labourers, then efforts should focus on providing them with better and less precarious wages and recognizing them as an essential component of the garment workforce. These are all highly relevant issues for future studies on industrial development as they underline the numerous ways in which the study of productive activities can lead to a better understanding of poverty and how to eradicate it.

[10] This dichotomy is generally present in numerous cluster classifications. The reader can refer to Gulati (1997), to Sandee (2002), Schmitz and Nadvi (1999), Altenburg and Meyer-Stamer (1999).

[11] On the issue of 'old' versus 'new' poverty, see Rigg (2006).

[12] This issue has already been raised by other studies focusing on rural labour markets in Africa. See, for instance, Sender, Cramer, and Oya (2005; 2006).

Home-workers, Kayala, Delhi outskirts, May 2005, photograph taken by the author

Home-workers, Kayala, Delhi outskirts, May 2005, Photograph taken by the author

**Factory workers, NOIDA, May 2005,
photograph taken by the author**

**Adda rural workers, village D. around Bareilly, May 2005,
photograph taken by the author**

**Adda workers, outskirts of Delhi, May 2005,
photograph taken by the author**

**Adda workers, outskirts of Delhi, May 2005,
photograph taken by the author**

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