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# How Trade Liberalization Affected Productivity in Morocco

Mona Haddad



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The economic literature now accepts theoretical arguments that liberal, outward-oriented trade policy is better than restrictive, inward-oriented policies. Traditionally such arguments for the gains from trade have rested on the concept of allocative efficiency. But a new argument for liberal trade has emerged: increased technical efficiency or productivity. The best-known attempts to link trade policy and productivity are based on "X-efficiency," economies of scale, capacity use, increased competition, and technological catch-up.

Haddad estimates total factor productivity (TFP) at the firm level using panel data from the Moroccan industrial census in a production-function framework during Morocco's period of trade liberalization (1984-89). Haddad corrected for several problems that usually bias the estimate of productivity. The use of panel data allowed Haddad to take into account the heterogeneity across firms. These firm-specific effects were tested for randomness. Differences between large firms and small firms were checked. She also corrected for errors in measuring capital stock, so common in data from developing countries, and for simultaneity bias because of the endogeneity of factor inputs or because managers have some knowledge about the noise in the production function.

Haddad then estimated the effect of various trade and market-structure variables on the level of TFP, as well as on the deviation of firm TFP from the efficiency frontier. The results are not very sensitive to the different measures of TFP and show that trade openness has a significant positive effect on firm productivity through:

- Outward orientation from export promotion.
- Import liberalization.
- More direct foreign investment.

By splitting the sample into protected and unprotected sectors, Haddad showed lower productivity in protected sectors.

The results are clear. Trade liberalization in Morocco improved productivity in manufacturing firms, so they could exploit their comparative advantage and compete better with foreign firms.



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# How Trade Liberalization Affected Productivity in Morocco

by

Mona Haddad

**This paper was prepared for the World Bank research project "Industrial Competition, Productive Efficiency, and Their Relations to Trade Regimes (RPO 674-46)." The author thanks Ann Harrison, Oleh Havrylyshyn, Jaime de Melo, and James Tybout for their comments and support.**

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## I. INTRODUCTION

Theoretical arguments for the preeminence of liberal, outward-oriented trade policies over restrictive, inward-oriented ones are now widely accepted in the economic literature. Traditionally, these arguments for the gains from trade rested on the concept of allocative efficiency, whereby an open economy is more likely to allocate its resources in areas where it has a comparative advantage. Yet another case in favor of more liberal trade has recently emerged in terms of increased technical efficiency or productivity. The best known attempts to link trade policy and productivity are based on 'X-efficiency', economies of scale, capacity utilization, increased competition, and technological catch-up.

First, trade liberalization can change the opportunity cost of leisure in such a way that managers work harder. That is, the return to entrepreneurial effort is increased by exposure to foreign competition, inducing managers to make an extra effort at eliminating inefficiency. Second, the existence of economies of scale implies that a widening of the market through trade should lead to reductions in real production costs, mainly in terms of increased demand through export expansion. The same argument holds for increased capacity utilization. Third, in a protected market dominated by several firms, trade reform will lead to increased competition, and hence a reduction of monopolistic inefficiency. Finally, trade reforms are likely to accelerate the transition to state-of-the-art technologies since domestic producers are more exposed to foreign competition.

The handful of studies which attempted to quantify the allocative gains from liberal trade policies found, in general, weak results. However, much greater benefits are likely to emerge from improvements in productivity. Unfortunately, the latter are more difficult to measure and the empirical literature does not offer definitive evidence on the effect of trade reform on productivity. Several recent overviews of the links between trade regimes and productivity gains (Tybout 1991, Havrylyshyn 1990, Bhagwati 1988, Nishimizu and Page 1987) suggest that the evidence is mixed.

One possible explanation for the lack of conclusive results may depend on how productivity is measured. The empirical research on industrial productivity has suffered from two major shortcomings. First, a large number of studies[1] were based on the traditional measure of total factor productivity, pioneered by Solow (1957). The consistency of this measure depends on the validity of the assumptions it makes, namely perfect competition, constant returns to scale, and perfect mobility of all inputs. Yet, although the potential biases of the productivity estimates which take place when these assumptions are violated have long been recognized[2], little was actually done to correct for these errors. Second, even when the problems of scale economies, quasi-fixed factors, and non-competitive pricing are successfully dealt with, the problem of aggregation remains. Most studies which attempted to estimate productivity have used macro or sectoral data, implicitly assuming that a well defined production technology describes all plants within the industry, sector or country of analysis. Tybout (1991) points out that "if technological innovation takes place through a gradual process of efficient plants displacing inefficient ones, and/or through the diffusion of new knowledge, the approaches to productivity measurement based on 'representative plant' behavior are at best misleading. At worst, they fail to capture what is important about productivity growth altogether, as Nelson (e.g. 1981) has long argued".

In this study, we will first attempt to get a consistent estimate of productivity by using industrial census data and taking into account the heterogeneity across firms. Second, we will ask the question: Does trade liberalization actually increase firm-level productivity? In section II, the production model and estimation techniques will be discussed. In section III, recent changes in the Moroccan trade policy will be reviewed and evaluated. Section IV describes the estimated TFP. In section V, the estimation results of the link between productivity and trade are presented. The conclusion is given in section VI.

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[1]See for example Nishimizu and Robinson (1984) or Krueger and Tuncer (1982).

[2]See for example Nishimizu (1979) or Kim and Kwon (1977).

## II. SPECIFICATION AND ESTIMATION OF A PRODUCTION MODEL

### 1. Specification of the production model[3]

The production technology: We begin with a stochastic Cobb-Douglas production function:

$$(1) \qquad Y_{it} = A\, L_{it}^{\alpha}\, K_{it}^{\beta}\, e^{u_{it}}$$

where the subscripts i and t represent the firm and the time period respectively. The industry subscript has been suppressed. Y is value added, L is labor measured in efficiency units, and K is true capital stock. A is the average level of Hicks-neutral technical efficiency within an industry. $\alpha$ and $\beta$ are scalars for which the sum represents returns to scale for each industry. The error term $u_{it}$ is assumed to have three components:

$$(2) \qquad u_{it} = \mu_i + \tau_t + \xi_{it}$$

where $\mu_i$ is a firm-specific effect that reflects firm efficiency and management skills; $\tau_t$ is a time effect common to all firms that reflects industry-level changes such as general fluctuations in capacity utilization, technological innovation, and returns to scale; $\xi_{it}$ is a random disturbance reflecting the remaining noise across firms and time which represents factors such as luck, weather conditions, and unpredicted variation in machine or labor performance.

All error components are unobservable to the econometrician; however, both $\mu_i$ and $\tau_t$ may be observable to the managers. In this case, they will be correlated with the exogenous variables as will be shown later. On the other hand, the errors represented by $\xi_{it}$ are uncorrelated with the exogenous variables and are assumed to be independently and identically distributed across firms and time. In this

[3] This model is an extension of Tybout (1990).

production function, $\mu_i$ will depict the firm-level technical efficiency which we would like to estimate and will be represented as a fixed or a random variable.

The producer behavior: Producers are assumed to maximize short-run profits. However, because of the stochastic nature of the production process, any given level of inputs will result in an uncertain level of output, and therefore, in an uncertain profit. The concept of profit maximization becomes ambiguous due to the presence of the random elements. It is therefore necessary to gear the problem towards the maximization of expected profits. However, this will involve the inclusion of the variance of the production function disturbance (see Zellner, Kmenta, and Drèze 1966). In order to avoid carrying along this extra term, we assume median profit maximization (see Kumbhaker 1987).

Furthermore, we assume that prices (of output, labor, and capital) are either known with certainty or statistically independent of the production function disturbance term. More specifically, with a short-run production function, capital is fixed and labor is variable. It becomes natural to assume that the price of capital is known with certainty since, typically, capital is purchased before it is used in production. On the other hand, let the expected real wage for labor be related to its actual ex-post value for each firm according to the following equation

$$(3) \qquad W^{e}_{it} = W_{it} e^{\epsilon_{it}}.$$

The expected short-run profit function can now be written as

$$(4) \qquad E(\pi_{it}) = E(Y_{it}) - W^{e}_{it} L_{it}$$

$$= A L^{\alpha}_{it} K^{\beta}_{it} E(e^{u_{it}}) - W_{it} E(e^{\epsilon_{it}}) L_{it}$$

By taking the first order condition of the <u>median</u> profit, after decomposing the error term $u_{it}$ into its three components and assuming that $\mu_i$ and $\tau_t$ are observed by managers, we get:

$$d\pi_{it}/dL_{it} = (\alpha/L_{it})Y_{it}e^{-\xi_{it}} - W_{it}e^{\epsilon_{it}} = 0 \tag{5}$$

In logarithmic terms we have

$$\ln L_{it} = \ln\alpha + \ln Y_{it} - \ln W_{it} - \epsilon_{it} - \xi_{it} \tag{6}$$

From equation 6 it becomes clear that the demand for labor by the firm not only depends on output and wages in the same period, but also on the unforseen random elements in both production and real wages. By combining the first order condition with the production function, we get the reduced form for employment

$$\ln L_{it} = (1-\alpha)^{-1}[\ln\alpha + \ln A + \beta\ln K_{it} - \ln W_{it} - \mu_i - \tau_t - \epsilon_{it}] \tag{7}$$

From equation 7, we can see that labor is only affected by the components of the production function's error term that are observed by managers ($\mu_i$ and $\tau_t$) and not by the unobserved component ($\xi_{it}$). Therefore, whenever managers have knowledge about a portion of the production function's disturbance, the employment decisions will be affected by it. In this case, simultaneity problems arise and labor cannot be taken as exogenous in the production function. However, if managers do not have knowledge of any portion of the production function's random element, equation 7 will be completely independent of $u_{it}$ and the simultaneity problem is eliminated.

