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Determinants of productivity in Morocco and Egypt - the role of trade?

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Abstract

The aim of this paper is to explore the determinants of productivity and productivity change in the Moroccan and Egyptian economies, with a particular emphasis on the role of international trade in impacting upon productivity levels. Methodologically this is achieved through a two-stage methodology. First we focus on productivity, and productivity change and its determinants at the micro (firm) level. The underlying data we have comprises both detailed cross section data, as well as slightly less detailed time series data. In the first stage then we derive estimates of firm and sectoral level productivity, and examine their evolution over time. For this first stage we derive the firm level productivity measures using both econometric and index number approaches. The second stage of the work is concerned with understanding and explaining the differences in productivity across the firms/sectors, and in particular of the role of trade liberalisation in this. This involves regressing the differences in productivity on a range of key explanatory variables. This analysisis carried out at both the sectoral and the firm level, and for different time periods.

Our results suggest that changes in firm level productivity are relatively modest (in particular in the latter half of the period), and that there are quite considerable changes in aggregate productivity arising from a relatively high degree of entry and exit of firms, and from changes in the shares of incumbent firms. This suggests clearly that it is changing market shares, and the entry and exit from the industry that are key to understanding the aggregate productivity changes. It also suggests that is important to consider carefully the institutitional, financial and regulatory framework within which firms operate, and thus the constraints they face. Central to the methodology and the results in this report is the need to recognise the importance of firm level heterogeneity. The results indicate that the relationship between key variables such as import or export openness can vary importantly according to the size (class) of the firm. It is thus important to understand the sources of these differences in these relationships better, and secondly to tailor policy accordingly. Hence, while overall we find a positive relationship between exports and productivity we also find that the relationship between exporting and productivity is weakest for large firms.

Introduction

Since the Barcelona Declaration of 1995, the EU and the countries of the Southern Mediterranean have been engaged in a more active process of integration and trade liberalisation. Whereas prior to 1995 the relationship was primarily asymmetric, the Barcelona process envisaged trade relations becoming both more symmetric as well as deeper than heretofore. Under the Barcelona process each of the Mediterranean partner countries have signed Association Agreements with the EU. The key feature of these agreements involved the gradual the elimination of Mediterranean partner tariffs on EU exports. The ultimate objective here was to achieve a Euro-Mediterranean free trade area, and hence for the process of integration to include both EU-Med liberalisation as well as integration between the Mediterranean partners themselves.

For the Mediterranean partners a key objective of this process was to stimulate higher rates of economic growth and development, and to achieve this through closer links to the EU. While trade reform, primarily for manufactured goods was clearly seen as an important means of achieving improved economic performance, there was also a recognised need for this to be coupled with domestic institutional reform. This process of closer integration is now moving to a new phase with the introduction of the EU's Neighbourhood Policy.

The objective of the research underlying this paper was to consider the micro-impact of these processes of trade liberalisation on firms and sectors, and through this shed light on the impact on poverty and development. In particular the aim was to focus on an understanding of the determinants of firm and sectoral level productivity, to consider the role of the transmission mechanisms between trade liberalisation, increased competition and the consequent impact on firm level productivity and reallocation of resources.

First, we explore the relationship between productivity and trade liberalisation by looking at data over time. Specifically, we focus on firm level data for Morocco over the 1990-2002 time period, and on sectoral level data for Egypt over the 1983-1994 time period. In this section of the report we look at the evolution of productivity over time, and across sectors, as well as on the role of trade in explaining changes in productivity. Secondly, we focus on a much more detailed firm level data set for

Morocco for the years 1997-1998. This enables us to consider in more detail firm level determinants of productivity.

The objective of this research is to shed light on the determinants of productivity, and through this on the possible poverty impact of trade liberalisation. Methodologically this is achieved through a three stage methodology. First we focus on productivity, productivity change and its determinants at the micro level. In so doing we derive estimates of firm and sectoral level productivity, and can then examine their evolution over time. Secondly, we use use those productivity estimates in order to obtain a clearer understanding of the determinants of productivity and of the role of trade in impacting upon productivity. For these analyses we use firm level data for Morocco, and sectoral level data for Egypt.

2. Conceptual background

Ultimately concerns about poverty with respect to given economies or societies translate into concerns about (a) the overall level of income per capita and its determinants (b) the distribution of that income across sectors of society and the determinants of that distribution (c) the rate of economic growth, and changes in that rate of growth.

Central to the approach taken in this report is that, ultimately, poverty is driven by low levels of productivity. Therefore, if the concern is on establishing possible effective mechanisms for raising per capita GDP for any given economy, than appropriate policy needs to focus on the mechanisms driving productivity growth. This suggests a focus on overall level effects and on factors driving the growth of those levels, as opposed to a concern solely with distributional effects. This is not to say that distributional effects are unimportant and the growing literature on trade and poverty highlights a number of such likely effects. These include, for example, the impact on domestic consumption as prices change, changes in production and employment and therefore also the rewards to employment, and changes in government revenue. Structural adjustment at the firm level - ie the entry and exit of firms from industries - is a process of adjustment, which takes time and there are costs associated with that process eg. workers being laid off by unsuccessful firms, and in declining sectors or industries. Also, the identified welfare gains (or losses) may well not impact equally on all groups in society. Those sectors of society who consume a smaller proportion of imports or import-competing products will correspondingly gain less from this direct effect. It is also important to note that if there are concerns about the distribution of income in society, than it is much easier socially, politically and economically to impact upon that distribution in a framwork of economic growth, rather then economic stagnation or decline.

These are all important issues of direct concern to policy makers. In the long run however, higher per capita income levels will arise with increases in efficiency and hence with higher growth rates. One can then distinguish between two channels of possible efficiency gain: First, improvements in allocative efficiency. Poor allocative efficiency may arise in two ways. First, it can arise purely domestically if either labour markets or goods markets function poorly. Secondly, trade barriers reduce international allocative efficiency. The gains from comparative advantage are precisely the gains from improved allocative efficiency across different national markets. Much of the existing literature on the impact of trade liberalisation has focussed on issues of allocative efficiency. Hence both theoretical and empirical models focussing on comparative advantage have as their principal concern the issue of international allocative efficiency. Equally, models, which allow for imperfect competition are typically also concerned, in good part, with allocative efficiency. The pro-competitive impact of trade liberalisation, for example, results in an improvement in allocative efficiency.

Secondly improvement in output or technical efficiency, ie. productivity. Implicit (though not inherent) in the first channel is that the underlying technology of firms' is a given and is held constant. Hence the reallocation of resources occurs conditional upon the given levels of efficiency or productivity of firms across sectors. The pro-competitive effect on firms, or the exploitation of economies of scale occurs holding the firm's production function technology constant. Trade liberalisation can, however, potentially have a substantial impact on productivity and economic growth by also impacting on the efficiency of the firms themselves, as well as through the expansion of the workforce by drawing in unemployed resources.

There is by now a well-established literature on the relationship between trade or openness and economic growth. While there is not unanimity about this relationship, most commentators tend to accept that more open economies tend to grow faster. There is a wide range of empirical evidence on this, which tends to support this conclusion (eg. Dollar, 1992; Sachs & Warner 1995; Edwards, 1998; Frankel and Romer, 1999), though much of the preceding was heavily criticised by Rodriguez and Rodrik (2001) either on the grounds of poor econometrics, or weak underlying data. There are indeed a number of methodological difficulties in the literature. These include data related issues such as finding satisfactory measures of openness, and/or the trade stance of given economies, to more fundamentally establishing the direction of any causal link between trade liberalisation or openness and growth. It is important here also to fully recognise that trade liberalisation, in and of itself, is clearly not sufficient to result in higher growth rates. To the extent that greater openness may lead to higher growth this will depend to a high degree on the underlying economic, institutional and indeed socio-political environment. The conditions for successful growth are then likely to be highly economy-specific.

There is then broad acceptance of the view that "under the right conditions" more open economies are more likely to grow faster. It is worth then, carefully thinking through the possible channels, which could drive increases in overall productivity levels. In the discussion that follows we focus on changes in trade policy, but clearly much of this could equally apply to other policy changes. Three key channels can be identified:

a) Inter-sectoral compositional shifts: Changes in trade policy are likely to lead to a reallocation of resources to relatively more productive sectors. If comparative advantage lies in those sectors in which an economy has higher productivity than aggregate productivity will rise. Note, that it is possible for the inter-sectoral shifts to lead to specialisation in the sector with lower productivity, in which case trade theory suggests that the allocative efficiency gains will dominate, hence leading to overall welfare gains. To the extent that the inter-sectoral reallocation is driven by differences in relative factor endowments across countries than there will be associated changes in real factor prices, and hence changes in the distribution of national income across groups within the economy.

b) Intra-sectoral compositional shifts: Here the changes take place within a given sector and are driven by more productive firms realising a higher share of the market than less productive firms. These intra-sectoral compositional shifts can either take place through changes in the relative sizes of more and less productive firms, or through the entry and exit of firms. The entry and exit of firms, driven by different characteristics such as different underlying productivity levels emphasises the importance of the presence of firm level heterogeneity, and the importance of addressing that heterogeneity in empirical work.

c) Changes in firm-level productivity: Here the channel is through existing firms increasing their levels of productivity. It is worth noting that much of the trade and growth literature tends to focus on this channel. Hence, that literature typically identifies the following possible mechanisms: technological progress eg. from increased R&D; technological transfer arising from increased exposure to technologies, ideas or even processes, or through importing higher quality intermediates; greater exploitation of economies of scale arising from access to larger markets; or reductions in firm-level inefficiency. These changes encompass both shifts in a given firm's production function, as well as moving firms closer to their respective frontiers.

Note, that an understanding of which of these channels is important and the circumstances under which it is important is extremely important from a policy perspective. That policy importance is two-fold. Firstly it is important to shed light on those policies that may be more likely to stimulate higher rates of economic growth. If, for example, compositional shifts appear to be central to economic growth (under certain given circumstances) than having policies in place, which facilitate the entry and exit of firms may be important. Hence there is evidence that in Egypt the process of both establishing and dis-establishing firms is complex and lengthy - this is then likely to hamper the growth process. Similarly, if the evidence suggests that trade liberalisation is more likely to lead to economic growth because of exploitation of economies of scale as opposed to from technology transfer than this has clear implications for policy. Secondly, the different mechanisms have different implications for the distributional implications of any changes in policy. Again, if changes occur via compositional shifts this entails firms exiting (and entering) workers being laid off and higher adjustment costs, than for example growth that takes place through improvements in technology or reductions in technical inefficiency.

The three channels identified above, as well as the more detailed mechanisms driving changes in firm level productivity are clearly all possible and plausible. However we have comparatively little information and evidence on which channels and mechanisms are in reality more important; or alternatively, under which circumstances are the different channels/mechanisms more likely to play an important role. In particular, also, we have comparatively little evidence on the actual transmission mechanism(s) mediating the linkages between changes in (trade) policy and growth for developing countries.

It is also worth pointing out that many of the mechanisms identified imply heterogeneity at the firm level. It therefore follows, that in order to address these questions it is then important to work with firm level data. There has recently been a growth in the availability of firm level data sets, in particular for developing countries, and the emergence of a literature which thus focuses on decomposing and better understanding the source of productivity growth, and productivity differences across firms (eg. Bailey, Hulten & Campbell, 1992; Levinsohn & Petrin, 1999; Barnard and Jenson, 2002, 2004; Tybout & Liu, 1996; Roberts & Tybout, 1997; Clerides, Lach & Tybout, 1998;, Van Biesebroecke, 2003). There is also an emerging theoretical literature focussing on firm level heterogeneity simulated inter alia by the work of Melitz.

3. Data and methodology:

As discussed above trade liberalisation can impact upon productivity in three principal ways: through the exit of less efficient firms; through the entry of new firms; or through an improvement of efficiency among existing firms. Central to each of these is the recognition of firm level heterogeneity. It is for this reason that ideally understanding the transmission mechanisms impacting upon firms is best carried out using firm-level data, although useful work can also be achieved when working at the sectoral level.

Methodologically we take a two-stage approach. In thei first stage we estimate productivity at the firm (for Morocco) or sectoral (for Egypt) level. In the second stage we regress those estimates of productivity on a range of explanatory variables. There are three principal methodologies for measuring productivity which are: Data Envelopment Analysis, an index number approach, or estimation of production functions. There is some debate in the literature over the relative advantages and disadvantages of each of these. A key difference is that DEA and the index number approaches are non-parametric, however they tend to allow for more flexibility in allowing for firm level heterogeneity. In this work, where possible, we use both the econometric and the index number approaches. This allows us to compare the robustness of the results across the different methodologies.

The second stage of the work is concerned with understanding and explaining the differences in productivity across the firms/sectors, and in particular of the role of trade liberalisation in this. This involves regressing the differences in productivity on a range of key explanatory variables. This analysisis carried out at both the sectoral and the firm level, and for different time periods. Clearly, however, the explanatory variables used will to some extent differ.

- For the time-series analysis the variables that can be used include: openness (either with regard to export markets or domestically), the age of the firm, the size of the firm, and the firms' relative skill intensity. For Morocco this is done at the firm level, for Egypt at the sectoral level.
- In contrast for Morocco for the detailed FACS based firm level cross section analysis, the explanatory variables include both structural variables which capture the overall context within which firms make decisions, as well as variables which capture the choices that firms themselves make. Hence, in the former category we include variables such as the degree of openness (with respect to both exports but also imports), the degree of concentration, firm size, the region of production, extent of foreign participation, sectoral fixed effects etc. In the latter category we include information on the extent of capital investments made, as well as possibly the type of investments made, in the preceding periods, the extent of investment in human capital, levels of R&D in the preceding periods etc. Clearly not all these are statistically significant, and in the results we focus on those that are.

A central variable of interest here concerns measures of openness and hence the impact of trade liberalisation. For the sectoral level work the aim is to pick up on the time-series variation in trade policy in order to assess the direct impact of policy changes on sectors. Trade policy / trade liberalisation here may be relevant both with respect to export markets and import markets. Hence, sectors may become more productive as a result of improved access to export markets. This may occur because of learning-by-doing, or because firms are required to produce to certain norms and standards which require investments in new technologies. Sectors may also become more productive because of the increased openness of import markets. This may occur because of increased competition from competing foreign suppliers which induces increased efficiency by local firms; it may occur because of spillovers between domestic and import competing firms; or it may occur because firms have access to higher quality intermediate input which improve their productivity.