Whether $\mu_i$ is observable or not to managers, it will represent our technical efficiency estimate, while the sum of the estimated $\alpha$ and $\beta$ will represent an index of returns to scale.

2. Estimation techniques with panel data

Given the nature of our data (cross-section, time-series), the empirical estimations for this model are based on panel data techniques. The use of panel data improves the efficiency of the econometric estimates and allows the introduction of firm-specific effects (representing technical efficiency in our production model) which can be treated as fixed constants or as random variables. Each case is briefly discussed below[4], assuming for the moment that all inputs are exogenous.

The fixed-effect model: The firm-level productivity $\mu_i$ is assumed to be fixed and can therefore be estimated as an intercept which varies across firms by introducing dummy variables. Assuming for simplicity that there are no time-specific effects, we have the following model

$$(8) \qquad Y_{it} = \mu_i + \gamma' X_{it} + \xi_{it}$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$. $Y_{it}$ is the dependent variable (output) for the $i^{th}$ firm at time t, $X_{it}$ is a Kx1 vector of K exogenous variables (inputs), $\gamma'$ is a 1xK vector of constant parameters, and $\mu_i$ is a 1x1 scalar constant representing the effects of the variables specific to the $i^{th}$ firm and invariant over time[5]. The $\mu_i$ for each i is obtained by including i dummy variables which take the value 1 for the corresponding i and 0 otherwise. The error term $\xi_{it}$ represents the effects of the omitted variables that are

[4]More details can be found in the econometric literature on panel data (see for example Hsiao, 1986).

[5]Note that we are using vector notation.

both time and cross-sectional varying. Assuming that $\xi_{it}$ is independently and identically distributed, the OLS estimator for $\mu_i$ is:

(9) $$\hat{\mu}_i = \bar{Y}_i - \hat{\gamma}_{CV}\bar{X}_i$$

where $\bar{Y}_i = (1/T)\Sigma_t Y_{it}$ and $\bar{X}_i = (1/T)\Sigma_t X_{it}$, and $\hat{\gamma}_{CV}$ is the OLS estimator of $\gamma$.

The estimator of $\gamma$ obtained from the fixed-effect model is sometimes called the covariance estimator or the within-group estimator, because only the variation within each group is utilized in forming this estimator. It is known from the literature that the covariance estimator $\hat{\gamma}_{CV}$ is unbiased. It is also consistent when either N or T or both tend to infinity. However, the estimator for the intercept $\hat{\mu}_i$, although unbiased, is consistent only when T tends to infinity.

The random-effect model: In the previous section, we treated the firm-specific technology effects $\mu_i$ as fixed constants over time. Alternatively, these firm-specific effects can be treated as random variables, like $\xi_{it}$. It is standard in regression analysis to assume that factors which affect the dependent variable, but are not explicitly included as independent variables, can be appropriately summarized by a random disturbance. In the case of panel data where some omitted effects vary across time but are firm-invariant, and others vary across firm but are time-invariant, it is natural to assume that the residual $u_{it}$ consists of three random components (see equation 2).

Because the error term has several components, this model is often referred to as the error-component model. Again, we assume that $\tau_t = 0$ for all t. It is clear that the presence of $\mu_i$ produces a correlation among residuals of the same cross-sectional unit, though the residuals from different cross-sectional units are independent. Therefore, the least-squares estimate of $\gamma$ ($\hat{\gamma}_{CV}$) is not efficient, although it is still unbiased and consistent. In the case of correlated errors, the generalized-least-squares (GLS) estimator is the BLUE estimator.

Given the GLS estimate of $\gamma$ ($\hat{\gamma}_{GLS}$), we can recover estimates of the individual cross-sectional unit's intercept $\mu_i$ from the residuals. Following Schmidt and Sickles (1984), if we define the residuals as $\hat{u}_{it} = Y_{it} - X'_{it}\,\hat{\gamma}_{GLS}$, we can estimate $\mu_i$ by the mean, over time, of the residuals for the individual cross-sectional unit i

(10) $$\hat{\mu}_i = (1/T)\,\Sigma_t\,\hat{u}_{it}$$

In our production model, this estimate will represent technical efficiency at the firm level in a random-effect model.

<u>Fixed versus random effects models</u>: How can we decide whether to assume fixed or random firm-specific effects? The GLS estimation, although being more efficient than the within estimation when N is large and T is small, requires the assumption of uncorrelatedness between the error term $\mu_i$ and the regressors. If the firm-specific TFP is correlated with input choices, the estimated regression coefficients will be biased and inconsistent. On the other hand, the advantage of the covariance model is that it protects against a specification error caused by such a correlation, but its disadvantage is a loss of efficiency because of the increased number of parameters to be estimated. Following Hausman (1978), we can test the null hypothesis that no such correlation exists [$H_o$: $E(\mu_i X'_{it}) = 0$], in order to assess the appropriateness of using a random-effect model.

## III. TRADE POLICY IN MOROCCO

Since 1983, the Moroccan government has been pursuing trade liberalization measures, within the framework of the structural reform, aimed at gradually reducing the anti-export bias and rationalizing the incentives to import substitution. There are basically three major import regimes in Morocco: import taxes, quantitative restrictions, and reference prices.

The import tariff is the most important taxation instrument for protection from foreign competition and a significant source of tax revenue. There are five individual taxes on imports: the customs duty, the special import tax, the stamp duty, the value added tax, and the excise tax.

The customs duty is considered the major fiscal instrument of protection and is levied on the c.i.f. value of the imported goods for domestic use. Prior to the liberalization in 1983, the customs duty was subject to a wide variation both across and within sectors. In 1988, the maximum rate declined to 45%, with 26 levels. The customs stamp tax is levied at 10% of the sum of all other import taxes administered by customs. Although it is applied uniformly, it magnifies the protective effect of both customs duty and special import tax. The special import tax (SIT) is a uniform tariff levied on the c.i.f. value of imports. In 1988, the SIT and the customs stamp tax were replaced by a Fiscal Levy on Imports (Prélèvement Fiscal sur les Importations or PFI), applicable in principle to all Moroccan's imports at the rate of 12.5% of the c.i.f. value. Contrary to the declining maximum tariff trend observed since 1983, this entailed an increase over the sum of the two abolished taxes. Although the intention was to generate additional fiscal revenue rather than to provide protection, in effect it also confered protection. The authorities proposed uniformity of rates in order to avoid discriminatory incentives. However, there are in fact numerous exemptions from the PFI (in 1988, over one-fourth of all imports were exempt from the PFI).

The value-added tax is levied on the c.i.f. value of imports inclusive of customs duty and the PFI tax and is neutral in terms of resource allocation. The excise tax is levied by customs at the port of entry for a limited number of products (primarily petroleum, petroleum products, sugar and beer). These two taxes cannot be regarded as trade policy instruments, as they apply regardless of the origin --domestic or foreign-- of the goods and do not create a wedge between domestic production and imports.

Next, consider the role of quantitative restrictions (QRs). They were regarded in the past as the principal instrument of domestic protection but were significantly reduced following the establishment of a generalized control of imports in March 1983. An annual General Import Program classifies goods by tariff line into three lists: goods in list A which can be freely imported without prior authorization, goods in list B which necessitate a prior authorization to be imported, and goods in list C for which imports are prohibited except in special circumstances. In 1986, list C has been formally abolished. Moreover, since 1983, products have steadily transferred from list B to list A which represented, in 1988, 81.8% of the imported products (six-digit CCCN tariff codes) as opposed to 67.6% in 1984 (Table 1a). Nowadays, import licenses for list B goods are almost automatically granted and the authorities consider that by 1992 list B would also disappear.

Finally, there is the system of reference price which is, in principle, intended as a safeguard against dumping and unfair trading practices by foreign producers. Reference prices are limited to 367 tariff headings (mainly ceramic tiles, end-of-series and second-hand clothing, used auto-parts). They are used to alleviate the concerns of domestic producers about the liberalization of QRs. However, there are questions arising about the reference prices being actually binding.

Despite the liberalization effort, the Moroccan economy is still far from being an open economy. Simply looking at the share of restricted imports and the average tariff rates is misleading and actually exaggerates the extent of the liberalization. First, the share of domestic production whose competing imports are subject to licensing is a more meaningful measure of protection. Indeed, although the share of imports which require an import license (List B) dropped to 12.7% in 1988, 40% of the value of industrial production is still protected by import licenses[6]. With import substitutes (which are calculated

[6]World Bank President's Report on Structural Adjustment Lending (1988).

as the residual of the industrial value added after accounting for the share of exports and non-tradables) covering about 55% of the industrial sector's value added, this implies that over 70% of the import substitutes are still protected by import restrictions[7]. Second, the average tariff is not an economically meaningful indicator of protection since the lowest rates apply to items not produced in Morocco. Indeed, although the import-weighted average tariff for the first six months of 1989 was 13.5%, with more than half of the imports paying 12.5% or below (Table 1b), when weighted by the share in production the average tariff is above 39%. Finally, reference prices also disguise restrictions and lack transparency. They tend to be arbitrary and it is difficult to determine how restrictive they are in practice.

On the export side, the Temporary Admission scheme (import to re-export) has played an important role in encouraging exports and is, in fact, the fastest growing export category: its imports, which in 1984 amounted to less than 10% of total imports, increased to over 25% by 1988. Nonetheless, the economy's anti-export bias remains. Generous tax exemptions (especially from value-added tax) to such non-tradable sectors as construction, and price controls in other sectors impede the transfer of resources to export and efficient import-substitution sectors. Moreover, every tariff represents protection from an import-substitution activity and a tax on exports. The tariff therefore leads to an anti-export bias.

It should be noted that further liberalization took place after 1989 but does not cover the period analyzed in this paper.

## IV. ESTIMATION OF FIRM-LEVEL PRODUCTIVITY

The empirical analysis of the Moroccan industrial performance during the period of trade liberalization is based on firm-level industrial survey data collected by the Moroccan Ministry of Commerce and Industry. The data cover the period 1985 to 1989. The surveys are exhaustive and include all enterprises with 10 or more employees, as well as enterprises with less than 10 employees which

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[7]See World Bank (1990), Morocco: Sustained Investment and Growth in the Nineties

realized a sales revenue greater than 100,000 dirhams (approximately US$11,000 at the average 1985-1989 official exchange rate). Descriptive statistics on the Moroccan manufacturing sector are provided in the Appendix.

The multi-factor productivity for each firm was estimated by assuming a Cobb-Douglas production technology. The reason behind choosing this functional form lies in the fact that census data are unlikely to support more intricate forms (Griliches and Ringstad, 1971), and that it provides maximum flexibility in dealing with data imperfections (Tybout, 1990).

Year dummies were included in the estimation to control for macroeconomic shocks. The panel data consisted of a total of 15,462 observations which incorporate 5 years and a varying number of firms each year (3933 firms appearing at least once each year). A joint regression on all industrial sectors would be meaningless since each sector uses a different technology, and therefore the production function parameters cannot be expected to be the same for all industries. For this reason, the production function was estimated for each industrial sector separately, allowing for the parameters to be different across sectors. Since the concept of productivity also relates to the technology used, and since technology is different across sectors, productivity in levels is therefore not comparable across sectors either. In order to be able to make such a comparison, the deviation of each firm's productivity level from the productivity of the most efficient firm (i.e. the firm with the highest productivity) within each sector was calculated and expressed in percentage term:

$$DTFP_{ij} = [TFP_{ij} - \max(TFP_j)] / \max(TFP_j) \tag{11}$$

where i refers to the firm and j to the two-digit industry. This variable is therefore going to be less than or equal to zero, and the smaller it is (or the larger in absolute value) the less efficient the firm compared to the most efficient one. The estimations were generalized to unbalanced panels since we do not observe the same number of firms each year. This matters only in the random-effect model (see Haddad, 1991, for details). In order to correct for simultaneity bias from the labor input or for measurement error in the capital stock, the Instrumental Variables (IV) method was used.

The results of the production function estimation using the fixed-effect model and the IV model are discussed in the Appendix. The Hausman test rejected the null hypothesis that inputs and technical efficiency are not correlated[8], therefore the random-effect model was not used since it does not improve on the within estimation.

Table 2 shows the mean of the estimated firm-level productivity for each sector. TFPFE is the firm-level productivity calculated from the fixed-effect model, MAXTFPFE is the highest TFPFE, and DTFPFE is the deviation of TFPFE from MAXTFPFE expressed in percent. Among the industries which exhibited the least deviation of productivity from their most efficient firm are electronics, which happen to have the highest share of foreign ownership in equity, and the textile and leather industries, which are highly export-oriented (see foreign share and export share in Table A.1).

The deviation of firm productivity from the efficiency frontier should be interpreted with caution since a small dispersion of productivity across firms in an industry does not necessarily mean that firms are at a high level of productivity. This is especially true if the industry in question enjoys high levels of protection from external competition or high barriers to entry due to monopoly power. This might be the case of the textile industry which has the highest tariff rate of the whole manufacturing sector, or the beverage and tobacco industry which has one of the highest concentration ratio (see CR4 in Table A.1).

Except for the chemical products and rubber and plastics, the average dispersion of productivity from the most efficient firm based on the IV model is higher than the one obtained from the fixed-effect model. For most sectors, the average level of TFP is lower than the one obtained from the fixed-effect model.

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[8]The null hypothesis was rejected for all sectors at the 0.005 significance level.

## V. ESTIMATING THE LINK BETWEEN PRODUCTIVITY AND TRADE POLICIES

### 1. Estimation model

After attempting to obtain a reliable estimate of total factor productivity, we are now ready to test the association between trade liberalization and productivity. This is done with the estimation of the following equation

$$(12) \qquad DTFP_{ik} = f(FORSH_{ik}, SFORSH_{k}, PUBSH_{ik}, SHERF_{k}, SHERFSQ_{k}, AGE_{ik}, AGESQ_{ik}, PRODIV_{k}, GEODISP_{k}, IMPENET_{k}, IMPENETSQ_{k}, EXSHARE_{ik})$$

where

i refers to the firm and k refers to the three-digit industry,
DTFP=Deviation of firm TFP from efficiency frontier (in %),
FORSH=Foreign share in total equity at the firm level,
SFORSH=Foreign share in total equity at the sector level,
PUBSH=Public share in total equity at the sector level,
SHERF=Herfindahl index at the sector level,
SHERFSQ=SHERF squared,
AGE=Age of the firm,
AGESQ=AGE squared,
PRODIV= Product diversification index,
GEODISP=Geographic dispersion index,
IMPENET=Import penetration,
IMPENETSQ=IMPENET squared,
EXSHARE=Firm export share in total sales.

The estimations are undertaken at the firm level, with no time series, because the productivity estimates obtained above do not vary across time. All explanatory variables are means across the 1985 to 1989 period, since this is how the dependent variable was computed. We use as the dependent variable the deviation of firm productivity from the productivity of the most efficient firm within each sector expressed in percent. As mentioned earlier, this measure allows for comparability of productivity across sectors. The regression can therefore be estimated jointly for all sectors. An alternative way of expressing this model is to use the productivity level (TFP) as the dependent variable (not as a deviation) and to include sector dummies in the regression in order to account for differences across sectors.

On the right-hand side, we have foreign share in ownership at the firm level (FORSH) and at the three-digit industry level (SFORSH). The former should show whether firms with high foreign ownership perform better than others, while the latter captures any "spillover" effect that might be due to the existence of foreign firms in the three-digit sector. It is often argued that foreign firms are more productive and use better technologies than domestic firms, and that the knowledge or new technology embodied in foreign firms is transmitted to domestic firms within the industry. Evidence of this hypothesis for the Moroccan case would be in the form of a significant positive coefficient on FORSH and SFORSH. The foreign share in ownership is measured as the share of the total equity of the firm provided by foreigners.

The public share in ownership (PUBSH) is also included as an explanatory variable. The public sector has played a major role in the manufacturing industry since Independence in 1956. Although it is often argued that public enterprises are inefficient compared to private ones, this is not clear, à priori, in the case of Morocco.

Variables which reflect market structure were added. The Herfindahl index (SHERF) controls for market power within the three-digit sector level. In principle, the more concentrated the market (the higher SHERF), the less competition and hence the lower the productivity. The square of this variable (SHERFSQ) was also included to capture any non-linear relationship.

The age of the firm (AGE) is expected to be negatively correlated with productivity as it is usually the case that when firms grow older their productivity declines. On the other hand, new firms are not expected to be the most productive either since it usually takes a few years for a new firm to understand the market and respond correctly to it. In order to capture a possible inverted U correspondence of the age of the firm with productivity, the square of the age variable was included.

The product diversification measure (PRODIV) should be negatively correlated with productivity as we expect firms which do not specialize in production to be less efficient.