At the sectoral level data constraints mean that it is not possible to identify which of the specific effects outlined above are present. While we can assess the extent to which trade liberalisation may or may not have impacted upon productivity across sectors, it is more difficult to identify all the possible mechanisms driving those changes. With the firm level analysis we can explore these issues more fully. In the firm-level analysis we include variables such as the extent of intermediate inputs imported, the extent of concentration in the industry, the presence of foreign capital in the firm, the extent of foreign participation in the industry, the shares of different types of labour employed, investment in human and physical capital. This enables us to build up a much more detailed picture of the possible determinants of firm level productivity, and of the role of trade policy in those determinants.

Trade and tariff data was obtained from the COMTRADE and TRAINS databases respectively. For Egypt there is no published nor publically available data set with firm level information. Sectoral level data is, in principal, available from the early 1980 to the late 1990s. In practice key data, such as sectoral level price deflators, for the latter half of the 1990s is missing and/or the data has inconsistencies. The data we end up working with is for the period 1983-1994. The sectoral level of aggregation is at the ISIC rev.2, 2-digit level - which thus comprises up to 13 sectors or industries. Important also in the Egyptian context is the distinction between public and private companies and this is also captured in the data set, as well as the size class of firms. For Morocco we had access to two complementary data sets which provided detailed information at the firm level. These were the Annual Census of Manufacturing for the period 1990-2002, and a detailed survey (FACS) undertaken over 1997-1999 in collaboration with the World Bank.

4. Results

4.1: Morocco: Time series analysis

The data we have derives from the Moroccan Annual Industrial Inquiry. This is an annual census which in principle covers 16 sectors. Partly because of data constraints, and partly to ensure comparability with the detailed cross section analysis in this report we have focussed on seven sectors. These are: Textiles, Clothing, Leather, Food Processing, Chemicals, Electrical, and Rubber & Plastics.

Given the focus on the role of trade liberalisaton in this paper it is important to note that tariffs in Morocco are typically high ranging from an average of 47%-99% in 1993 to 17%-52% in the year 2000 (see Table 1). Secondly, the period has experienced a substantial decline in tariffs and this is true in all sectors. The biggest declines are in Textiles and Electrical where the reductions were 74% and 58% respectively, and the smallest declines were in Food products (28%) and in Leather goods (29%)

Table 1: Moroccan Tariffs

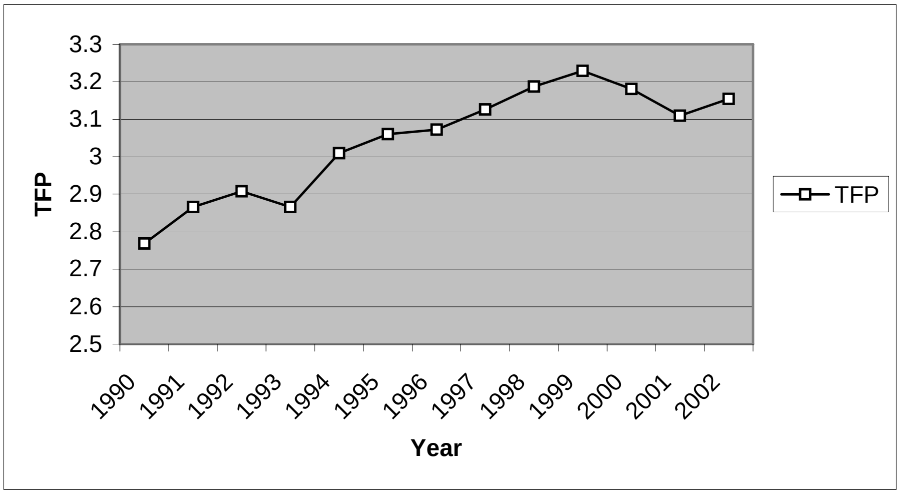
	1993	1997	2000
Food	72	61	52
Textiles	92	61	38
Clothing	99	71	50
Leather	60	50	43
Chemical	47	35	26
R&P	61	48	38
Electrical	65	37	17

Source: Trains database

4.1.1 Analysing the productivity estimates

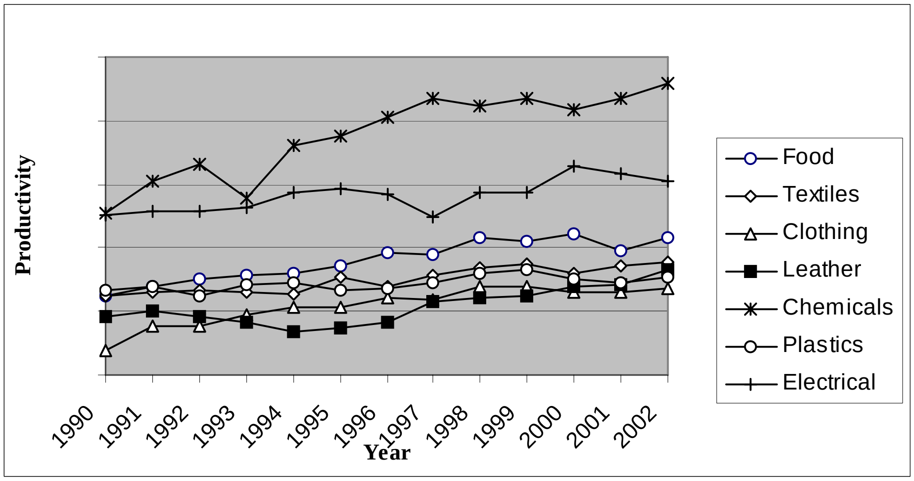
We now turn to a consideration of the results derived from our estimations of firm level productivity by year (please refer to Appendix 1 for a full description of the methodologies employed). Figure 1 gives the aggregate change in weighted TFP over the period 1990-2000. It can immediately be seen that from 1990 to 1999 there was overall a steady rise in TFP, equal to just over 16.6% over the time period, followed by a decline in aggregate productivity until 2001, which is then followed by a small productivity improvement in the last year of the sample.

Figure 1: Aggregate Productivity: Morocco



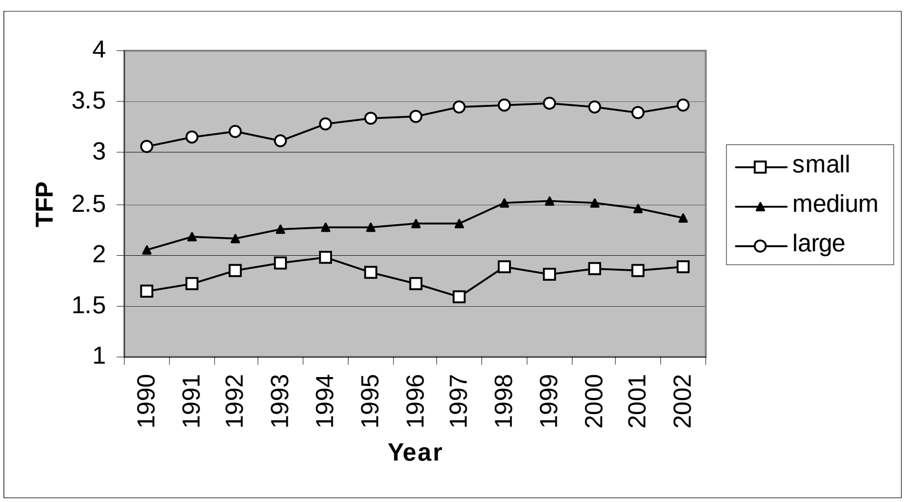
As discussed earlier this change in aggregate productivity can arise either because of intra or inter-sectoral reallocations, or because of existing firms becoming more productive. Figures 2, which gives the change in productivity by sector and by year, sheds more light on this, and then the issue is subsequently explored more formally by decomposing the changes in productivity across these different categories. Three clear messages emerge from Figure 2 First, that the sector with the highest level of productivity throughout the period is that of Chemicals, and the sectors with the lowest productivity for most years are Leather and Clothing. Over the entire time period, all sectors experience a rise in productivity with the largest rise in productivity for Chemicals (31.1%), followed by Clothing (22.8%) and Food products (17.3%). Two sectors, Rubber and Plastic, and Electrical experience only very modest increases in productivity (4% and 8% respectively) over the 12 year period. It is also interesting to note that from 1998 onwards (ie. in the period following the launching of the Barcelona process) productivity rises are for most sectors extremely modest and in two cases there is a small decline in productivity (Clothing, and Rubber and Plastic). Once again the two sectors with the highest productivity growth over this period are Chemicals (4%) and Leather (8%).

Figure 2: Productivity by sector and by year: Morocco



It is also usefull to consider the changes in productivity over the time period for different size classes of firms which is shown in Figure 3. In the figure the size categories are: small firms are those with less than 10 employees; medium sized firms with 10-100 employees, and large firms, with more than 100 employees. Immediately noticeable is that there is a direct correlation between the size of the firm, and the level of productivity. Hence large firms are significantly more productive than medium sized firms, who are in turn more productive than small firms. The pattern of changes over time is similar with all size categories showing an overall increase in productivity of between 13%-15%, and very little productivity growth if not productivity decline (for medium sized firms) from 1998 onwards.

Figure 3: Changes in productivity by size of firms



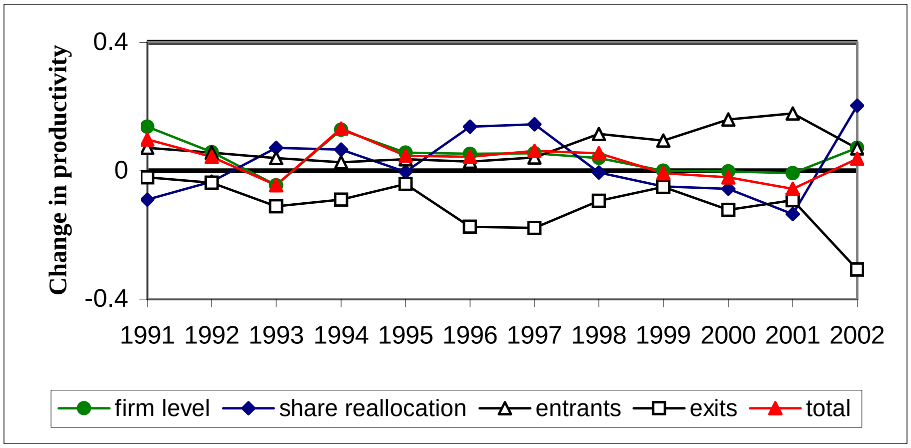
As discussed earlier the changes in productivity can have a number of different underlying causes, and can be reflected in different forms of structural adjustment at the firm level. In particular the changes in productivity can arise because of (a) changes in the productivity level of existing firms; (b) changes in the share of existing firms in production at given levels of productivity; and (c) from the entry or exit of firms into the industry, where the productivity levels of those entering and exiting differs from existing firms.

Figure 4 gives the decomposition for all firms in aggregate, and where the four elements of the decomposition are labelled – firm level, share reallocation, entrants, and exits – respectively. The latter two components, that is to say entrants and exits, are often referred to in the literature as representing the "replacement effect". The graph also gives the total change in aggregate productivity from one period to the next. Note that each of the series give the *change* in productivity from one period to the next. Hence, any point above "0" represents an increase in productivity, and below this a decrease in productivity. The solid red line gives the change in total productivity and the message here is the same as that in Figure 2 earlier – for most of the early 1990's productivity increases, and from 1999-2001 there is a decrease in productivity.

The remaining four series decompose these changes in productivity. The decomposition of course, sums to the total change in productivity over each time period. Hence, consider first the changes in firm level productivity. This gives the change in productivity for those firms who survive from one period to the next. Looking at this series we can see that the pattern of changes is very similar to the total change in productivity discussed earlier – for most of the years incumbent firms increase their productivity, and this therefore contributes to the overall changes in productivity. The share reallocation component and the replacement effect (entrants + exits) are inevitably interrelated. This is because where there is net entry (exit) of more (less) productive firms, than this increases (decreases) aggregate productivity, hence the replacement effect is positive. At the same time the entry (exit) of firms decreases (increases) the share of incumbent firms, and tends to push the share reallocation effect downwards.

The effect of share reallocation appears to be largely dominated here by entry and exit of firms, as opposed to by changes in incumbent firms' levels of productivity. Indeed in the census data we have here for Morocco, there is considerable entry and exit of firms. This is then reflected in the contribution to the total productivity change of the entrants and those that exit. Note that by definition in the decomposition entrants must increase productivity, and firms that exit decrease productivity. This is because the decomposition is the weighted sum of each of the respective elements. Hence, a new firm enters positively, and a firm that leaves enters negatively. What is relevant therefore is the extent to which entrants and exits impact upon aggregate productivity.

Figure 4: Aggregate Decomposition of Productivity Changes



From Figure 4 it can be readily seen that the contribution of new firms to aggregate productivity is fairly low up until 1997, and then starts to rise. There is then a fall between 2001-2002. At the beginning of the period, exits decrease productivity by only a small amount, and then other than 1999, there is a larger decrease in productivity arising from the exit of firms.

An interesting issue is whether the net replacement effect is positive or negative – in other words does the combined effect of entry and exit of firms lead to an increase or a decrease in productivity. This will depend on two factors. First, on the productivity level of those firms entering and exiting firm, and secondly on these firms' respective market shares. Table 2 below is comprised of two panels. In the top panel we give the net replacement effect, which as outlined earlier will depend on two factors. In the bottom panel we then give the difference in the unweighted average productivity level between entrants and those that exit. Hence the top panel indicates whether overall the replacement effect is positive or negative; and the bottom panel indicates whether the aggregate productivity level of entrants is higher or lower than those who exit the industry.

Table 2: Differences in productivity between entrants and exits

Difference in average productivity for entrants & exits - weighted by shares							
	Food	**Textiles**	**Clothing**	**Leather**	**Chem.**	**R&P**	**Elec.**
	15	**17**	**18**	**19**	**24**	**25**	**31**
1991	0.0080	0.0164	-0.0893	-0.0006	-0.0048	-0.0035	-0.0486
1992	-0.0272	-0.0379	-0.0996	-0.0617	-0.0118	-0.0166	-0.1913
1993	-0.1944	-0.1044	-0.0760	-0.0265	-0.0227	-0.0378	-0.0123
1994	-0.0429	-0.1594	-0.1624	-0.1111	-0.0066	-0.0747	-0.3187
1995	-0.0151	-0.0417	-0.0556	-0.0983	-0.0151	-0.0209	-0.1770
1996	-0.1242	-0.0178	-0.0908	-0.1255	-0.3832	-0.0726	-0.0560
1997	-0.1475	-0.1381	-0.1142	-0.3221	-0.1111	-0.0799	-1.6433
1998	-0.0925	0.0226	-0.1399	-0.0424	-0.0795	-0.0571	0.3858
1999	-0.0023	0.0149	-0.1207	-0.1048	-0.0304	0.0258	0.4541
2000	0.0082	-0.0017	-0.1118	0.2454	-0.0726	-0.0161	1.4677
2001	0.0091	-0.0466	-0.0350	0.0255	-0.1053	-0.4256	-0.0525
2002	-0.2382	-0.2464	-0.0640	-0.0967	-0.2806	-0.0509	-0.5411

Difference in average productivity for entrants & exits - unweighted by shares							
	15	**17**	**18**	**19**	**24**	**25**	**31**
1991	-0.0052	-0.0012	-0.0111	-0.0012	-0.0026	0.0000	-0.0015
1992	-0.0142	-0.0106	-0.0203	-0.0063	-0.0023	-0.0025	-0.0019
1993	-0.0076	-0.0116	-0.0180	-0.0043	-0.0048	-0.0011	-0.0009
1994	-0.0886	-0.0292	-0.0273	-0.0085	-0.0041	-0.0056	-0.0034
1995	-0.0037	-0.0064	-0.0084	-0.0031	-0.0019	-0.0009	-0.0015
1996	-0.0069	-0.0054	-0.0076	-0.0037	-0.0058	-0.0033	-0.0022
1997	0.0211	-0.0063	-0.0093	-0.0023	-0.0029	-0.0008	-0.0025
1998	-0.0012	-0.0067	-0.0063	-0.0023	-0.0084	-0.0026	0.0005
1999	-0.0067	-0.0042	-0.0065	-0.0039	-0.0031	0.0000	0.0003
2000	-0.0021	-0.0018	-0.0046	-0.0030	0.0016	-0.0008	0.0010
2001	-0.0067	-0.0038	-0.0028	-0.0012	-0.0007	-0.0014	-0.0006
2002	-0.0185	-0.0112	-0.0065	-0.0023	-0.0031	-0.0020	-0.0019

Consider the top panel first. What is striking is that this indicates that for most years, and for most industries the net replacement effect on the change in productivity was negative. In turn this means that in considering the change in productivity from one period to the next the impact of exiting firms in lowering this change in productivity was more significant that the impact of new firms on raising the change in productivity. Of course this could simply arise because the number of exiting firms was much larger than the number of new entrants, as opposed to any underlying differences in productivity between entrants and those that exit. Light is shed on this in the bottom panel of the table. Here, we compute the difference in the average unweighted productivity for the two groups of firms, by industry. A negative entry indicates that the average productivity of those that leave the industry was higher than the productivity of those entering the industry. Again, it is striking that the substantial majority of the entries are negative, and that a positive entry is exceptional.

4.1.2: Econometric Analysis

We now turn to consider the results from our second stage regressions. Here we take the productivity measures derived in the first stage, and run panel regressions on key explanatory variables. Of course there are a large number of possible factors which could impact upon productivity – these include the openness of the economy, access to export markets and experience in exporting, extent of foreign direct investment, investment in human and physical capital, the underlying infrastructure, the legal and regulatory environment…. With respect to this data set information on all these variables is simply not available – especially at the firm level. However, some of these factors we are able consider below when we turn to our more detailed cross section estimates. The main variables of interest in this section, and upon which we do have information is the size of the firm, the export orientation of the firm, the age of the firm, and the degree of sectoral openness (measured by imports / output, and also by exports / output), and the relative skill intensity of the firm. Information on the latter variables was only available from 1996-2000, hence we run two sets of regressions – one set on the entire time period and the second set from 1996-2000. Time dummies were included in all of the regressions but are not reported here.

For each of the time periods we run two regressions – one where we allow for sectoral level fixed effects (2nd and 4th columns), and one where we allow for fixed effects at the level of the firm. For the 1996-2000 time period we also run the model in first differences in order to see if there are any short run dynamics which can be identified. In terms of the fixed effects, the firm level effects control for characteristics specific to individuals firm over the time period; and the sectoral effects are designed to capture whether there any features which may be specific to a given sector over the time period in question (and thus common to firms within the sector) that may impact upon productivity levels. We report on these sectoral level fixed effects in columns 2 and 4 of Table 3. Over both time periods it can be seen that the sectoral fixed effects are statistically significant and show that there are indeed differences in productivity across the sectors. These results indicate that Chemicals is the most productive of the sectors, while Electrical and Leather Goods are the least productive sectors.

The first five rows of the results focus on the variables that are common across our two time periods. The first of these gives the ratio of exports to output at the firm level. This coefficient is positive and statistically significant across all the regressions, and indicates that increasing exports are associated with an increase in productivity. Interestingly the size of the coefficients is somewhat different over the two time periods. Hence over the period 1990-2002, the coefficient is 0.016 in both cases, which suggest that a 10 percentage points increase in the ratio of exports to output would lead to 0.16% increase in productivity, on average and ceteris paribus. While the coefficient is statistically significant the impact is relatively small. For the shorter and later time period – 1996-2000 – the coefficient ranges between 0.13 and 0.17. This suggests that a 10 percentage points increase in the ratio of exports to output leads to an increase in productivity of between 1.3%-1.7%, on average and ceteris paribus - which represents a non-negligible impact. The final column of the table gives the results for the regression in first differences. This too suggests that an increase in exports from one period to the next leads to an increase in productivity, though the size of the coefficient is somewhat smaller.

For the latter time period we also have information on the ratio of exports and imports to output at the sectoral level, and the results for these variables (expoutsec, and impoutsec) are given towards the bottom of the table. The level of sectoral export orientation does not appear to impact upon productivity, and there is some evidence from the firm level fixed effects regression, that increased openness on the domestic market leads to a decrease in productivity. This is also the case for the regression in first differences which suggests that a 10 percentage points increase in the ratio of imports over output in the preceding period, may lead to a decrease in productivity of 1.3%, on average and ceteris paribus. This is an interesting result as it is often argued that opening up to international trade, and encouraging more competition in domestic markets should lead to increases in productivity. Those increases in productivity could arise as less efficient firms exit the industry, and also with the possible entry of more efficient firms. There is no clear evidence of this occurring here. Indeed in the decomposition earlier we showed that if anything it appeared the reverse was taking place - less efficient firms were entering the industry and more efficient firms were leaving. There are alternative explanations too - increases in competition may be forcing firms to produce less and with economies of scale this implies an increase in average costs and a decrease in efficiency. However, in principle the first stage regressions check for the presence of economies of scale, and the evidence suggested that firm produced under constant as opposed to increasing returns to scaled.

Table 3: Firm level productivity – estimation results

	1990-2002		1996-2000		
	Sectoral FE	**Firm level FE**	**Sectoral FE**	**Firm level FE**	**First differences**
expout1	0.016	0.016	0.138	0.17	0.0759
	(3.05)**	(10.43)**	(8.03)**	(6.42)**	(2.12)*
size2	0.494	0.196	0.503	0.179	
	(52.39)**	(15.65)**	(27.78)**	(6.15)**	
size3	1.007	0.252	0.944	0.137	
	(86.86)**	(12.43)**	(41.82)**	(2.78)**	
Size					0.068
					(2.11)*
age	0.007	0.029	0.006	0.033	
	(8.23)**	(16.15)**	(3.33)**	(3.79)**	
sqage	0	0	0	0	-0.598
	(1.47)	(6.79)**	(0.05)	(3.79)**	(-4.07))**
Food	-0.471		-0.83		
	(19.66)**		(16.29)**		
Textiles	-0.34		-0.596		
	(14.01)**		(12.73)**		
Clothing	-0.376		-0.714		
	(15.51)**		(12.25)**		
Leather	-0.26		-0.583		
	(9.70)**		(10.26)**		
Chemicals	0.324		0		
	(10.73)**		(.)		
Rubber & Plastic	-0.492		-0.828		
	(18.54)**		(15.61)**		
Electrical	0		-0.256		
	(.)		(4.22)**		
skunsk1			0.023	0.003	0.078
			(1.77)+	(0.46)	(1.04)
Expoutsec			-0.195	-0.08	0.252
			(1.03)	(-0.65)	(1.58)
Impoutsec			-0.034	-0.143	-0.132
			(0.8)	(-1.06)*	(-2.01)*
Constant	1.777	1.582	2.398	1.548	
	(63.36)**	(68.71)**	(34.12)**	(16.64)**	

+ significant at 10%; * significant at 5%; ** significant at 1%

We also ran the regressions using the tariff information as given above. However, these coefficients were never statistically significant. This could arise either because of the limitations of the data as reflected in the relatively few years for which we have data, or because tariff information does not accurately capture the degree of domestic protection afforded to industries. In Morocco there are a number of additional taxes and restrictions which were placed on imports over this period which are not captured in our tariff data.

We also explore the role of firm size in these regressions. Hence the variables size2 and size3, assess the likely impact of a firm being either a medium sized or a large sized firm respectively. The variables in the model here are dummy variables (for each of the size classes) and therefore the percentage equivalent of these dummies can be found by taking [exp(dummy)-1]*100. The size variables are also positive and statistically significant indicating that larger firms are typically more productive. Here it is noticeable that there are substantial differences between the sectoral level, and the firm level fixed effects results with the latter being considerably smaller. It would seem plausible that there may well be size factors specific to firms over the time period which impact on productivity, and hence the controlling for these seems appropriate. With the firm level fixed effects, the results suggest that being a medium size firm in comparison to a small firm is likely to result in productivity being 21.6%-28.6% higher depending on the time period being considered, and being a large firm results in productivity being between 14.4%-19.6% higher. Once again this reinforces the discussion earlier in section 2.2.2.

Finally, we also explore the role of the age of the firm, and for the latter period of the relative skill intensity of the firm. In terms of the age of the firm, there is some evidence that older firms tend to be more productive, and while the coefficient is statistically significant, its' size is relatively small. There is also some evidence that the higher the skill-intensity of the firm (measured as the ratio between skilled and unskilled workers) the higher is the productivity. Once again the coefficient is relatively small, and when we control for firm level fixed effects it becomes non-significant.

The preceding regressions were based on the entire sample. Tables 4 and 5 repeat these regressions but now do so separately for each of the sectors. The aim here is to see if there are any significant differences in the key coefficients of interest - such as the trade variables, or the size variables – across the different sectors.

Table 4 gives the results for the period 1990-2002. The first line of the table gives the coefficient on the ratio of exports to output. As seen earlier this coefficient is positive and statistically significant with the largest impact of exports on productivity occurring in Rubber and Plastics, and in Leather goods where a 10% increase in the ratio of export to output is associated respectivtly with a 1.6% and a 0.9% increase in productivity. The smallest impact appears with respect to Food Products and Textiles, where the change in productivity following a 10% increase in the exports to output ratio leads respectively to 0.1% and a 0.2% increase in productivity.

Table 4: Sectoral Regressions 1990-2002

	Food	**Textiles**	**Clothing**	**Leather**	**Chemicals**	**R & P**	**Electrical**
	15	**17**	**18**	**19**	**24**	**25**	**31**
expout1	0.01	0.02	0.046	0.093	0.041	0.163	0.087
	(4.80)**	(7.30)**	(7.09)**	-1.51	(4.00)**	(1.69)+	(1.70)+
size2	0.294	0.16	0.141	0.049	0.143	0.164	0.047
	(13.90)**	(5.59)**	(5.54)**	-1.08	(2.51)*	(3.44)**	-0.55
size3	0.221	0.307	0.136	0.097	0.21	0.028	0.235
	(4.38)**	(6.96)**	(4.51)**	-1.12	(2.36)*	-0.26	(1.67)+
Age	0.021	0.036	0.034	0.012	0.076	0.018	0.023
	(6.67)**	(7.84)**	(9.51)**	-1.57	(8.67)**	(2.34)*	(1.73)+
Sqage	0	0	0	0	-0.001	0	0
	(3.18)**	(4.76)**	(2.87)**	-0.49	(4.23)**	-0.53	-1.24
Constant	1.971	1.391	1.053	1.546	2.416	1.149	4.12
	(46.44)**	(25.70)**	(29.20)**	(16.94)**	(16.44)**	(13.16)**	(24.25)**

Once again size is also statistically significant in almost all cases (except for Leather goods) and this appears particularly true for Food Products, and for Textiles. For these two industries medium sized firms tend to be 34.2% and 17.6% more productive than small firms, and large firms tend to be 24.7% and 35.9% more productive, as well as 26.5% more productive in the Chemical industry. The age of the firm is also positively related to its productivity and once again this is the case for all of the sectors.