Geographic dispersion (GEODISP) captures the geographic concentration of firms. In Morocco, most of the industries are located in Casablanca. This concentration might put pressure on the availability of resources and might crowd out the access of important infrastructure facilities such as various transportation modes. On the other hand, if not excessive, geographical concentration might be beneficial to efficiency since it concentrates all necessary facilities into one place. Empirical evidence will tell us which of these two forces is actually stronger. Note that geographic dispersion is measured such that the larger this index, the less the geographic dispersion, and the less the regional power.

Finally, we get to the trade variables. Unfortunately no good measures of the degree of protection at the sector level were available. Therefore, we had to resort to implicit measures of protection, namely import penetration (IMPENET) and export share in total sales (EXSHARE). Recent economic theory has often advocated that a more open trade would propel productivity. Although this hypothesis has been tested by a handful of economists at the industry level, very few studies investigate this relationship at the firm level, since this sort of disaggregated data has only recently started to be available. Do less restrictions on import actually enhance the competitive atmosphere in the manufacturing sector and hence increase productivity? Or does the relationship between import penetration and productivity exhibit an inverted U shape (see Havrylyshyn, 1990)? On the other hand, is it true that firms which export more are more productive because they face foreign competition? All these hypotheses will be addressed in the upcoming estimations.

In the regression analysis, we use three models which differ by their definition of the dependent variable. In Model 1, the dependent variable is the total factor productivity in deviation terms obtained from the fixed-effect model where the production function was estimated for each sector (DTFPFE).[9] In Model 2, we use the total factor productivity measure (in deviation terms) estimated from the instrumental variable model (DTFPIV). In the latter case, only the sectors which passed the selection criteria (see Appendix) were included. Finally, in Model 3, the dependent variable is the total factor productivity (in level) obtained from the fixed-effect model. In this model, sector dummies are added to the regression to account for differences in technologies. These three models will allow us to check whether the results obtained are sensitive to the TFP measure.

2. The results

The results of the first two models, shown in Table 3, look reasonably similar, which accentuates their robustness. Allowing the production function parameters to vary across sectors as well as firm size (not shown here), or correcting for measurement error and simultaneity bias did not change the general pattern of the results. The only difference between Model 1 and Model 2 is the sign on public share in ownership and geographic dispersion. These two variables, however, are not significant in Model 2.

For the analysis that follows, we will therefore concentrate on Model 1, which explains the deviation in productivity from the efficiency frontier, and Model 3, which explains the level of productivity.

In Model 1, foreign share in ownership, which can also reflect one kind of openness, is positively related to firm productivity: the higher it is, the lower the deviation from the most efficient firm. Moreover, the positive and significant coefficient on sectoral foreign investment suggests an overall smaller deviation from maximum productivity levels in sectors with a large foreign presence. This result confirms the spillover hypothesis in which the presence of foreign firms brings on more exposure of

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[9]We also used as a dependent variable a measure of total factor productivity (in deviation terms) obtained from the fixed-effect model where the production was estimated by sector and by firm size. The results obtained were virtually similar to Model 1 and are not reported here.

domestic firms to new technologies, and more incentive to adopt them. In addition, foreign presence induces greater competition in the corresponding industries, forcing inefficient firms to exit the industry. However, simply because the dispersion of productivity is narrower in sectors with significant foreign presence does not necessarily imply that overall levels of productivity should be higher in those sectors. Indeed, the regression in Model 3 which was performed on the level of TFP (not the deviation) reveals that foreign firms have a higher (and significant) level of productivity, but the presence of foreign firms in an industry does not cause a higher TFP level for firms in that industry (as can be depicted by the significant negative coefficient on SFORSH), although it does induce less deviation of firms from the efficiency frontier. This result indicates that if any productivity spillovers exist, they are negative. One possible explanation for this negative relationship is that foreign firms are attracted to sectors with a low level of productivity, i.e. sectors where foreign firms could exploit their comparative advantage[10].

Firms with a high public share in ownership exhibit less deviation from the efficiency frontier and a higher level of productivity than firms with a lower share of public investment. This finding might indicate that, despite the financial crisis that resulted, the high-investment strategy followed by the government in the early seventies has allowed public firms to reach a larger size (therefore taking better advantage of scale economies) and obtain more technological capabilities compared to new, private firms. On the other hand, this result might be capturing high public equity sectors which are of national importance (such as phosphate derivatives) and where the government usually aims at reaching maximum productivity. Finally, note that the presence of public equity has a higher impact on productivity than the presence of foreign equity, as depicted by the elasticity of each variable.

[10]For a more extensive study on dynamic externalities from foreign investment in Morocco see Haddad and Harrison (forthcoming).

The deviation of productivity from best-practice first increases then decreases as the age of the firm increases. Very young firms and old firms exhibit the widest deviation from the most efficient firm within the industry. The elasticities with respect to age are, however, quite small.

As the Herfindahl index --which measures concentration or scale effects at the three-digit industry level-- increases, the dispersion of productivity, as well as the level of productivity, first increases and then decreases. This might show that for low levels of concentration, firms may not have yet achieved their economies of scale and therefore exhibit low productivity levels, while for high levels of concentration it is the low degree of competition which causes low levels of productivity.

As firms are more geographically concentrated (i.e. as GEODISP increases), they show a greater deviation from the most efficient firm within a sector (i.e. DTFP decreases) and a lower level of productivity. Therefore, being more concentrated geographically is not increasing the level of competition but rather is crowding out on the use of limited infrastructure and services. As noted earlier, this surely seems the case of Casablanca. In fact, the Government is putting effort into encouraging firms to move out of the condensed areas. As expected, the less firms specialize in production (the greater the product diversification) the lower the productivity.

Finally, looking at the trade variables, which we are mainly concerned about, they turn out to be the most significant of all other explanatory variables in explaining productivity and have the expected signs as stipulated by our hypotheses above.

A higher share of export in total sales increases the level of productivity of the firm, or alternatively decreases the gap between the firm's productivity and the efficiency frontier in the corresponding industry. This confirms the hypothesis that firms selling in external markets are forced to increase their productivity to stand up to the high competition found abroad. This is an important result considering the effort put by the Moroccan authorities to encourage exports as part of its liberalization program. It should be noted that the direction of causality between export and productivity is not known.

However, the Sim's causality test used on the same data for Morocco in Haddad, de Melo, and Horton (forthcoming) shows that an increase in exports causes an increase in productivity and not vice-versa. Despite the fact that this is not necessarily a strong test, it gives an idea of the causality.

Although import liberalization was rather limited in Morocco, the results show that import penetration increases the level of productivity up to a certain point after which it has a negative effect on productivity. This pattern can be explained by the inverted U-curve hypothesis related to infant industries which states that limited and selective protection, or alternatively moderate import penetration, may be successful in enhancing productivity as sheltered markets permit increased economies of scale or capacity utilization, or both. On the other hand, if import penetration is overwhelming, the domestic infant industries may not be able to face the competition and a decline in productivity will take place. This latter phenomenon finds support from our regression as detected by the negative coefficient on the square of import penetration. This negative effect is expected to dampen over time (see Havrylyshyn, 1990) but the period after the start of the liberalization is not long enough to capture it.

The empirical evidence on the positive correlation between trade liberalization and productivity, controlling for market structure, is quite strong. This result has rarely found such a robust support, especially when dealing with firm-level data. It suggests, for the Moroccan case, that an increase in productivity is generated not only by outward orientation (through export promotion) but by import liberalization as well. Therefore, given the market structure in Morocco, the experience of trade liberalization, which started around 1984 and consisted mainly of reducing the anti-export bias, seems to have been beneficial to productivity in the manufacturing sector. On the one hand, firms with a higher level of exports, by facing more competition from abroad, have been forced to become more productive. On the other hand, import penetration also put pressure on domestic firms, driving them to increase their efficiency or to exit the industry. The results seem to suggest, however, that a gradual opening of import is more beneficial for productivity than a shock treatment.

After assessing the influence of trade openness on firm productivity, we test for the structural stability of these conclusions. Are these results the same for protected and non-protected industries? The following section addresses this question.

3. High-protection versus low-protection sectors

Since an explicit measure of protection could not be directly incorporated in the above model, it is important to verify whether protected industries behave in the same way as non-protected ones. One way of checking the difference in behavior between these two categories is to separate the sample into high-protection versus low-protection sectors and estimate the same model for each one separately. We expect the direction of the effect of trade openness to remain the same for both protected and unprotected sectors, but the magnitude of this effect to vary across these two categories.

Since tariffs are generally more binding than QRs in Morocco[11], we use as a measure of protection the average tariff level within a two-digit sector for those years where it was available --1984, 1987, and 1988. Taking the median as the dividing point, sectors were categorized as protected or unprotected (see Table 4).

The estimation results for each category (protected and unprotected) are shown in Table 4. The dependent variable is the dispersion of total factor productivity obtained from the fixed-effect production model (DTFPFE). Controlling for market structure, the results on trade variables show little variation compared to the previous model where the above protection criteria were not used. Indeed, the signs of the coefficient on import penetration and export share remain the same in the protected and unprotected sectors. We will concentrate on the analysis of differences in the magnitude of the effects of trade variables on productivity.

[11]QRs have been drastically reduced during the liberalization period which corresponds to our sample.

The difference in the magnitude of the coefficients on import penetration and export share between the protected and unprotected sectors, although small, is quite revealing. Firms which export a larger share of their total sales have a higher productivity in the protected sectors than in the unprotected ones. This might be due to the larger disparity, within the protected sectors, between firms which produce for the domestic market and face little competition, and firms which export and therefore have to adjust to heavy foreign competition. Moreover, the positive effect of import penetration on productivity switches to a negative effect at a lower level of import penetration for protected sectors than for unprotected ones (the level at which the slope changes from positive to negative is obtained by setting the derivative with respect to import penetration equal to zero). The explanation is straight forward since, although firms in both sectors do increase productivity when faced with import competition, firms in protected sectors, which are usually infant industries, have less "resistance" to competition than firms in unprotected sectors. This cannot but enforce the finding that the liberalization effect is indeed strong and that protection creates inefficiencies.

Another subtle difference between protected and unprotected sectors is depicted in terms of the effect of foreign share in ownership. The spillover effect of foreign investment is higher in the unprotected sectors than in the protected ones, as shown by the coefficients on SFORSH. This suggests that, since protected firms usually have less incentive for being more efficient because they are shielded from external competition, they will be less responsive to any transfer in technology brought about by foreign-owned firms. Moreover, the coefficient on FORSH is also higher in unprotected sectors than in protected ones, suggesting that even foreign-owned firms take advantage of the protective regime and enjoy a "quiet life".

The Chow test was performed to statistically test whether or not the parameter values associated with the protected sectors (based on the tariff criterion only) are the same as those associated with the unprotected sectors. The results of the Chow test show that there is indeed a statistical difference in the behavior of protected sectors compared to unprotected ones.[12]

## VI. CONCLUSION

The effects of trade liberalization on total factor productivity (TFP) in Morocco were estimated using various measures of firm-level productivity, namely TFP from a fixed-effect model estimating a production function by sector, TFP from a fixed-effect model estimating a production function by sector and firm size (not reported here), and TFP from a difference model using instrumental variables to correct for simultaneity bias and measurement error in the factor inputs within a production function framework. These different models aimed at getting an accurate estimate of the TFP index. The results of the regressions linking trade and market structure variables to productivity showed little variation across different TFP measures. In all cases, we get a strong positive correlation between trade openness, as measured by export share in sales and import penetration, and firm-level TFP. Moreover, by separating the sample into protected and unprotected sectors using the average tariff criterion, the results remained unchanged in terms of the signs of the coefficients of trade variables, although a difference in the magnitude of these coefficients was noticeable across the two categories. We therefore conclude with reasonable confidence that trade openness has had a significant positive impact on firm efficiency in the Moroccan manufacturing sector, this effect being present in all our models in a robust manner.

[12]The F-statistic that we obtained with degrees of freedom (12 , 3905) is 5.42, falling above the critical value of 1.75.

## APPENDIX

### 1. Data

The production function estimations required data on value added, capital, and labor. Value added was used instead of total output because of the unavailability of intermediate inputs in the Moroccan data set. The firm-level value added was deflated by an industry-specific (at the two-digit level) price index, with 1985 as the base year.

Information on labor provided by the annual Moroccan surveys included only the number of employees for each firm. This, however, is not a very meaningful measure of labor input because it does not take into consideration the heterogeneity among different types of workers and implicitly assumes that all workers are equivalent. Since no information was provided in the surveys on the skill level of the workers employed, the only way of taking into account the heterogeneity of labor was to express the work force actually used by a firm in terms of simple efficiency units, the unit of measurement (or the measuring rod) being the minimum wage. Labor input measured in efficiency units is simply calculated as the wage bill of each firm divided by the minimum wage prevailing in the Moroccan manufacturing industries. This of course implicitly assumes that wage is a good proxy for productivity and skill, an assumption which usually holds if the labor market is competitive. Despite some rigidities in the Moroccan labor market, this assumption seems reasonable for the case of Morocco.

The ideal capital input measure should be in terms of flows. This, however, is not measurable and only capital stock can be obtained. A capital stock measure was available only in 1988 as the total assets in equipment goods owned by the firm. The 1988 capital stock was expressed in constant 1985 prices using a wholesale price deflator, and the perpetual inventory method was used to build the capital stock (in 1985 prices) forward and backward for the other years in the sample. Unfortunately, firms which were not included in the 1988 survey had to be excluded from the estimations since no capital stock benchmark was available for them. At least two major problems arise with this variable: it reflects book-value of capital and it does not include rented capital stock. Our measure of capital stock is therefore a very crude proxy of the true capital. An attempt was made later to correct for this measurement error in the estimations.

2. Descriptive Statistics of the Moroccan Industrial Sector

Table A.1 provides descriptive statistics about the Moroccan industrial sector in 1987. In terms of the number of firms (column 1) and the number of labor (column 2), the largest sectors are food products and textiles. However, in terms of the share in manufacturing revenue (column 8), the chemical products sector emerges as a major sector besides the other two. This is fully understandable given the importance of phosphate in Morocco. Output per worker (column 6) is highest in relatively capital-intensive (see the capital-output ratio in column 5) sectors such as basic metal and chemical products. Capacity utilization (column 17), defined as the ratio of actual output to feasible output, is lowest in textile and precision equipment and highest in food products.

Concentration is measured in two ways. The first is concentration in terms of the share of output produced by the four largest firms, CR4 (column 9), and the second is in terms of the share of output produced in different regions measured by the geographic concentration index (column 16). The two industries where a large portion of total output is produced by few firms are beverage and tobacco and basic metal, both being regulated by the government, while the most geographically scattered industry, as shown by the low geographic dispersion index, is food products.

The public share in ownership (column 13) is the highest in industries of national importance, basic metal and chemical products, while the foreign share in ownership (column 12) is the largest in the sector which requires perhaps the most advanced technology, electronics.

By far, the most export-oriented sector is clothing which sells over 80 percent of its output abroad (column 11). The other sectors which export a relatively high share of their sales are chemical products, which include the derivative of phosphate, and leather and shoes. As expected, import penetration (column 14) is high in intermediates and capital-good producing sectors. Except for beverage and tobacco, these are also the most concentrated sectors as shown by CR4.

What emerges from this brief glance at the firm-level census data is a structure of production and trade typically found among semi-industrial countries that have largely pursued an import-substitution industrialization strategy. The concentration in production is characteristic of countries at that stage of development where the small size of domestic markets naturally leads to a fairly concentrated structure of production. The revealed pattern of comparative advantage is one of a narrow export base in labor-intensive activities, mostly textiles.

### 3. Empirical Estimation of the Production Function

The fixed-effect model[13]: The estimation results are shown in Table A.2. The overall fit of the fixed-effect model seems quite reasonable as reflected by the adjusted $R^2$. In general, the estimated output elasticities with respect to labor are much higher and much more significant than the estimated output elasticities with respect to capital. More specifically, all labor elasticities are positive and significant at the 0.05 level while capital elasticities are negative in four industries and significant at the 0.05 level for only four industries, and at the 0.10 level for another industry. One reason behind these results is the problem of measurement error in capital stock which biases the coefficient on capital downward.

The time dummies, which are mostly significant and positive, show a general increasing trend that reflects an overall better performance across years. However, a steady decline relative to 1985 is observed in certain industries, such as beverage and tobacco, transport material, chemical products, and

[13]The fixed-effect model was also estimated by industry and by firm size (large vs small firms). The results indicate that in general there is no major difference in the coefficients estimated across size.

rubber and plastic. It is interesting to note that most of these sectors have a relatively high public share in ownership.

What about returns to scale? Conceptually, two forces come into operation when all inputs are, for example, doubled. First, a doubling of scale permits a greater division of labor, and hence there is some presumption that efficiency might increase --production might more than double. Second, doubling of the inputs also entails some loss in efficiency, because managerial overseeing may become more difficult. Which of these two tendencies will have a greater effect is an important empirical question. In the case of Morocco, the estimated returns to scale exhibit a decreasing rate for all but two industries. The hypothesis of constant returns to scale is therefore not supported by the fixed-effect model.

Correcting for measurement error and simultaneity bias: Two sources of bias in the previous estimations are dealt with. These are measurement error in capital stock and simultaneity bias in labor input. The bias from the measurement error in capital stock will underestimate the coefficient on that input. On the other hand, the simultaneity bias in labor, which might be due either to the fact that labor decisions are made at the same time as output decisions or to the fact that firm managers do observe part of the random error in the production function, will overestimate the coefficient on this input. Indeed, if labor is endogenous then an increase in the disturbance of the production function will increase value added. This in turn increases labor. Thus the disturbance of the production function and the regressor are positively correlated. An increase in the disturbance term, directly implying an increase in value added, is accompanied by an increase in labor, also implying an increase in value added. When estimating the influence of labor on value added, however, the OLS technique attributes both of these increases in value added (instead of just the latter) to the accompanying increase in labor. This implies that the OLS estimate of the labor elasticity is biased upward, even asymptotically.