Table 5: Sectoral Regressions – 1996-2000

	Food	Textiles	Clothing	Leather	Chemicals	R & P	Electrical
	15	**17**	**18**	**19**	**24**	**25**	**31**
expout1	0.129	0.027	0.039	0.322	0.05	0.126	0.113
	(2.20)*	(4.65)**	(6.02)**	(2.74)**	-0.8	-0.54	(2.21)*
size2	0.265	0.111	0.21	0.04	0.313	0.114	-0.142
	(7.32)**	(1.72)+	(4.67)**	-0.4	(2.66)**	-1.09	-0.99
size3	0.043	0.282	0.174	0.012	0.358	-0.224	-0.318
	-0.45	(2.70)**	(3.23)**	-0.06	(1.70)+	-0.83	-1.4
skunsk1	-0.007	-0.006	0.004	0.005	0.06	0.019	0.086
	-0.26	-0.13	-0.8	-0.09	-1.24	-0.33	-1.35
age	0.055	0.02	0.016	-0.028	0.053	0.022	0.014
	(5.43)**	-1.24	-1.48	-1.01	(1.89)+	-0.88	-0.36
sqage	0	0	0	0.001	0	0	-0.001
	(2.55)*	-0.66	-1.1	-1.32	-0.65	-0.67	-0.78
Constant	1.547	1.689	1.298	1.829	2.644	1.06	4.605
	(12.41)**	(9.58)**	(14.63)**	(6.25)**	(6.20)**	(4.23)**	(10.37)**

Table 5 then gives the results for the 1996-2000 time period. As with the aggregate results, we see that over this period the impact of exporting on productivity is much higher. The largest impact is on Leather, followed closely by Food products, Rubber and Plastic, and Electrical. For these sectors the impact of a 10% increase in the exports to output ratio is associated with productivity being respectively 3.2%, 1.3%, and 1.1% higher. The smallest impact is on Textiles, Clothing and Chemicals, where the impact of a 10% increase in the ratio is associated with 0.2%, 0.3% and 0.5% increases in productivity respectively. As before the size of the firm typically impacts positively on productivity. In most cases the coefficients are of a similar order of magnitude to that reported in Table 4. The exception to this is Electricals where the coefficients suggest that medium sized and larger firms are less productive than small firms - however these results are statistically insignificant. Finally, there is little evidence that either the skill-intensity, or the age of the firm is statistically significant. The exceptions to the latter are in Food products and Chemicals where there is some evidence that older firms tend to be more productive.

In the preceding results a common feature was the role of exports/output as a significant positive variable, and also the interesting lack of significance of the import/output variable. In order to explore this further in Table 6, we repeat our 1996-

2000 regression, but do so separately for each size class of firm. As was the case before the three size classes of firms are: less than 10 employees, 10-100 employees, and greater than 100 employees

Table 6: Productivity by size class - Morocco

	Small Firms	Medium Firms	Large Firms
expout1	0.281	0.1	0.047
	(4.01)**	(2.76)**	-0.71
expoutsec1	-0.859	0.123	0.269
	(2.81)**	-0.71	-1.42
impoutsec1	-1.055	-0.05	0.418
	(2.69)**	-0.27	(2.13)*
skunsk1	-0.103	0.003	-0.02
	(1.83)+	-0.41	-0.2
age	0.034	0.049	0.002
	(1.65)+	(3.63)**	-0.13
sqage	0	-0.001	0
	-0.45	(1.92)+	-1.56
Constant	1.62	1.621	2.29
	(8.87)**	(11.43)**	(14.11)**

Absolute value of t statistics in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

These results are extremely interesting, as there are some important differences, which emerge between the different size classes. The first row captures the impact of changes in exports/output at the level of the firm. Here we see that increasing exports does lead to higher productivity levels but that this is particularly true for small firms, to a lesser extent for medium sized firms, and the coefficient is not significant with regard to large firms. The second and third variable captures the degree of openness at the sectoral level. As before these represent exports/output, and imports/output at the sectoral as opposed to the firm level. With regard to export openness for small firms, where the coefficient at the firm level was positive, at the sectoral level the coefficient is now negative. This suggests that for individual firms access to export markets leads to an increase in productivity, but that for those sectors which have a high proportion of exporting small firms that their productivity tends to be lower. For medium and large firms the sectoral export openness coefficient is not statistically significant. With regard to domestic market openness we see that for small firms an increase in openness tends to reduce their productivity, wheras for large firms it tends to increase their productivity. The coefficient for medium sized firms is again not significant.

Clearly, therefore it appears that the impact on small, medium and large firms both of access to foreign markets, as well as to domestic liberalisation are quite different, and therefore possibly call for quite different policy conclusions (see Section 3 for a more detailed discussion).

4.2. Cross-section analysis: Morocco

In comparison to the preceding the analysis in this section is based on cross-section as apposed to time-series data. In addition in estimating the firm level productivity measures the data allows us to employ both parametric (as above) and non-parametric approaches in order to provide a broader basis of comparison. We also explore a wider range of parametric approaches. Finally with the cross section data we have considerably more information and detail with regard to possible explanatory variables and this enables us to build up a richer picture of the possible determinants of productivity.

The data for this paper derives from a detailed firm level survey (FACS) carried out jointly by the World Bank and the Ministry of Trade and Industry, Morocco. The survey covers 859 enterprises and contains data for seven sectors for 1998 and 1999. The seven sectors covered are: clothing, textiles, food processing, plastics, chemicals, leather and electrical machines. One of the substantial advantages of this survey is that it contains extremely detailed information at the firm level. Hence, for example, for each firm we have information on the sales of each of the three principal products produced by the firm. We also have detailed information on labour supply and training within each firm, the use of intermediates both imported and domestically supplied, as well as a range of information concerning the underlying financial structure of each firm, the institutional environment within which it operates, as well as the view of the firm concerning issues such as trade barriers, degree of competition for its products etc. In contrast the key disadvantage of this data set as currently constituted is that the data is for two years only. This entails a focus on cross-section work as opposed to panel estimation, and therefore also means that we cannot easily address issues to do with the inter or intra-sectoral compositional changes that may be driving differences in productivity which were considered earlier.

4.3.1 Empirical Methodology

As earlier, the first stage of the empirical methodology requires estimating or calculating a measure of productivity at the firm level. For this data we work with both the parametric approach, as well as the index number approach. The advantage of the latter concerns the ease of implementation, allowing for technology to vary across individual units, as well as being able to handle multiple outputs and inputs. The advantage of the former is that it is less prone to measurement error and generated statistical tests for the significance of the results.

For the first stage we undertake six different regressions from which we derive our firm level productivity estimates. The purpose of this is in part methodological – to explore the extent to which results may differ across different methodologies; and in part practical – as the different results allow us to see how consistent the picture that emerges is across the different measures. The six measures of productivity that we derive come from the application of the following methodologies:

1. OLS (referred to in the tables of results as OLS1) regression of the production, where the inputs are capital and labour. This is the simplest, "bare-bones" regression. In the literature there is considerable discussion about the limitations of this, in particular concerning the issue of endogeneity between productivity and firms' choice of inputs which serves to bias the results. In order to partially address this issue, and as is common in the literature we control for unobservable productiviy shocks by including electricity as one of the inputs.

2. OLS (OLS2) regression of the production function, where the inputs are capital, and two different categories of labour – skilled and unskilled workers. Here we are exploring whether greater disaggregation of the labour supply improves the quality of the regressions and materially impacts upon the results. Here again, we control for unobservable productivity shocks by the usage of electricity.

3. OLS (OLS2 2 blocs) as in (2) above but where we divide our sample into two separate groups. One group of industries comprises Textiles, Clothing and Leather, and the second group comprises the remaining industries. The reason for this was that in examining the ratio of skilled-unskilled workers in the sample, the former group of industries appeared significantly the most skill-intensive. As this could be a result of sectors making the distinction between skilled and unskilled on the basis of quite different criteria, this was a way of controlling for this possibility. Here again, we control for unobservable productivity shocks by the using of electricity as an input.

4. Instrumental Variables (IV) estimation. Here we are using instrumental variables in order to control for the problem of endogeneity between a firm's productivity level and it's choice of inputs.

5. Lev-Pet. Here we employ an alternative semi-parametric approach, which also provides a means of controlling for the problem of endogeneity, as suggested by Levinsohn and Petrin (1999).

6. Klette-Johansen (KJ). Unlike the preceding here we employ an index number approach to the measurement of productivity , which has the considerable advantage of allowing the technology to vary across the individual firms. In addition the Klette-Johanson approach also allows us to control for imperfect competition and economies of scale. In some of the results we report on two different variants of the Klette-Johanson model. This is because the model was run in both levels and in first differences.

Table 7 provides correlations of the results across the different methodologies. From this it can be seen that there is a high degree of correlation across the three parametric approaches employed, and a fairly high degree of correlation between the two Klette-Johansen indices (0.82). Across the two methodologies the correlation is generally lower, except for between the Levinsohn and Petrin approach, and the Klette-Johansen (levels) approach (0.93). Overall, this suggests a high degree of consistency across the results, though with some differences.

Table 7: Correlation of productivity estimates across methodologies

		Parametric	Index No.

		L&P	IV	OLS	K-J (levels)	K-J (F D)
Parametric	**L&P**	1				
	IV	0.9694	1			
	OLS	0.9771	0.9934	1		
Index No.	**K-J (levels)**	0.9342	0.8763	0.9079	1	
	K-J (FD)	0.7678	0.7323	0.78	0.8201	1

Aggregate productivity measures: Table 14 then gives the aggregate measure of productivity across the different productivity measures, where the second column in each case gives the rank for each sector, for each of the productivity measures. The table comprises two panels – the top panel gives the weighted average productivity – where the weights are the share of each firm in total production. The bottom panel gives the unweighted average productivity. Thus the former takes into account the contribution of each firm to total sectoral productivity, whereas the latter provides a comparison of the extent to which productivity on average differs across the sectors.

For the weighted averages across the different measures we see a fairly high degree of consistency of the relative rankings. Hence, Electricial is the most productive industry for all but one of the measures, and similarly for Chemicals as the second most productive industry. There is some variation for Food products whose rank ranges from 3rd for two of the measures, to 7th with regard to the K-J index number approach. Generally Clothing, and Leather goods, and to a slightly lesser extent Textiles emerge as the least productive sectors. The difference in productivity across sectors is also quite large, though of course to some extent this does depend on the measure used.

Turning now to the unweighted averages we see a slightly greater variation in the results. Across the majority of the measures the most productive sectors are Chemicals and Electrical; and the least productive sectors are typically Leather and Clothing. In most cases Textiles is in the mid-range of the productivity estimates, though interestingly in one case (OLS2 2-blocs) it does appear as the most productive industry. The difference in productivity levels within each measure is smaller than that with the weighted average productivities.

Table 14: Productivity by sector and by measure:

Sector	OLS2 2-blocs	rnk	OLS2	rnk	LevPet	rnk	IV	rnk	OLS	rnk	K-J	
	Weighted average											
Chemicals	1.06	4	1.22	2	0.90	2	1.17	2	1.07	2	0.65	2
Electrical	1.18	3	1.29	1	0.97	1	1.23	1	1.14	1	0.76	1
Food	0.94	6	1.12	4	0.71	3	0.98	3	0.89	3	-0.10	7
Clothing	1.30	2	1.03	6	0.60	6	0.82	6	0.74	6	0.25	3
Leather	1.03	5	0.76	7	0.37	7	0.55	7	0.47	7	0.08	5
Plastics	0.92	7	1.07	5	0.70	4	0.95	4	0.87	4	-0.01	6
Textile	1.48	1	1.18	3	0.68	5	0.95	5	0.86	5	0.18	4
	Unweighted average											
Chemicals	1.08	3	1.21	1	0.81	1	0.98	1	0.91	1	0.16	2
Electrical	1.03	4	1.11	4	0.77	2	0.96	2	0.89	2	0.36	1
Food	1.02	5	1.20	2	0.72	3	0.96	2	0.88	3	-0.42	7
Clothing	1.23	2	0.99	6	0.56	6	0.72	5	0.65	6	0.14	3
Leather	0.95	6	0.71	7	0.36	7	0.48	5	0.42	7	-0.19	5
Plastics	0.88	7	1.01	5	0.59	5	0.80	4	0.73	5	-0.31	6
Textile	1.40	1	1.13	3	0.61	4	0.83	3	0.75	4	0.01	4

Productivity by size class of firms: We now explore another dimension of the data. Here we are considering the role of the different size classes of the firms, and examining whether productivity differs across size class. As before, in Table 7, we report on two sets of calculations – based on weighted and unweighted averages. The size classes reported on here are: less than 30 employees, 30-100 employees, and more than 100 employees. Table 15 reports on the average productivity for all sectors by size class and as before across our different productivity measures. What we see is that for two of the econometric measures (OLS2 2-blocs, and OLS2), and also for the K-J approach there is clear evidence of weighted average productivity being higher the larger the firm. This is also consistent with the time series results we derived earlier. However, once we control for the problem of endogeneity (LevPet and IV) that relationship appears to disappear

The higher productivity of large firms in comparison to small firms is true across all the measures when looking at the unweighted averages. Hence if we simply compare the mean productivity levels of small firms in comparison to large firms we see that they appear unambiguously less productive. This is not always the case with respect to medium sized firms, where in three of the cases (LevPet, IV and OLS) medium sized firms appear more productive than large firms.

Table 7: Average productivity by size class

Size	OLS2 2-blocs	OLS2	LevPet	IV	OLS	K-J
	Weighted					
Small	0.96	0.96	0.88	1.10	1.04	0.07
Medium	1.05	1.06	0.72	0.94	0.87	-0.17
Large	1.28	1.16	0.70	0.96	0.86	0.37
	Unweighted					
Small	1.04	0.99	0.59	0.74	0.68	-0.29
Medium	1.13	1.03	0.63	0.82	0.75	0.04
Large	1.29	1.10	0.59	0.80	0.72	0.21

Aggregate productivity by exporting status: Finally, with regard to the descriptive statistics we explore whether there is any difference in aggregate productivity according the exporting status of the firm (Table 8). Again, we have information from the firm as whether they export or not, so here we divide our sample into exporting and non-exporting firms and consider the differences in productivity for each of the sectors, and for each of our productivity measures. The shaded cells indicate whether the exporters or non-exporters are more productive, for each of the productivity measures and each of the industries.