In order to correct for simultaneity bias in the labor input, we have fit in Section II a simultaneous-equation model where the first equation is the production function and the second equation is a reduced form for labor demand (capital being assumed exogenous). This model could have been estimated using two-stage least squares. However, another way of tackling the problem which allows for more flexibility is to use instrumental variables to estimate the labor demand using a wider variety of instruments, instead of being limited to the predetermined variables of the model (which is in essence what two-stage least squares does).

The instrumental variables (IV) method can also be used to correct for the measurement error in capital stock. Moreover, if there is simultaneity bias in the capital stock, it will be taken care of at the same time. Thus, the IV method will correct for any situation in which a regressor is contemporaneously correlated with the disturbance term, whether it is measurement error or simultaneity bias.

The major problem with the instrumental variables technique is to find "good" instruments, i.e. variables that are highly correlated with the independent variable with which it is associated, but uncorrelated with the disturbance. Moreover, it is extremely difficult to instrument the deviation of a variable from its mean, conceptually and in terms of finding relevant instruments. An easier way to tackle the problem is to estimate the production function in differences instead of in deviations from the mean[14]. This approach has a more palpable interpretation since it reflects growth rates in the variables (see Tybout and Westbrook, 1991). The difference between the last year of the sample (1989) and the first year (1985) was used. The instruments to be chosen should not be correlated with any demand or productivity shocks in those two years, but should be correlated with labor and capital.

[14]I am indebted to Jim Tybout for this suggestion.

In the difference estimation, the capital stock variable was slightly modified. It was actually the utilized capital stock that was used, which is the capacity utilization rate[15] times the original capital stock. It was possible to correct for the utilization of capital in the difference estimation because the utilization rate was only available for 1984, 1987, and 1989. The capital stock of 1985 was adjusted by the average utilization rate of 1984 and 1987, while the capital stock of 1989 was adjusted by the utilization rate of the same year. This is a much better measure of capital input since it reduces the bias on the capital stock estimated coefficient (see Kim and Kwon, 1977) and therefore also reduces the bias on the estimated TFP.

The following instruments were selected for the growth in labor and capital stock between 1985 and 1989: 1) lagged valued of labor input since it is correlated with labor as well as capital but it is not contemporaneously correlated with the error term. The lagged value of capital, however, cannot be used since it also incorporates measurement error; 2) equity and financial cost, under the assumption that the firm's borrowings should be correlated with the ability to expand inputs but are predetermined; 3) average capacity utilization (used to correct the capital input variable in the difference estimation) since they are correlated with the capital input we are trying to instrument without being correlated with the noise in capital due to measurement error; 4) total surface-area of the firm and real expenditures on heat and transportation, these being correlated with input decisions but independent of any demand or productivity shocks affecting the firm; 5) foreign share and public share in ownership, since they determine the amount of labor and capital used in a firm; 6) wage rate since firms decisions to use labor and capital depend on the wage rate but the latter is not correlated with output.

Due to the fact that the variables in the difference production function are taken as the growth rate between two years, the sample size is dramatically reduced. Industries with a very small number of

[15]The rate of capacity utilization is the ratio of realized output to feasible output, the latter being defined as the maximum output that can be produced given the available inputs of the firm.

observations or with implausible or insignificant results were eliminated. The following criteria were used for elimination: any sector with less than 25 observations or any sector with an $R^2$ less than 0.1 was removed.

The results of the IV estimation are presented in Table A.3. We detect an increase in the coefficient of capital stock in half of the sectors analyzed, but also an increase in the coefficient of labor for most industries. Two industries, mineral products and machinery and equipment, have a negative but insignificant coefficient on capital stock. Overall, the returns to scale are higher than in the pure fixed-effect model.

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**Table 1a: Import coverage (1984-1988)**

**(In percent)**

| | Tariff positions | | | Import value | | |
|---|---|---|---|---|---|---|
| | 1984 | 1986 | 1988 | 1984 | 1986 | 1988 |
| List A | 67.6 | 66.7 | 81.8 | 84.2 | 86.3 | 87.3 |
| List B | 30.8 | 33.3 | 18.7 | 17.5 | 13.7 | 12.7 |
| List C | 1.6 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 |
| | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Six-digit CCCN tariff code

Source: World Bank-UNDP (1990), "Morocco 2000: An Open and Competitive Economy"

**Table 1b: Selected customs duties paid by imports**

**(January-June 1989)**

| Proportion of imports | Tariff rate (%) |
|---|---|
| 8.6 | 0.0 |
| 32.2 | 2.5 |
| 16.9 | 12.5 |
| 13.3 | 17.5 |
| 5.5 | 22.5 |
| 7.6 | 45.0 |

Import-weighted average tariff = 13.5%
Production-weighted average tariff = 39%

Source: World Bank (1990), "Sustained Investment and Growth in the Nineties"

## Table 2: Productivity indicators

(average)

| | SECTOR | Firm | TFPFE | MAXTFPFE | DTFPFE | TFPIV | MAXTFPIV | DTFPIV |
|---|---|---|---|---|---|---|---|---|
| 10 | FOOD PRODUCTS | 721 | 3.052 | 5.321 | −0.426 | 2.362 | 5.246 | −0.550 |
| 11 | OTHER FOOD PRODUCTS | 332 | 4.307 | 6.852 | −0.371 | 3.045 | 5.127 | −0.406 |
| 12 | BEVERAGE & TOBACCO | 30 | 4.919 | 7.401 | −0.335 | | | |
| 13 | TEXTILE | 370 | 3.580 | 5.460 | −0.344 | 2.452 | 4.269 | −0.425 |
| 14 | CLOTHING | 504 | 3.382 | 5.176 | −0.346 | 2.565 | 4.278 | −0.400 |
| 15 | LEATHER & SHOES | 202 | 3.323 | 4.922 | −0.325 | 2.417 | 3.827 | −0.368 |
| 16 | WOOD PRODUCTS | 147 | 3.607 | 3.245 | −0.378 | | | |
| 17 | PAPER & PRINTING | 276 | 3.245 | 5.218 | −0.378 | 1.974 | 3.574 | −0.448 |
| 18 | MINERAL PRODUCTS | 242 | 3.673 | 6.104 | −0.398 | 4.540 | 7.794 | −0.417 |
| 19 | BASIC METAL | 11 | 3.004 | 4.879 | −0.384 | | | |
| 20 | METALLIC PRODUCTS | 258 | 3.724 | 5.708 | −0.348 | 4.167 | 6.385 | −0.347 |
| 21 | MACHINERY & EQUIPMENT | 194 | 3.058 | 4.483 | −0.318 | 3.185 | 4.577 | −0.304 |
| 22 | TRANSPORT MATERIALS | 92 | 3.763 | 5.723 | −0.342 | −0.376 | 2.497 | −1.150 |
| 23 | ELECTRONICS | 101 | 3.900 | 5.426 | −0.281 | | | |
| 24 | PRECISION EQUIPMENT | 21 | 0.613 | 2.568 | −0.761 | | | |
| 25 | CHEMICAL PRODUCTS | 228 | 3.875 | 6.075 | −0.362 | 3.854 | 5.737 | −0.328 |
| 26 | RUBBER & PLASTICS | 177 | 2.410 | 5.504 | −0.562 | 3.431 | 6.514 | −0.473 |
| 27 | OTHER INDUSTRIAL PRODUCTS | 27 | 2.635 | 5.372 | −0.509 | | | |

Note: TFPFE is total factor productivity calculated from the fixed–effect model.
TFPIV is total factor productivity calculated from the IV estimation on the difference model.
MAXTFPFE and MAXTFPIV are the maximum value of TFPFE and TFPIV respectively within each sector.
DTFPFE is the percentage deviation of firm–level TFPFE from MAXTFPFE.
DTFPIV is the percentage deviation of firm–level TFPIV from MAXTFPIV.
'Firm' is the number of firms appearing at least once between 1985 and 1989.
Some sectors are omitted from the IV estimation (see Appendix).