Table 8: Productivity by exporting status

	TFP Index	Chemicals		Electrical		Food		Clothing		Leather		Plastics		Textile	
Non Exporter	**OLS2 - 2-blocs**	1.10	2	1.09	3	0.99	4	0.95	5	0.89	6	0.76	7	1.29	1
	OLS2	1.22	1	1.18	2	1.18	2	0.76	6	0.69	7	0.89	5	1.04	4
	LevPet	0.80	3	0.90	1	0.82	2	0.51	4	0.45	7	0.48	5	0.46	6
	IV	0.92	3	1.08	1	1.07	2	0.60	6	0.47	7	0.69	4	0.66	5
	OLS	0.86	3	1.01	1	0.99	2	0.55	6	0.42	7	0.62	4	0.59	5
	K-J	0.07	2	0.39	1	-0.92	7	-0.50	5	-0.03	3	-0.55	6	-0.48	4
Exporter	**OLS2 - 2-blocs**	1.04	5	0.96	6	1.06	4	1.28	2	0.96	6	1.20	3	1.44	1
	OLS2	1.20	3	1.04	5	1.21	2	1.03	6	0.72	7	1.36	1	1.18	4
	LevPet	0.82	2	0.63	4	0.63	4	0.57	5	0.33	6	0.91	1	0.69	3
	IV	1.11	2	0.84	5	0.85	4	0.75	6	0.49	7	1.14	1	0.91	3
	OLS	1.02	2	0.76	5	0.77	4	0.67	6	0.42	7	1.06	1	0.83	3
	K-J	0.68	1	0.32	3	0.21	6	0.29	4	-0.24	7	0.54	2	0.26	5

The first aspect worth noting is that there is no unambiguous relationship between higher levels of productivity and exporting in this data. For example in Electricals across all the measures of productivity it is the non-exporters which are more productive. In contrast for Clothing, Plastics and Rubber, and Textiles it is the exporters across all the productivity measures which are more productive. For the remaining sectors the picture is more mixed and depends on the measure of productivity employed. Finally it is interesting to compare the relative ranking across the different categories of firms. Hence for non-exporters the most productive industries are Chemicals and Electrical, and the least productive industries Leather, Clothing, and Rubber and Plastic. In contrast for exporting firms the contribution to aggregate weighted productivity is highest for Rubber and Plastics, followed largely by Textiles and Chemicals.

4.3.2: The determinants of productivity - FACS

In the preceding we used descriptive statistical analysis to see what could be learnt from the productivity estimates derived in the first stage of our methodology. In this section of the paper we explore these relationships more formally, by econometrically testing for the significance of some of these relationships. As before the purpose is in order to try and better understand the possible determinants of productivity.

The underlying FACS survey is very rich in firm level detail. Hence the number of possible explanatory variables is potentially quite considerable. In the first instance we have focussed on those variables which a priori one might expect to be important. Here we distinguish between those variables, which are related to international trade, institutional variables, and those, which relate to firm specific characteristics such as the age of the capital stock or information on R&D at the firm level. The results are given in Table 9, where we give the results for the estimations based on the six different productivity measures detailed earlier. In each case the model was run with both sectoral and regional dummies but these are not reported here. The explanatory variables we include here are:

1. ***Trade barrier variables:***

- *Tariff barriers on exports*
- *Non-tariff barriers on exports*
- *Average domestic tariffs*

2. ***Intermediate trade variables:***
   - *Share of imported intermediates*
   - *Share of imported capital*
   - *Share of imported raw materials*
   - *Duty paid on imported capital*

3. ***Other trade variables***
   - *Share of production exported (calculated at the firm level)*
   - *Share of production exported (calculated at the sectoral level)*
   - *Preparation undertaken for trade liberalisation with the EU.*

4. ***R&D variables***
   - *Does the firm invest in R&D*
   - *No of products less than 5 years old*
   - *Share of workforce in R&D*

5. ***Capital variables***
   - *Age of capital less then 5 years old*
   - *Age of capital between 5 & 10 years old*
   - *Age of capital more than 10 years old*
   - *Training by suppliers (of new machinery)*
   - *Training undertaken abroad*
   - *Training from manuals*

6. ***Other***
   - *Share of foreign ownership*
   - *Has the firm experienced any infrastructure related difficulties in the preceding year.*
   - *Is the firm multiplant?*
   - *Has the firm applied for MEDA funding*
   - *Are the firm's products ISO certified*
   - *No. of employees.*

In this first table of results we have included all the coefficients which a priori one might consider could be important or could play a role in explaining differences in productivity across firms. A number of these coefficients prove not to be statistically significant. We include them here however, partly to indicate that this was indeed the case, and partly because it is frequently worth reflecting on why this might arise. In the second table, we then run the same regressions but this time on much smaller sample of explanatory variables essentially largely on those which the first sets of regressions suggested are statistically significant.

The first column of the table gives a brief description of the variable. Several of the variables are dummy variables where the firm was, for example, asked to respond yes or no; some of the variables are dummy variables, some of the variables are shares, and some are absolute values. Hence if, for example, we take the second row of the results where we report on whether firms perceived non-tariff barriers to trade to be an obstacle in export markets. Those firms that do perceive there to be such an obstacle, are ceteris paribus and on average 62% more productive, when the estimation is based on the Klette-Johansen productivity measures. Where a variable is a share or percentage, than the marginal effect is a semi-elasticity. It gives the percentage impact on productivity as a result of one percentage point increase in the variable. Finally, there are two variables in absolute values – the number of new products, and the total no.of employees. These variables were logged and hence the coefficient on the variable gives the elasticity.

If we now turn to the results. The first shaded panel of the table focuses on the trade related variables. Here we look at variables with respect to both firms' export markets as well as the domestic market. With respect to the export market the firms report on whether they experienced any difficulties in exporting either arising from high tariffs or from non-tariff barriers in export markets. Here we might expect that high tariffs impede exports and thus reduce the incentives for firms to improve productivity levels. If this were true we might expect a negative coefficient on this variable. However, it is equally possible that successful, exporting firms face higher barriers precisely because they are more productive and thus more successful. In this case we could find a positive coefficient. Interestingly the coefficient on tariff barriers is significant and negative for three of the estimations and suggests that firms that experience higher barriers in export markets are approximately 25% less productive. In contrast the coefficient on non-tariff barriers is positive across all the models, and significant in three cases. The size of the coefficient suggests that firms with perceived non-tariff barrier obstacles to trade are on average between 61% and 78% more productive. It is worth noting, however, that this applies to 10 firms in the sample.

With respect to protection in the domestic market the variable here represents, *average domestic tariffs*. Here we have computed the average tariff based on each firm's three principal products exported. Hence this measure captures the degree of domestic protection for the firm's principal products. High domestic protection could again reduce the incentives for firms to improve their productivity, and if this were the case we would expect a negative coefficient on this variable. Again, there could be reverse-causality here whereby inefficient firms seek greater protection. The coefficient here is negative and statistically significant in all cases. Hence, if we take the coefficient arising from the OLS2 procedure this suggest that a 1% point increase in tariff protection corresponds with a decrease in productivity by 0.39%. Overall the impact of domestic tariffs on productivity is negative across all the regressions and significant for all but one. The impact of a 1% increase in domestic tariff protection on productivity ranges from 0.38-0.49%. There is clear evidence then that protected domestic industries tend to be less productive.

Looking at the second bloc of results, the intermediate trade variables, we see that in none of the cases are any of the variables statistically significant. The aim here was to seek to establish whether there is any evidence if the presence of imported and possibly higher quality intermediates might be related to higher productivity levels (see for example Amiti, 2004). There appears to be little direct evidence of this here.

In the third panel of the table we examine other trade related variables. The first two of these look at the relationship between exporting and productivity, as there is some evidence in other studies that exporting firms tend to be more productive. There are important issues of causality here, but the aim in the first instance is to investigate whether such a relationship exists or not. The first of our variable here does so at the level of the firm and the second at the sectoral level. At the firm level there is limited evidence of a relationship between exports and productivity, and at the sectoral level none of the coefficients are significant.

Table 9: Determinants of Productivity – cross section

	OLS 2	OLS 2 Blocs	LevPet	IV	OLS 1	K-J
Tariff obstacles on exports	-0.138	-0.133	-0.242	-0.202	-0.209	0.040
	(1.23)	(1.17)	(2.24)*	(1.87)+	(1.93)+	(0.23)
NTB obstacles on exports	0.582	0.538	0.394	0.430	0.424	0.480
	(2.39)*	(2.20)*	(1.50)	(1.52)	(1.50)	(2.30)*
Ave domestic tariffs	-0.392	-0.381	-0.478	-0.487	-0.492	-0.276
	(2.87)**	(2.95)**	(3.41)**	(3.69)**	(3.70)**	(1.30)
Share of imported interm.	0.003	0.003	0.002	0.002	0.002	0.002
	(1.40)	(1.47)	(1.11)	(1.20)	(1.17)	(0.89)
Share of imported raw mats	-0.243	-0.230	-0.148	-0.131	-0.131	-0.202
	(0.97)	(0.97)	(0.70)	(0.63)	(0.63)	(0.72)
Share of imported capital	-0.000	-0.000	-0.000	-0.000	-0.000	-0.001
	(0.47)	(0.43)	(0.61)	(0.35)	(0.39)	(0.81)
Share of prod exported	0.002	0.002	0.002	0.002	0.002	0.006
	(2.61)**	(2.77)**	(2.44)*	(2.01)*	(2.02)*	(4.21)**
Exp penetration (sector)	-0.002	-0.002	-0.003	-0.003	-0.003	0.001
	(0.34)	(0.30)	(0.38)	(0.46)	(0.45)	(0.14)
Does the firm invest in RD	0.057	0.081	0.015	0.045	0.039	-0.165
	(0.46)	(0.64)	(0.13)	(0.39)	(0.34)	(0.55)
Number of new products	-0.000	-0.000	-0.000	-0.000	-0.000	0.004
	(0.19)	(0.19)	(0.28)	(0.18)	(0.19)	(2.00)*
Share of workforce in R&D	0.996	1.002	1.492	1.256	1.284	-1.575
	(1.19)	(1.11)	(2.02)*	(1.80)+	(1.82)+	(0.49)
Age of capital < 5 years	0.094	0.050	0.024	0.284	0.278	-0.429
	(0.56)	(0.30)	(0.16)	(1.44)	(1.41)	(1.42)
Age of capital: 5-10 years	0.152	0.097	0.130	0.369	0.365	0.133
	(0.93)	(0.59)	(0.85)	(1.85)+	(1.83)+	(0.51)
Age of capital > 10 years	0.063	0.033	0.033	0.229	0.228	-0.182
	(0.35)	(0.18)	(0.19)	(1.04)	(1.04)	(0.53)
Training by suppliers	0.088	0.075	0.119	0.136	0.132	-0.181
	(0.92)	(0.78)	(1.25)	(1.44)	(1.39)	(0.57)
Training abroad	0.026	0.030	0.057	0.072	0.069	0.396
	(0.22)	(0.24)	(0.50)	(0.68)	(0.64)	(1.82)+
Training from manuals	-0.106	-0.141	-0.016	-0.026	-0.028	-0.134
	(0.85)	(1.12)	(0.14)	(0.23)	(0.24)	(0.39)
Share of for. Ownership	-0.109	-0.103	-0.200	-0.188	-0.191	-0.312
	(1.18)	(1.13)	(2.20)*	(2.13)*	(2.16)*	(1.53)
Infrastructure problems	0.000	0.000	-0.000	-0.000	-0.000	-0.003
	(0.23)	(0.08)	(0.19)	(0.67)	(0.62)	(1.82)+
market share	0.420	0.411	0.496	0.518	0.508	0.326
	(2.41)*	(2.34)*	(3.21)**	(3.24)**	(3.17)**	(0.82)
No. of competitors	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(1.52)	(1.50)	(0.70)	(0.83)	(0.82)	(1.08)
multiplant firms	-0.009	-0.008	-0.047	-0.036	-0.037	0.042
	(0.23)	(0.19)	(1.35)	(1.04)	(1.07)	(0.61)
Meda funding applied for	0.119	0.156	0.143	0.174	0.172	0.453
	(1.03)	(1.37)	(1.36)	(1.79)+	(1.75)+	(2.19)*
iso	0.106	0.082	0.100	0.140	0.130	0.413
	(0.75)	(0.57)	(0.77)	(1.08)	(0.99)	(2.26)*

Number of employees	0.000	0.000	-0.000	-0.000	-0.000	0.000
	(0.59)	(1.30)	(1.06)	(0.13)	(0.46)	(1.47)
Constant	1.053	1.041	0.556	0.534	0.477	0.004
	(3.26)**	(3.17)**	(1.84)+	(1.65)+	(1.47)	(0.00)

Note: +, *, ** indicate significance at the 10%, 5%, and 1% levels respectively.

The fourth panel of the table considers three different R&D variables. The hypothesis here is that higher levels of R&D expenditure should lead to higher levels of productivity and we try and capture this by looking at whether the firm has invested in R&D, the number of new products, and the share of the workforce in R&D. Again, almost all of the variables are statistically significant here, hence indicating little evidence of such a relationship. This is interesting and it is worth reflecting back on the results in the descriptive statistical discussion earlier. There we saw that the picture with regard to the relationship between productivity and the R&D status of the firm was mixed. It was mixed in the sense that it appeared to hold for certain industries and not for others. It is perhaps therefore not surprising that in these regressions the coefficient is insignificant. Ideally, we would like to run these regressions separately by sector, but the number of observations in most cases simply becomes too small.

We next turn to looking at the role of capital, and the training involved in the use of new machines. We have divided up the information on the age of capital into three – capital less then five years old, capital between 5 & 10 years old, and capital greater than 10 years old. The purpose of this was to see if we could distinguish any differential role of capital according to its age. Hence, there is some evidence and theory that when introducing new capital for an initial period productivity may decline. This occurs partly because in the transition period firms may be using both new and old capital simultaneously, and partly because there is a learning by doing process in using new capital most efficiently. Although the results do lend support to this hypothesis, the coefficients here are not statistically significant and therefore clear conclusions cannot be drawn. With regard to the training variables, the only one which is significant here is the one relating to training abroad, when using the Klette-Johansen measures of productivity. The result here suggests that where firm’s workers have undergone training abroad, firms tend to be up to 49% more productive.

Finally, in the last panel of the table we explore the role of other firm specific variables. The first of these focuses on the share of foreign ownership by firm. Here we are interested in exploring whether high rates of foreign ownership lead to firms being more productive, for example through the introduction of techniques and technologies from abroad. If this were the case we would expect the coefficient here to be positive. Interestingly the coefficient is negative and in several of the parametric approaches statistically significant. This suggests that firms with a higher degree of foreign ownership tend to be less productive. This is an interesting and possibly counter-intuitive results.

For the second variable (*infrastructure problems)* firms reported on a number of possible problems which may have impacted on their production in the preceding year. These include electricity cuts, water shortages, days lost as a result of strikes or disputes with workers etc. Here we have aggregated all these into a single dummy whenever a firm has reported on the presence of such a problem in the preceding year. Production problems such as these are likely to impact negatively on productivity, and hence we would expect to find a negative coefficient. However, the coefficient is negative and statistically significant only when using the Klette-Johansen measures, and suggests that where firms did experience such difficulties on average firms were 0.3% less productive.

The following two variables deal with the extent of competitive interaction firms face. The first of these gives each firm's domestic market share, and the second of these gives the number of competitors each firm perceives itself to have for its principal product. There is evidence here that a higher domestic market share leads to higher levels of productivity and this is true of all the parametric based results. The coefficient is also positive for the Klette-Johansen index, but not statistically significant. There little evidence that an increased number of competitors tends to decrease productivity. In terms of the remaining variables two appear significant in certain cases. For the first of these firms were asked whether they had applied for any MEDA funding. Eleven firms replied in the affirmative, and these firms are on average between 19% (OLS1) and 57% (Klette-Johansen) more productive, ceteris paribus. Again, it is important to be careful with interpretation here, as there could be reverse causality at work. Hence it is just as likely that it is the more productive firms that apply for MEDA funding, as it is that MEDA funding helped to boost firms productivity. In order to answer this question we would need panel data. Finally, we also have information on whether the firm's products are ISO certified or not. Using the Klette-Johansen measure it appears that ISO certified firms tend to be on average 51% more productive. This is an interesting result, which could have several interpretations. One possible interpretation is that ISO certification itself cannot lead to higher productivity, and therefore this is simply a reflection of that in order to be ISO certified firms are required to produce higher quality goods and therefore in order to do so (competitively) they need to be more productive. This in turn however raises questions about the motives and processes underlying the ISO certification process. Alternatively it is possible that ISO certification because it provides a guaranteed mark of quality allows firms to charge higher prices, and this is being picked up by our productivity measures. Finally the last row of the table gives the number of employees which can be seen as a proxy for size. There appears to be no evidence that larger firms are more productive, and therefore no evidence of economies of scale.

Given the lack of significance of a number of the preceding variables, in the next table we turn to a similar set of estimations but this time run on a reduced set of explanatory variables. The first row of the Table 10, thus gives the significance of the extent of average domestic tariffs. Once again this clearly indicates that domestic tariff protection is negatively correlated with productivity levels where a 1% increase in domestic tariffs is associated with approximately a 0.4% decrease in productivity. In the second row we include the ratio of skilled to unskilled workers for each firm. Here we are interested in exploring whether there is any evidence that firms, which employ a higher proportion of skilled workers may be more or less productive. The coefficient here is positive, hence indicating that the greater the skill intensity the higher the productivity, but is only statistically significant for two of the productivity measures (OLS2 and OLS2 Blocs). Once again the share of foreign ownership is negatively related to productivity, although the coefficients remain statistically insignificant. Productivity is also positively related to the share of production exported at the firm level, as well as the share of the workforce involved in R&D activity. There is a negative coefficient with regard to this latter variable for the Klette-Johansen measure of productivity but this is not statistically significant.

Table 10: Determinants of productivity – key variables

	OLS 2	OLS 2 Blocs	LevPet	IV	OLS 1	K-J
Ave domestic tariffs	-0.391	-0.380	-0.409	-0.408	-0.414	-0.282
	(3.09)**	(3.19)**	(3.06)**	(3.27)**	(3.29)**	(1.47)
skilled/unskilled ratio	0.012	0.011	0.001	0.001	0.001	0.004
	(7.94)**	(7.33)**	(0.70)	(0.59)	(0.58)	(1.64)
share of for. Ownership	-0.105	-0.096	-0.098	-0.065	-0.071	-0.029
	(1.38)	(1.27)	(1.08)	(0.72)	(0.79)	(0.18)
Share of prod exported	0.002	0.002	0.002	0.002	0.002	0.006
	(3.08)**	(3.31)**	(2.39)*	(2.42)*	(2.33)*	(4.33)**
Share of workforce in R&D	1.248	1.319	1.386	1.283	1.290	-1.991
	(1.40)	(1.36)	(1.87)+	(1.68)+	(1.69)+	(0.64)
market share	0.314	0.308	0.305	0.284	0.277	0.101
	(1.88)+	(1.84)+	(2.05)*	(1.87)+	(1.83)+	(0.27)
multiplant	0.045	0.050	-0.005	-0.000	-0.002	0.120
	(0.90)	(1.04)	(0.09)	(0.01)	(0.04)	(1.45)
Sales	0.000	0.000	0.000	0.000	0.000	0.000
	(2.11)*	(2.26)*	(1.52)	(2.21)*	(2.05)*	(2.48)*
Constant	1.295	1.189	0.830	1.065	0.999	0.219
	(6.01)**	(5.61)**	(3.94)**	(5.23)**	(4.89)**	(0.51)

The role of market share remains positive and statistically significant, and where the impact of market size on productivity is substantial. A 1 percentage point increase in market share is associated with an increase in productivity in the order of 0.3%. This is an interesting results. In principle one could imagine the role of market share is operating in either direction. Firms, with more substantial market shares are likely to yield more market power. In those circumstances the need to be more efficient may be lessened. The presence of what is commonly referred to as x-inefficiency could thus lead to lower levels of productivity. Conversely, it is perhaps more likely that more productive firms are likely to be more successful and thus would have a higher market share. It would appear that this is the effect we are observing here. Of course the two effects are not mutually exclusive. Ceteris paribus more efficient firms could well have a higher market share, but could be less efficient than they would be if the environment was more competitive. In order to test this proposition one would need time series data to explore whether changes in market share are associated with changes in productivity. We also see from the table that there appears to be no association between the level of productivity and whether the firm is multiplant or not. Finally, the coefficient on sales, which proxies for the size of the firm, is now positive and statistically significant but the overall size of the coefficient is extremely small.

There are a number of conclusions, which emerge from this section of the report. First, we have explored the use of different approaches to measuring productivity. Those different approaches each yield highly comparable and consistent results. Secondly, our results suggest that the seven sectors covered in this data set all produce under constant returns to scale, and except for food have similar capital-labour ratios. We then explored the possible determinants of productivity, though bearing in mind the issue of reverse causality, which is present with respect to a number of our variables. The key results indicate that more productive firms tend to face lower domestic tariffs, export more, have a larger domestic market share, and have a higher proportion of workers engaged in R&D activity. It also appears to be the case that firms which are more productive may have applied for MEDA funding, and may have products which are ISO certifies. In contrast there appears to be little evidence to suggest that imported intermediates, training in the use of equipment, foreign ownership or size appear significant determinants of productivity. All these are factors that a priori one might expect to influence the level of productivity.

4.3: Egypt

The data for Egypt derives from the CAPMAS industrial survey (1983-1994) and gives information at the sectoral as opposed to firm level. Within each sector however there is a distinction between public sector firms, and private sector firms, and within each of these there is information by size class of firms. In total there are nine sectors in the survey and these are: Food, Beverages and Tobacco (FBT), Textiles, Clothing and Leather (TCL), Paper products, Chemical products, Wood products, Non-metallic minerals, Base Metals, Metal products, and Other manufacturing.

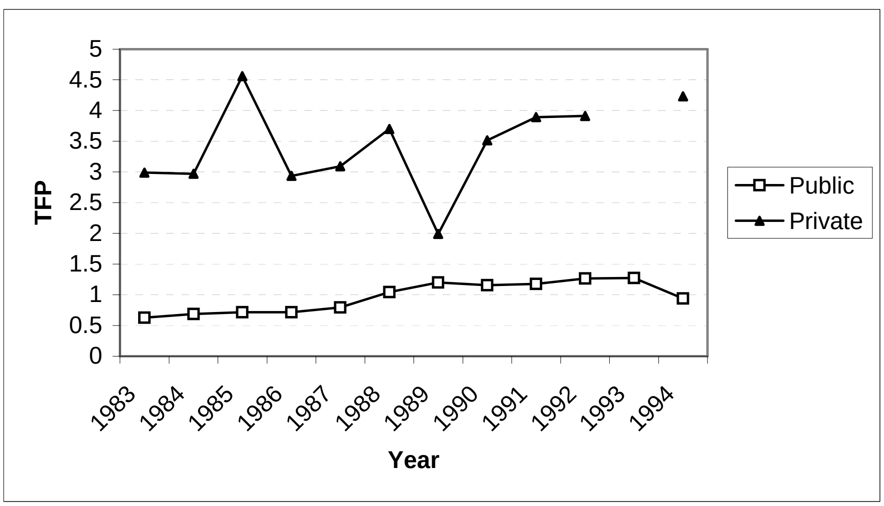
In the case of Egypt the size and role of the public sector is extremely important, hence the need to distinguish between the two. At the beginning of the period the share of the public sector was very high in a number of sectors such as Wood Products (over 90%), and Food, Beverages and Tobacco, and Textiles, Clothing and Leather (just under 80%). The sector with the smallest public sector involvement was

Other (just over 20%), followed by Paper (~40%) and Chemicals (~45%). By the end of the period the sector with the largest public sector share was Non-metallic Minerals (just over 75%), followed by Food, Beverages and Tobacco, and Basic Metals (around 60%). The share of the public sector declined significantly for all sectors over the period.

4.3.1 Analysing the productivity estimates

Figure 5 gives the aggregate change in productivity over the period in question – 1983-1994. As in the previous discussion of Morocco these measures of productivity over time are derived from production function estimatations, and the full methodological details can be found in Appendix 3. Whereas for Morocco this was based on firm level data, here the estimations are based on sectoral data, but where within each sector we distinguish between both the public and the private sector, and where we distinguish between different size classes. We thus report on two measures of aggregate productivity here - productivity over time for both the public and the private sector, where the weights in the aggregation procedure are given by the shares in production.

Figure 5: Aggregate TFP over time: Public and Private sector



A number of interesting features emerge from the Figure. First, it is noticeable that the private sector has consistently much higher productivity than the public sector and this is true over the entire time period. Secondly both sectors experience a rise in productivity over the entire time period (except for one anomalous year for the private sector). That increase is just under 42% for the private sector, and 49% for the public sector. However, in the latter part of the period, from 1990 onwards, while the private sector experiences productivity growth of over 20%, the public sector witnesses a decline in productivity.

4.3.2: Econometric Analysis

We now turn to the second stage of our analysis. Here we take the productivity estimates for both the public and the private sector, for each of the ISIC industries and for each of the size classes, and run several regressions in order to establish the possible significance of key explanatory variables. In comparison to the Moroccan case we have significantly less information with regard to the explanatory variable. Here, therefore, we focus on the role of openness, and on the role of firm size. With regard to openness, as earlier we capture this with the two variables exports/output and imports/output in each case at the sectoral level. Tariff data is unfortunately not available for the relevant years. With regard to size, as above, we have six size classes of firms by numbers of employees – less than 10, 10-25 employees, 25-50 employeees, 50-100 employees, 100-150 employees, and greater than 500 employees. The regressions are then run separately on the public sector and on the private sector, and in each case we also run the model both with and without sectoral fixed effects.

Hence the first two columns of the Table 11 give the results for the public and the private sector, but with no sectoral fixed effects. There are some striking features which emerge from these results. First, none of the coefficients for the public sector are significant – which suggests that in this data there is no evidence that changes in exports behaviour, openness of the domestic market, or the size of the firm play any significant role in determining productivity. This is interesting and to a large extent corroborates the picture, which emerged earlier concerning the diverse changes in productivity over time in the public sector, and the lack of a correlation between productivity levels and size class.

Table 8: Determinants of productivity - Egypt

Variable	Public	Private	Public	Private
Impoutsec	0.021641	-0.13471	0.047417	-0.12386
	(0.76)	(-3.65**)	(0.98)	(-1.82+)
Expoutsec	-0.18833	0.889801	-0.33111	1.607784
	(-0.65)	(1.6)	(-0.69)	(2.11*)
size1 (less than 10)	0.1139	-1.59989	0.283249	-1.65836
	(0.52)	(-5.68**)	(1.19)	(-5.93**)
size2 (10-25)	0.192999	-0.41958	0.210601	-0.35488
	(1.34)	(-3.12**)	(1.5)	(-2.73**)
size3 (25-50)	0.114318	-0.72949	0.089258	-0.67763
	(0.71)	(-4.75**)	(0.65)	(-4.45**)
size4 (50-100)	0.061867	-0.56188	0.048112	-0.49714
	(0.51)	(-3.97**)	(0.44)	(-3.61**)
size5 (100-500)	-0.40291	-0.04999	-0.38571	-0.00737
	(-4.16)	(-0.37)	(-3.94**)	(-0.06)
sector 32			0.15454	-0.58086
			(0.62)	(-2.77**)
sector 33			0.159013	-0.69979
			(0.82)	(-3.01**)
sector 34			0.16715	-0.53202
			(1.2)	(-2.54*)
sector 35			1.414068	-0.07635
			(8.65**)	(-0.38)
sector 36			-0.08255	-0.21851
			(-0.49)	(-1.07)
sector 37			0.04548	-0.9883
			(0.22)	(-4.26**)
sector 38			-0.05939	-0.00681
			(-0.45)	(-0.03)
sector 39			-0.03235	-0.94468
			(-0.11)	(-4.68**)
_cons	0.789866	3.293628	0.558545	3.613052
	(15.24**)	(29.17**)	(5.08**)	(18.12**)

Absolute value of t statistic in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

If we now turn to the private sector a different picture emerges. The first row indicates that increases in domestic openness, captured here by imports/output, serve to decrease productivity levels. The size of the coefficient suggests that a 10% increase in this variable, decreases productivity by 1.3%. The coefficient on exports/output is positive but not statistically significant. Secondly, each of the size coefficients except for one are negative and highly statistically significant. These coefficients should be interpreted as being in comparison to the largest size class (greater than 500 employees). Hence the results indicate that relative to this largest size class, each of the other size class have a lower productivity. As before these are dummy variables therefore the size of the effect can be found by taking [exp(dummy)-1]*100. Applying this we see that the results suggest that firms with 50-100 employees are 43% less productive, and small firms (less than 10 employees) are 80% less productive, on average and ceteris paribus. There is no evidence that firms with between 100-500 employees are more or less efficient than those with more than 500 employees.