Table 3: Estimation of the effect of trade and market structure variables on TFP

(parameter estimates)

| | Model 1<br>Dependent var.<br>DTFPFE | Model 2<br>Dependent var.<br>DTFPIV | Model 3<br>Dependent var.<br>TFPFE |
|---|---|---|---|
| Independent variables | | | |
| Intercept | −0.177(0.066)* | −0.316(0.120)* | n.a. |
| FORSH | 0.022(0.008)* | 0.011(0.014) | 0.177(0.039)* |
| SFORSH | 0.114(0.020)* | 0.148(0.038)* | −0.328(0.126)* |
| PUBSH | 0.163(0.019)* | −0.015(0.036) | 0.976(0.098)* |
| SHERF | 0.346(0.048)* | 0.021(0.096) | 1.710(0.279)* |
| SHERFSQ | −0.282(0.072)* | −0.176(0.160) | −1.050(0.396)* |
| AGE | 0.003(0.000)* | 0.001(0.001) | 0.016(0.002)* |
| AGESQ | −0.000(0.000)* | −0.000(0.000) | −0.000(0.000)* |
| PRODIV | −0.304(0.065)* | −0.199(0.119)** | −1.807(0.329)* |
| GEODISP | −0.069(0.017)* | 0.015(0.032) | −0.143(0.108) |
| IMPENET | 0.274(0.026)* | 0.303(0.047)* | 0.503(0.199)* |
| IMPENETSQ | −0.399(0.035)* | −0.404(0.068)* | −0.934(0.238)* |
| EXSHARE | 0.092(0.006)* | 0.061(0.011)* | 0.381(0.038)* |
| SECTOR DUMMIES | n.a. | n.a. | included |
| Adjusted $R^2$ | 0.18 | 0.03 | 0.48 |
| Standard error | 0.01 | 0.04 | 0.33 |
| F–statistic | 72.54 | 10.50 | 4856 |
| N | 3931 | 3593 | 3931 |

Note: DTFPFE is the deviation of TFP from the efficiency frontier (fixed–effect model).
DTFPIV is the deviation of TFP from the efficiency frontier (IV model).
TFPFE is the level of firm TFP obtained from the fixed–effect model.
In Model 3, sector dummies are included in the estimation but are not reported here.
* implies significance at the 0.05 level; ** implies significance at the 0.10 level.

Table 4: Estimation of the effect of trade and market structure on TFP
(protected sectors vs unprotected sectors)

| Independent variables | protected sectors | unprotected sectors |
|---|---|---|
| Intercept | -0.161(0.079)* | -0.232(0.120)** |
| FORSH | 0.020(0.009)* | 0.029(0.016)** |
| SFORSH | 0.062(0.027)* | 0.094(0.040)* |
| PUBSH | 0.141(0.022)* | 0.216(0.040)* |
| SHERF | 0.381(0.067)* | 0.375(0.082)* |
| SHERFSQ | -0.227(0.125)** | -0.431(0.113)* |
| AGE | 0.003(0.000)* | 0.003(0.001)* |
| AGESQ | -0.000(0.000)* | -0.000(0.000)** |
| PRODIV | -0.297(0.079)* | -0.283(0.119)* |
| GEODISP | -0.119(0.022)* | -0.022(0.033) |
| IMPENET | 0.181(0.034)* | 0.382(0.054)* |
| IMPENETSQ | -0.289(0.052)* | -0.539(0.062)* |
| EXSHARE | 0.099(0.007)* | 0.096(0.018)* |
| Adjusted $R^2$ | 0.18 | 0.19 |
| Standard error | 0.01 | 0.02 |
| F-statistic | 72.54 | 21.89 |
| N | 3931 | 1090 |

Note: The dependent variable is DTFPFE.
The protection criterion is based on the average tariff.
The protected sectors are: 10, 11, 12, 13, 14, 16, 17, 20, 26, 27.
* implies significance at the 0.05 level; ** implies significance at the 0.10 level.

Table A.1: The Moroccan manufacturing sector in 1987

| | SECTOR | (1) N | (2) L | (3) VA/Q | (4) L cost/VA | (5) K/Q | (6) Q/L | (7) Price-cost margin | (8) Revenue share | (9) CR4 | (11) Exports/Sales | (12) Foreign share | (13) Public share | (14) Import penetration | (15) Tariff | (16) Geographic dispersion | (17) CU |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | FOOD PRODUCTS | 899 | 25103 | 16.9 | 38.5 | 33.1 | 38793 | 116.0 | 12.8 | 26 | 1.5 | 5.1 | 38.3 | 4.0 | 31.3 | 0.11 | 60 |
| 11 | OTHER FOOD PRODUCTS | 422 | 51293 | 21.3 | 37.0 | 19.3 | 20941 | 46.6 | 14.8 | 27 | 24.0 | 12.0 | 23.6 | 11.8 | 30.6 | 0.21 | 41 |
| 12 | BEVERAGE & TOBACCO | 33 | 9807 | 72.4 | 9.9 | 21.3 | 50182 | 11.8 | 6.7 | 78 | 1.2 | 15.2 | 14.6 | 7.7 | 39.1 | 0.51 | 43 |
| 13 | TEXTILE | 464 | 55778 | 31.1 | 44.7 | 35.3 | 13108 | 58.5 | 9.6 | 16 | 31.7 | 11.6 | 12.0 | 37.5 | 35.3 | 0.15 | 25 |
| 14 | CLOTHING | 473 | 43718 | 30.1 | 55.1 | 13.8 | 7145 | 11.2 | 4.2 | 18 | 84.0 | 20.2 | 4.5 | 3.4 | 44.2 | 0.20 | 47 |
| 15 | LEATHER & SHOES | 248 | 13363 | 28.8 | 55.2 | 38.5 | 11724 | 9.7 | 2.1 | 23 | 41.6 | 16.5 | 1.8 | 21.3 | 21.8 | 0.30 | 43 |
| 16 | WOOD PRODUCTS | 194 | 10188 | 31.2 | 47.1 | 19.4 | 14930 | 19.7 | 2.1 | 38 | 20.6 | 14.2 | 0.0 | 42.1 | 29.4 | 0.19 | 38 |
| 17 | PAPER & PRINTING | 336 | 11957 | 30.1 | 37.9 | 36.4 | 26467 | 69.2 | 5.0 | 47 | 11.2 | 22.4 | 17.3 | 17.4 | 37.0 | 0.16 | 60 |
| 18 | MINERAL PRODUCTS | 305 | 25538 | 45.4 | 30.0 | 70.4 | 16421 | 84.8 | 6.5 | 31 | 1.3 | 22.0 | 22.6 | 8.7 | 28.1 | 0.13 | 60 |
| 19 | BASIC METAL | 26 | 2870 | 34.3 | 13.0 | 54.3 | 75631 | 4.2 | 3.2 | 81 | 14.9 | 3.5 | 83.9 | 53.1 | 9.1 | 0.57 | 58 |
| 20 | METALLIC PRODUCTS | 328 | 16196 | 27.4 | 46.9 | 18.0 | 20383 | 49.4 | 4.6 | 25 | 1.2 | 19.7 | 6.8 | 17.6 | 31.5 | 0.29 | 41 |
| 21 | MACHINERY & EQUIPMENT | 202 | 6565 | 41.0 | 46.2 | 21.2 | 16061 | 28.4 | 2.2 | 50 | 0.1 | 20.8 | 5.0 | 66.2 | 17.2 | 0.20 | 34 |
| 22 | TRANSPORT MATERIALS | 99 | 7654 | 32.9 | 37.9 | 17.0 | 29663 | 15.1 | 3.8 | 60 | 8.6 | 25.5 | 17.9 | 51.8 | 23.8 | 0.48 | 47 |
| 23 | ELECTRONICS | 110 | 9969 | 36.5 | 46.6 | 23.7 | 20691 | 20.1 | 3.0 | 35 | 11.1 | 27.7 | 10.3 | 43.2 | 25.9 | 0.30 | 54 |
| 24 | PRECISION EQUIPMENT | 22 | 868 | 43.5 | 43.3 | 31.1 | 13634 | 5.9 | 0.2 | 45 | 3.8 | 17.6 | 0.0 | 83.5 | 28.6 | 0.16 | 18 |
| 25 | CHEMICAL PRODUCTS | 241 | 22284 | 18.9 | 38.8 | 48.7 | 55529 | 63.6 | 16.7 | 52 | 36.4 | 10.1 | 70.8 | 30.2 | 20.6 | 0.28 | 39 |
| 26 | RUBBER & PLASTICS | 195 | 8100 | 31.7 | 41.0 | 26.1 | 23129 | 22.9 | 2.5 | 45 | 5.4 | 12.1 | 1.9 | 22.4 | 28.6 | 0.65 | 52 |
| 27 | OTHER INDUSTRIAL PRODUCTS | 26 | 436 | 43.1 | 62.4 | 14.0 | 7618 | -8.0 | 0.0 | 52 | 9.9 | 22.7 | 0.0 | 87.1 | 37.6 | 0.41 | 64 |

Note: N=number of firms; L=labor; VA=value added; K=capital stock; Q=production; CU=capacity utilization.
CR4 is the concentration ratio of the four lagest firms in the industry.
Variables are in thousands of dirhams where relevant.

## Table A.2: Production function estimation (fixed–effect model)

### (parameter estimates)

| | SECTOR | ln(L) | ln(K) | D86 | D87 | D88 | D89 | RTS | Adj.R² | St.Dev. | F–stat. | N | Firm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | FOOD PRODUCTS | 0.787(0.020)* | 0.065(0.039)** | 0.053(0.029)** | 0.067(0.028)* | 0.173(0.027)* | 0.082(0.027)* | 0.852 | 0.92 | 0.20 | 48.93 | 2970 | 703 |
| 11 | OTHER FOOD PRODUCTS | 0.641(0.021)* | 0.031(0.040) | 0.065(0.029)* | 0.147(0.028)* | 0.171(0.027)* | 0.211(0.027)* | 0.672 | 0.91 | 0.30 | 37.60 | 1255 | 324 |
| 12 | BEVERAGE & TOBACCO | 0.893(0.020)* | −0.130(0.039)* | −0.003(0.028) | −0.021(0.027) | −0.090(0.027)* | −0.156(0.027)* | 0.763 | 0.97 | 0.16 | 140.03 | 136 | 30 |
| 13 | TEXTILE | 0.704(0.021)* | 0.081(0.040)* | 0.161(0.029)* | 0.155(0.028)* | 0.202(0.028)* | 0.242(0.028)* | 0.785 | 0.93 | 0.25 | 49.06 | 1551 | 402 |
| 14 | CLOTHING | 0.813(0.021)* | −0.014(0.041) | 0.058(0.030)** | 0.106(0.029)* | 0.096(0.028)* | 0.257(0.028)* | 0.799 | 0.93 | 0.20 | 44.69 | 1616 | 462 |
| 15 | LEATHER & SHOES | 0.872(0.021)* | −0.057(0.040) | 0.155(0.029)* | 0.131(0.028)* | 0.082(0.027)* | 0.073(0.028)* | 0.815 | 0.93 | 0.24 | 61.27 | 773 | 192 |
| 16 | WOOD PRODUCTS | 0.762(0.021)* | −0.065(0.040) | −0.046(0.029) | −0.032(0.028) | −0.099(0.027)* | −0.059(0.027)* | 0.697 | 0.91 | 0.34 | 38.21 | 595 | 149 |
| 17 | PAPER & PRINTING | 0.772(0.020)* | 0.034(0.040) | 0.129(0.029)* | 0.129(0.028)* | 0.008(0.027) | 0.002(0.027) | 0.806 | 0.95 | 0.16 | 75.15 | 1183 | 278 |
| 18 | MINERAL PRODUCTS | 0.753(0.021)* | 0.032(0.039) | 0.131(0.029)* | 0.144(0.028)* | 0.206(0.027)* | 0.327(0.027)* | 0.785 | 0.95 | 0.18 | 80.55 | 977 | 243 |
| 19 | BASIC METAL | 0.783(0.022)* | 0.056(0.043) | 0.193(0.032)* | 0.295(0.031)* | 0.013(0.030) | 0.180(0.030)* | 0.839 | 0.95 | 0.23 | 49.51 | 74 | 20 |
| 20 | METALLIC PRODUCTS | 0.701(0.021)* | 0.042(0.041) | 0.063(0.030)* | 0.055(0.029)** | 0.128(0.028)* | 0.111(0.028)* | 0.743 | 0.91 | 0.25 | 37.04 | 1044 | 284 |
| 21 | MACHINERY & EQUIPMENT | 0.856(0.021)* | 0.023(0.040) | −0.081(0.030)* | −0.096(0.029)* | 0.117(0.028)* | 0.099(0.028)* | 0.879 | 0.91 | 0.23 | 37.07 | 692 | 185 |
| 22 | TRANSPORT MATERIALS | 0.702(0.021)* | 0.006(0.040) | 0.084(0.029)* | −0.006(0.028) | −0.064(0.028)* | −0.057(0.028)* | 0.708 | 0.97 | 0.15 | 112.70 | 329 | 82 |
| 23 | ELECTRONICS | 0.685(0.021)* | 0.005(0.040) | 0.102(0.030)* | 0.214(0.029)* | 0.122(0.028)* | 0.104(0.028)* | 0.690 | 0.94 | 0.16 | 59.37 | 347 | 95 |
| 24 | PRECISION EQUIPMENT | 1.161(0.021)* | 0.304(0.041)* | −0.016(0.030) | 0.030(0.029) | 0.098(0.028)* | 0.109(0.028)* | 1.465 | 0.93 | 0.11 | 34.86 | 75 | 21 |
| 25 | CHEMICAL PRODUCTS | 0.618(0.021)* | 0.064(0.040) | 0.013(0.029) | 0.071(0.028)* | −0.024(0.028) | −0.092(0.028)* | 0.682 | 0.98 | 0.22 | 84.02 | 829 | 215 |
| 26 | RUBBER & PLASTICS | 0.745(0.021)* | 0.212(0.040)* | −0.194(0.029)* | −0.057(0.028)* | −0.096(0.028)* | −0.127(0.028)* | 0.957 | 0.89 | 0.28 | 30.01 | 624 | 161 |
| 27 | OTHER INDUSTRIAL PRODUCTS | 0.982(0.022)* | 0.035(0.041) | 0.065(0.030)* | 0.238(0.029)* | 0.306(0.029)* | 0.442(0.029)* | 1.017 | 0.95 | 0.12 | 51.77 | 85 | 23 |

Note: Dependent variable is ln(Y); Standard errors in parentheses.

'Firm' is the number of firms appearing at least once between 1985 and 1989; N is the number of observations.

D86–D89 are time dummies (omitted year is 1985); RTS is returns to scale.

* implies significance at the 0.05 level; ** implies significance at the 0.10 level.

**Table A.3: Production function estimation (Instrumental-variables estimation on a difference model)**

**(parameter estimates)**

| | SECTOR | Intercept | ln(L89)-ln(L85) | ln(K89)-ln(K85) | RTS | Adj.$R^2$ | St.Dev. | F-stat. | N |
|---|---|---|---|---|---|---|---|---|---|
| 10 | FOOD PRODUCTS | 0.123(0.088) | 1.113(0.268)* | 0.033(0.117) | 1.146 | 0.16 | 0.69 | 9.80 | 93 |
| 11 | OTHER FOOD PRODUCTS | -0.037(0.101) | 0.643(0.194)* | 0.201(0.097)* | 0.844 | 0.15 | 0.70 | 11.10 | 110 |
| 12 | BEVERAGE & TOBACCO | | | | | | | | |
| 13 | TEXTILE | 0.187(0.073)* | 0.824(0.144)* | 0.165(0.108) | 0.989 | 0.20 | 0.61 | 22.18 | 166 |
| 14 | CLOTHING | 0.089(0.083) | 0.723(0.080)* | 0.190(0.078)* | 0.913 | 0.49 | 0.35 | 49.55 | 101 |
| 15 | LEATHER & SHOES | 0.081(0.109) | 1.016(0.145)* | 0.039(0.103) | 1.055 | 0.52 | 0.44 | 28.61 | 51 |
| 16 | WOOD PRODUCTS | | | | | | | | |
| 17 | PAPER & PRINTING | -0.059(0.064) | 1.187(0.176)* | 0.024(0.052) | 1.211 | 0.32 | 0.37 | 25.15 | 101 |
| 18 | MINERAL PRODUCTS | 0.036(0.089)* | 0.779(0.195)* | -0.119(0.103) | 0.660 | 0.20 | 0.44 | 9.55 | 69 |
| 19 | BASIC METAL | | | | | | | | |
| 20 | METALLIC PRODUCTS | -0.003(0.074) | 0.560(0.129)* | 0.052(0.097) | 0.612 | 0.15 | 0.52 | 10.82 | 109 |
| 21 | MACHINERY & EQUIPMENT | 0.034(0.107) | 0.871(0.176)* | -0.018(0.017) | 0.853 | 0.26 | 0.73 | 12.64 | 66 |
| 22 | TRANSPORT MATERIALS | -0.204(0.145) | 1.621(0.285)* | 0.101(0.151) | 1.722 | 0.56 | 0.43 | 18.01 | 27 |
| 23 | ELECTRONICS | | | | | | | | |
| 24 | PRECISION EQUIPMENT | | | | | | | | |
| 25 | CHEMICAL PRODUCTS | -0.057(0.094) | 0.723(0.168)* | 0.014(0.079) | 0.737 | 0.17 | 0.59 | 9.51 | 81 |
| 26 | RUBBER & PLASTICS | -0.100(0.130) | 0.825(0.242)* | 0.012(0.118) | 0.837 | 0.13 | 0.68 | 5.83 | 63 |
| 27 | OTHER INDUSTRIAL PRODUCTS | | | | | | | | |

Note: Dependent variable is ln(Y89)-ln(Y85); Standard errors in parentheses.
* implies significance at the 0.05 level; ** implies significance at the 0.10 level.
Sectors with R-squared less than 0.1 or with less than 25 observations are omitted.
The capital stock variable is adjusted for the utilization rate.

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