If we now consider the last two columns of the table, here we report on the results when we allow for sectoral dummies. Thus here we are controlling for any possible differences that may arise due to factors common to any given sector. Once again the results for the public sector are almost invariable insignificant. There is some evidence that firms with 100-500 employees are less productive than larger firms, and there is some evidence that sector 35 (non-metallic minerals) is relatively more productive. For the private sector, the results are similar to those in the earlier experiment. For example we see the same pattern of results with regard to the size classes of firms.

We also see that once again increased imports/output serves to decrease productivity. We also saw some evidence of this when looking at the results for Morocco. Whereas in the earlier regression the variable exports/output was not statistically significant, now it is significant and the coefficient is positive. This too reinforces the results we saw when looking at the Moroccan data, which is that there is a positive relationship between increases in exports and increases in productivity. The size of the coefficient is quite large suggesting that a 10% increase in export/output is associated with a 16% increase in productivity, on average and ceteris paribus. We also ran the regressions separately on each size class of firms (not reported here). There we found a positive correlation between firm size, productivity and exporting activity. Hence, an increase in exports/output leads to the following changes in productivity: less than 10 employees: 11.8%; 10-25 employees: 30%; 25-50 employees: 14.4%; 50-100 employees: 14.6%; 100-500 emplyees: 21.6%; more than 500 employees: 40.9%. Finally, we see that four of the sectoral dummies (textiles, clothing and leather, paper products, non-metallic minerals, and wood products) are negative and statistically signficant – this indicates that relative to the omitted sector (food, beverages and tobacco), these sectors have a lower productivity.

In summary the picture that emerges for Egypt is both complicated and interesting. The complications arise from the important differences between the private and the public sector. As seen earlier the public sector over the time period in question comprised an important (though declining) proportion of manufacturing in Egypt. Productivity in this sector was consistently lower, and more variable than productivity in the private sector. There is little evidence of much of a pattern either at the industry level, or at the level of the size class of firms. There is also no apparent relationship between increases in trade openness, either with regard to imports or with regard to exports, and levels of productivity. The picture is then quite different with regard to the private sector. Here we see much higher levels of productivity, consistent differences in productivity across sectors, and significant coefficients with regard to size, and trade openness. The evidence suggests that (a) larger firms are more productive than smaller firms, (b) that increased access to export markets (as a proportion of domestic output) is positively associated with levels of productivity, and (c) that increased imports tend to lower levels of productivity.

5. Summary and policy implications:

1. The decomposition of the sources of productivity growth over time for Morocco indicated that in aggregate the contribution of changes in firm level productivity to aggregate productivity was small, and appeared to be declining over time. Thus the evidence appears to suggest that changes in firm level productivity were relatively modest, and this was true of most sectors.. Our results also appeared to suggest little evidence of economies of scale which could enable productivity improvement to occur via scale effects. It would be interesting to examine more carefully the issue of the presence of lack of economies of scale and to see if there are factors specific to the economic environment which mitigate against the exploitation of economies of scale. In addition to the above, and reinforcing the message from the discussion earlier, it is important not to underestimate the importance of the overall environment and the presence of appropriate flanking policies which enable firms to increase the productivity and competitiveness. This touches upon issues such as the quality of service provision, the competitiveness and flexibility of the financial sector, administrative and bureaucratic procedures, infrastructure investment and so on. An improved economic environment, and improved flexibility in product and factor markets, can greatly facilitate productivity improvement.

2. To the extent then that changes in productivity are driven more by sectoral reallocation effects and by the entry and exit of firms, this also suggests considerable churning in the labour market. This is reinforced when we look at the proportion of new firms and exiting firm in any given year as a proportion of the total number of firms for that year. On average over 1990-2002 the proportion of exiting firms was 10.4%, and the proportion of new firms 9.5%. This is a high figure, which indicates considerable turnover amongst firms, and consequently in the labour market[1]. There is clearly then a need for policies, such as social security

[1] It is of course possible and likely that to some extent these figures overstate the extent of entry and exit of firms. Although the data is based on a census it is clearly possible and likely that firms simply may not report in any given year, and thus appear as exiters, and then choose to report in a subsequent year and then would appear as entrants. To some extent we have attempted to control for this. Hence,in the data where a firm disappears from the data set, but the reappears either a year or two years later, we

policies, designed to alleviate the short term adjustment costs associated with these processes. There is also a need for policy to assess why there appears to be such a high-degree of firm level turnover. This would involve examining in more detail the characteristics of the entrants and exiters, and seeking to establish whether for example exiting firms are genuinely exiting because of a lack of competitiveness of due to other reasons.

3. There is some evidence in our analysis for Morocco that changes in the skill-composition of the workforce at the firm level impacts positively upon productivity – however the evidence is slight. This in turn might suggest that change in policy at the firm level designed to increase productivity, or the entry and exit of firms does not appear to be significantly impacting upon the skill composition of the workforce and hence on factor returns. Care, however, should be taken in drawing this conclusion, as the division of workers by skill category may well differ across industries and thus might be impacting upon our results.

4. In contrast what is clear both from our analysis of Morocco and of Egypt is that there are important changes in the sectoral shares in production (for example the growing share of clothing and electrical in Morocco, the changes between the private and the public sector for Egypt) which again point to structural adjustment and the need for policies to alleviate that process of adjustment both at the level of the individual but also at the level of the firm. What is interesting is that these processes are not clearly linked to changes in productivity at the sectoral level, and this again is related to the discussion above concerning the high rates of entry and exit.

5. There is clear evidence that trade and openness do interact in important ways with productivity. Here we need to distinguish between openness at the level of exports, and openness at the level of domestic imports:

   Export openness: The results suggest that exporting activity tends to lead to higher levels of productivity, and not surprisingly the extent of that impact differs across sectors, but also across different size classes of firms. One has to bear in mind that

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have interpolated the missing data, and thus the firm is then treated as being an incumbent throughout the time period.

there is an issue of endogeneity here in that it could be that higher levels of productivity may lead to higher export levels, as opposed to higher export levels leading to higher productivity. However, the nature of the fixed effects regression, as well as the analysis in first differences lends more support to the latter.

There is then a clear need to understand more fully what drives this association between exporting and productivity, and the source of the variation in this relationship across sectors. Some of the difference in the productivity of those firms that export and those that do not may arise from differences in the other characteristics of these firms. An appropriate methodology for exploring this is based on the Oaxaca decomposition. The principle underlying the Oaxaca decomposition is that the sample is divided into two groups (in this case exporting firms and non-exporting firms), and then the regression of productivity on the explanatory variables is run separately on each of the two sub-groups. The decomposition then considers the source of the *difference* between the productivity levels across the two groups. Hence, it is possible that the difference in productivity levels is entirely explained by these other characteristics. For example, it is possible that exporting firms, are also larger firms, and that the difference in productivity is entirely explained by this difference in size. Similarly, with respect to the age of the firm. This aspect of the difference in productivity is called the “difference in characteristics”. Alternatively it is possible, that all these other characteristics do not explain any of the difference in productivity, but instead that the exporting firms derive a higher productivity out of their given characteristics. For example that for a firms of a given size and age etc, that the exporting firms have a higher return (productivity) on those same characteristics. This aspect of the decomposition is know as the “difference in returns”.

Given the importance of the relationship between exports and productivity we have then run the Oaxaca decomposition for our Moroccan sample of firms over the period 1996-2002. That decomposition suggests that 42% of the difference in productivity between exporting and non-exporting firms derives from the difference in characteristics, and that 58% of the difference derives from the difference in returns. This is extremely interesting, for it suggest that in part it is the difference in the characteristics in the firms that matters – and from the aggregate estimations this is likely to be associated with size and age of firms. But importantly we see that an important part of the difference arises from the differences in the returns to those characteristics for the exporting firms. This raises interesting questions as to whether this arises as a result of greater exposure to technology or market conditions in export markets, or does this arise from a need to produce to certain standards (imposed either at the level of eg. the EU, or by individual subcontracting firms.).

In terms of policy, it is important that policy focuses on ensuring the appropriate environment for firms to engage in exporting activity. Recognising that productivity and exporting status are positively correlated should not lead to a return to simple export promotion policies, nor to a policy of trying to pick future export growth firms or industries. More important is to ensure that the correct environment is in place. This involves a focus on issues such as infrastructure, the bureaucratic arrangements in place, customs procedures, the regulatory and institutional environment for exporters, as well as costs of transport. Thus policies aimed at improving local infrastructure, aimed at better understanding the regulatory and /or bureaucratic obstacles or barriers to exporting are all likely to improve that environment, encourage a higher growth of exports and thence productivity, and ultimately poverty. The preceding focussed on the domestic market, but equally it is important that policy addresses issues of access to export markets. Those issues of access clearly concern both direct barriers to trade such as remaining tariffs or quotas, as well as indirect barriers to trade such as the role of rules of origin in constraining firms' access to markets. Reducing such barriers, reducing protection of key competing European industries, simplifying and relaxing the rules of origin are all important policies to be pursued.

Access to market also concerns issues of what is often referred to as "deep integration". Here one typically has mind issues of quality assurance, norms and standards, after sales service activities and links to distributors, knowledge of the market and market research, developing links with commercial partners and so on. These are issues both of information, but also of service provision. This too is an area where policy makers can assist exporting or potential exporting firms. It is also an area where it is important to ensure that norms and technical standards are not being used as protectionist instruments but are instead there to facilitate market access, and that the appropriate environment is in place for firms in order to take advantage of that market access.

Import openness: Our results suggest mixed evidence on the impact of increased domestic openness on productivity. For Morocco, in the time series analysis we saw that increased openness in aggregate was negatively associated with productivity. When we distinguished between small and large firms however, this appeared to apply to the small firms and for the large firms there was a positive relationship. For Egypt, where we only have aggregate results there is again a negative coefficient. In contrast, for the Moroccan cross-section analysis (1998-1999), we saw a negative coefficient on the average level of domestic protection. This indicates that a reduction in domestic tariffs is associated with an increase in productivity.

In the literature much has been made over a number of years of the supposed benefits of the "cold shower of competition". The increased domestic competitive environment is supposed to lead both to the exit of less efficient firms, as well as to increases in productivity (through for example reductions in x-inefficiency of existing firms). What is interesting about our results here is that it is far from clear that this is indeed occurring when looking at Egypt and Morocco. The picture that emerges from the above is mixed, and the evidence suggests that both effects are likely to be present. There are several possible explanations for this. One possible explanation for the negative effect of increased openness on productivity is that we are simply picking up on a short term phenomenon here, which is that the heightened domestic competition is resulting in firms reducing their levels of output. If firms produce under conditions of economies of scale that this reduction in output increases average costs and thus decreases efficiency. Clearly, this may well be the case, and it is thus more likely to apply to larger firms. However, it is worth noting that in our regressions we tested for the presence of economies of scale, and these were typically rejected. This therefore suggests, that maybe alternative explanations need to be found. Those alternative explanations involve looking more closely at understanding the mechanisms driving the changes in aggregate productivity which we find.

Note that in order for a positive impact from the “cold shower of competition” it is important that the correct domestic conditions have to be in place in order to allow firms to adjust appropriately. Central here of course is the way that firms adjust to changes in policy and ensuring that these adjustments are as optimal as possible. From a policy point of view it is therefore important to understand more about the causes of the exit of firms. Clearly if this occurs because of the increase in competition and the lack of competitiveness of the firm than this constitutes part of the necessary process of adjustment and change. However, if it occurs because of, for example, limited and inefficient access to credit, or because of other administrative and regulatory obstacles to productive activity than policy should address those obstacles. Hence, an alternative explanation for the negative impact of openness on productivity suggests that in the face of openness relatively productive and possibly competitive firms may be exiting the industry because of other constraints and difficulties.

Consider also that our results suggest that this negative coefficient appears to impact more on the smaller firms. It is quite plausible to suppose that small firms may indeed experience problems of invoices being paid on time, may have more limited access to credit, or may be less able to deal with regulatory or inftrastructure problems, or find it more difficult to meet the (growing) demands made upon them by the firms with whom they have sub-contracted. It is also plausible that changes in policy such as the Barcelona process invoke uncertainty for firms. In the fact of uncertainty firms may well choose to invest less – either in capital equipment, training of workers or R&D – which then impacts upon productivity. Again, it is perhaps more likely that small firms would react differently in the face of uncertainty than large firms. Hence there is a need to understand better the constraints and needs of firms and in particular smaller firms, and for policy to address those needs and concerns where it can.

On this issue it is finally also worth noting that it is also possible that small firms may well resort to the informal sector faced with the need to adjust to changes in policy. Hence, while for the purposes of our data they exit the industry, it might be that instead they are producing in the informal sector. More generally, it is worth emphasising that our analysis focuses on the data which is available and this concerns the formal sector. The non-agricuiltural informal sector in Morocco, for example, is very large and is estimated to constitute 17% of economic activity, and 20% of total employment[2]. There is thus a clear need for policy to understand better the relationship between the formal and the informal sector.

6. From the descriptive statistical discussion of the productivity estimates for Morocco and Egypt there was some key sectoral patterns which emerged. These include differential changes in productivity across sectors with certain sectors experiencing large and positive changes in productivity while other sectors witnessed a decline. For example in Morocco, Textiles, Chemicals, and Leather saw a decline in productivity over the period. Similarly for Egypt there was a marked difference in the changes in productivity between the private and the public sector, and then for individual industries within these sectors. Changes in productivity are likely to be closely linked to changes in competitiveness, and thus ultimately to sectoral changes in production. Hence, prima facie, the results here shed light on sectors which may well have experienced, be experiencing or are likely to experience problems with regard to structural adjustment. These are thus sectors which thus may require more assistance, or indeed different types of assistance than sectors where productivity and market share appear to be growing.

   Take textiles in Morocco as an example. This is a sector with low levels of productivity growth, a declining share in production, and a rise in imports. In the first instance therefore it would appear that this is a sector where policy could be targeted in order to focus on the workers and firms being displaced as part of this process. However, policy should not only be addressed to ease the process of transition. It is also important to understand why these changes are taking place. Is it the case that textiles in Morocco are uncompetitive and given the world market conditions are likely to remain so? Alternatively, is their scope for increasing the competitiveness of the sector. For example, are rules of origin sufficiently constraining in the sector that this is impacting negatively on their competitivness, and that signing regional trade agreements with other southern partners such as

[2] "Synthese des principaux resultats de l'enquete nationale sur le secteur informel non-agricole" (1999/2000), Direction de la Statistique, Royaume du Maroc.

Turkey or Egypt which allow for diagonal cumulation could significantly impact on their competitivness; is there scope for increasing the competitiveness in certain aspect or niches in the textile market, and to what extent can facilitating sub-contracting ease this process. These are difficult and important questions, but ones which effective policy needs to address.

7. Another result which emerges from the preceding analysis is that there are important differences in productivity levels, and in productivity changes by sector and by size class. In part these issues were discussed in more detail above, when we discussed the role of openness on productivity. The diverse relationship between size class of firms and productivity highlights the importance of recognising the heterogeneity of firms in both analysing productivity and structural change but also with respect to policy.

8. As when discussing the issue of the difference in productivity between exporting and non-exporting firms, it is important to establish the extent to which difference in productivity by size class are driven by differences in other characteristics, or by differences in the returns to those characteristics. For example, it may be that larger firms are more productive because this reflects economies of scale (size), but it may also be that there returns to scale are very low and there are other constraints and issues which need to be addressed. In order to address these sort of issues we employ the Oaxaca decomposition again, where look at the difference in TFP between small and large firms for Morocco. Here we find that 26% of the difference in productivity appears to be explained by underlying differences in other characteristics of small and large firms; and that 76% of the difference is driven by the difference in returns from those characteristics. It is clear that firms of different sizes appear to respond differently to changes in the economic environment, and in particular that large firms obtain a higher return from the same characteristics than do small firms.

Appendix: Approaches to Productivity Measurement

The first stage of the empirical methodology requires estimating or calculating a measure of productivity at the firm level. There are three principal techniques which are most often utilised in the literature. These are parametrically estimating a production function (eg. Cobb-Douglas or Translog), the index number approach, and Data Envelopement Analysis (DEA). In this paper we work with both the parametric approach, as well as the index number approach. The advantage of the latter concerns the ease of implementation, allowing for technology to vary across individual units, as well as being able to handle multiple outputs and inputs. The advantage of the former is that it is less prone to measurement error and generated statistical tests for the significance of the results. The principal underlying data required for each of these approaches is: value added, variables to capture the cost of labour and the stock of capital. Value added is calculated as the difference between total production and intermediate consumption. The variables proxying for capital and labour respectively are the capital stock (machines and buildings after depreciation) as reported in the balance sheet of the firms. and total wages and social charges. With regard to the latter we do not have data on labour disaggregated by type, hence using total wages and social charges we are capturing the heterogeneity in labour that would not captured by using total hours worked or total workers.

2.2.1 Parametric approaches

For the parametric approach we assume a standard neo-classical production function $Q_t = Q(L_t, K_t)$, which we assume to be log-linear Cobb-Douglas:

$$Q_t = \alpha_0 + \alpha_l L_t + \alpha_k K_t + u_t \qquad (1)$$

Where α_1 and α_2 represent the Cobb-Douglas coefficients for labour (*L*), and capital (*K*) respectively and u_t is the error term. An OLS estimator could then be used to obtain a fitted vector of coefficients α, and where then the residual captures productivity. However, as is now widely recognised firms' choice of inputs will depend on their technology and productivity, which is in turn unobserved (Marschak & Andrews, 1944). For example, more productive plants are more likely to invest more due to higher productivity. The rationale for the relationship between productivity and the choice of inputs can also be seen in the face of a positive productivity shock. For a profit maximising firm a positive productivity shock raises the marginal product of capital and labour, and with constant factor prices, the firm will expand output and hence use more inputs to drive down the marginal products. Analogously for a negative productivity shock. As productivity is unobserved and as the choice of inputs is likely to be correlated with the former, the residual, which contains productivity will be thus be correlated with L and K. This problem of simultaneity means that an OLS regression is likely to lead biased estimates of the coefficients on capital and labour, and thus biased estimates of productivity. In particular one would expect that the OLS regression would lead to an upward bias in the capital coefficient and therefore maybe a downward bias in the labour coefficient. In order to overcome this problem of simultaneity we use two alternative methodologies. The first is that of instrumental variables, and the second follows the semi-parametric approach of Levinsohn & Petrin (1999), which is in turn based on the work of Olley and Pakes (1996). In both the IV and the OLS regressions we control for sectoral and regional differences through sector and region-specific dummy variables.

For the IV estimation the instruments we use for capital and labour are lagged values of capital (1998) and wages (1998) as well as the replacement book value of machines and buildings (1999). We test for both the relevance and the validity of the instruments. For the former we look at the R^2 of the first stage regressions, and the results invariably suggested the relevance of the instruments as the R^2 with respect to the instrumented regressors was typically over 0.9. For the latter we test that the instruments are orthogonal to the errors using the Sargan and Basmann tests. Again across several variants of the model the Sargan and Basman tests were invariably passed. As the use of IV estimation to address the endogeneity problem implies a cost in terms of efficiency vis-à-vis OLS, once the relevance and validity of the instruments is established, we then use the Hausman test to see if there are systematic differences between the OLS and IV estimates and thus whether the IV estimator is preferred to the OLS. Generally but, interestingly, not invariably, it was the case that the IV estimation procedure was preferred to the OLS procedure and that the OLS procedure tends to understate the labour coefficient, and overstate the capital coefficient. This in line with our expectation about the possible bias present in the OLS regression. We also tested for the presence of constant returns scale and in no case was this rejected.

One of the implications, and possible limitations, of the parametric approach we utilise, is that it imposes the same capital and labour coefficients across all sectors. In the cross section regressions we tested for the valiidity of this by running the above procedure with the inclusion of interaction terms between the sector specific dummies and capital and labour, as well as running the regressions separately for each industry. Note that this strategy reduces the number of observations available for the estimation of the sector specific parameters. The results suggested that for only one sector (Food) were the coefficients for capital and labour significantly different. We then calculated the productivity measures using the sector specific residuals and found that they were correlated with the aggregate ones at levels of 95% or higher. Given the size of our sample, and the greater efficiency associated with the aggregate residuals, and given the high degree of correlation between the different approaches where we regress our productivity estimates against a range of explanatory variables we have therefore focussed on the aggregate first stage regressions.

The second approach we take follows Levinsohn & Petrin (1999) in which they use electricity usage as a proxy for the unobserved productivity shocks. This is analogous to the work of Olley and Pakes who used investment as a proxy. Levinsohn & Petrin suggest, however, that as investment is "lumpy" plants may not respond fully to productivity shocks via investment. In addition it is typically the case in firm level surveys that there are a substantial number of missing observations on investment or zero recorded investment, which thus significantly reduces the sample size. For example, in our sample 247 firms or 29% of the sample report zero investment levels. They therefore propose electricity usage as an alternative.

Under the LP approach production is assumed to be a function of capital, labour and the intermediate – in this case electricity (m). Hence:

$$Q_t = \alpha_0 + \alpha_l L_t + \alpha_k K_t + \alpha_m m_t + \omega_t + u_t \qquad (2)$$

Where now the error term has two components. The productivity component, ω, which is correlated with input choice, μ, which is uncorrelated with input choice. Electricity usage can then be shown to be a monotonically increasing function of capital (K), and productivity (ω). That monotonic function can then be inverted to express productivity as some unknown function of electricity and capital. Hence, production can now be expressed

$$Q_t = \alpha_l L_t + \phi_t(K_t, m_t) + e_t \qquad (3)$$

And where:

$$\phi_t = \alpha_0 + \alpha_k K_t + \omega_t(m_t, K_t) \qquad (4)$$

The unkown function, ϕ, can then be approximated by a third-order polynomial in K_t and m_t . In the first stage of the procedure, α_t and ϕ_t are estimated, and in the second stage the capital and productivity coefficients are identified where productivity is assumed to evolve according to a first-order Markov process. Note therefore that in order to identify the capital and productivity coefficients panel data is required.

The results for the parametric approaches are given in Table A1 below. For each of the estimations the dependent variable was value-added. In principle the OLS estimates are biased because of the problem of the simultaneity between the choice of inputs and the firms' underlying productivity. Each of the IV and the LP approaches are designed to deal with this problem. However, as discussed earlier, the IV estimates suggest that the OLS estimates tend to overstate the capital coefficient and understate the labour coefficients. Interestingly the LP approach implies the reverse. All of the approaches suggest constant returns to scale.

Table A1: Comparison of parametric results

OLS	(No. of obs. = 814; R^2=0.781)			
lva99	Coef.	Std. Err.	T	P>|t|
lk199	0.176061	0.019837	8.88	0
lwages99	0.77676	0.025405	30.58	0
_cons	0.820941	0.224051	3.66	0
IV	(No. of obs. = 730; R^2=0.789)			
lva99	Coef.	Std. Err.	T	P-value
lk199	0.153995	0.02626	5.86	0
lwages99	0.836874	0.034399	24.33	0
le99	0.010646	0.0284	0.37	0.708
_cons	0.415698	0.250094	1.66	0.097
L&P	(No. of obs. = 1597; R^2=0.813)			
Lvacons	Coef.	Std. Err.	T	P>|t|
lkcons	0.202008	0.012102	16.69	0
lwcons	0.761515	0.015729	48.42	0
_cons	0.773489	0.088338	8.76	0

2.2.2: Non-parametric approach – index numbers:

The non-parametric index number approach derives directly from the growth accounting framework. Assume production can be represented by: $Q_{it} = F(X_{it}, A_{it})$. Where Q_{it} is the output level of unit *i* at time *t*., X_{it} is a vector of factor inputs of unit *i* at time *t*, .and θ_{it}

$$\theta_{it} - \theta_{jt} = [\log Q_{it} - \log Q_{jt}] - \frac{1}{2}[s_{ki} + s_{kj}][\log X_{kit} - \log X_{kij}] \quad (5)$$

is an index of technology. It can then be shown that:

i.e. the difference in the technology of two units of production (θ_{it} & θ_{jt}) is a function of the differences in output differentials, Q_{it} & Q_{jt}, and weighted factor intensities X_{kit} & X_{kjt} , where the weights s_{ki} & s_{kj} are share of each factor in value added. This index, the Tornqvist-Theil index is said to be *exact* & *superlative* because it can be derived from any flexible functional form. For comparisons across firms, the comparison is usually made with respect to a reference firm, eg. to a hypothetical firm with average log output, shares etc.

The standard index as derived above has the advantages outlined earlier and in particular that no underlying assumptions are made about the production technology, which can thus differ across firms. However, a possible disadvantage is that the index assumes constant returns to scale and perfect competition in both input and output markets. Klette and Johansen (1999) propose a modification of the above, which at least partially addresses these issues and involves a two-stage procedure. They derive a performance

$$\hat{a}_t = \hat{s}_t - \phi_{Lt}(\hat{x}_{Lt} - \hat{x}_{Kt}) - \hat{x}_{Kt} \quad (6)$$

index, which takes the following form:

Where we are now using the ^ notation to denote the difference between units. Hence, $\hat{S}_t$ gives the difference in sales between firms at time *t*, ϕ is the share of the variable input in total revenue, $\hat{x}_{Lt}$ and $\hat{x}_{Kt}$, give the difference in labour and capital inputs across the firms. Equation 6 is essentially a Tornqvist index where sales have replaced output in the

Solow residual[3]. The first stage thus involves calculating the performance index as given by equation 6. Klette and Johansen then show that:

$$\hat{a}_t = \left(\frac{\varepsilon}{\mu} - 1\right)\hat{x}_{Kt} + \frac{\theta_t}{\mu} - \frac{1}{\eta}\hat{d}_t \qquad (7)$$

where θ is the productivity parameter of interest, ε is the elasticity of scale, μ is the mark-up of price over marginal cost, and η is the price elasticity of demand, *d* is a demand shift parameter. Hence the performance index depends on the productivity parameter, on the degree of returns to scale, and on any demand shifts. In the absence of any demand shifts, under perfect competition, and with constant returns to scale, the performance index is thus simply equal to the Tornqvist index ($\hat{a}_t = \hat{\theta}_t$). In the second stage therefore we estimate,

$$\hat{a}_t = \delta\hat{x}_{Kt} + \sigma_t \qquad (8)$$

where the parameter, δ captures either the presence of economies of scale and/or imperfect competition, and where in the absence of any demand shocks, the error term on this regression, σ_t, captures the productivity parameter. Clearly, if δ is significant and negative than this suggests either deviations from perfect competition, or from constant returns to scale or both. Note that as in the parametric approach, it could still be the case that there is a correlation between the capital stock in equation 8, and the error term, in which case our estimate of δ would be biased upwards. In order to correct for this we therefore ran two version of equation 8 – in levels and in first differences. The aim of the latter was to try and remove any systematic correlation between capital and productivity. The coefficient on δ in the two cases (with t-statistics given in brackets) was –0.34 (-3.18) when done in first differences, and –0.09 (-3.24) when done in levels. As suggested above it is likely that the coefficient on the latter is upward biased, and that the former to some extent controls for this, although clearly there is considerably more measurement error also in this case. We take these coefficients as representing upper and lower bounds, and hence the results suggest some evidence of either imperfect competition or economies of scale.

[3] See Klette & Johanson, 1999, p.381.

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