ERF WORKING PAPER SERIES

TFP AND ECONOMIC POTENTIAL OF THE TUNISIAN ECONOMY

Sofiane Ghali and Pierre Mohnen

Working Paper 0225

As of August 1998, financial support towards the ERF Working Papers Series from the Commission of the European Communities (through the FEMISE Program) is gratefully acknowledged. The views expressed in the Working Papers are those of the authors and do not necessarily reflect the views of the European Commission.

ECONOMIC RESEARCH FORUM
7 Boulos Hanna St. Dokki, Cairo, Egypt
Tel: (202) 3370810 – (202) 7485553 – (202) 7602882
Fax: (202) 7616042. Email: erf@idsc.net.eg. Website: http://www.erf.org.eg

Abstract

In this paper we try to measure and to explain total factor productivity (TFP) growth in Tunisia over the period 1983-1996. We do not measure TFP growth by the conventional Solow residual. Instead we define TFP as the shift of the economy's production frontier, which we obtain year by year by a linear programming method, a sort of aggregate DEA analysis. We then decompose this aggregate TFP growth into a Solow residual, a terms of trade effect, and a shift in demand composition. We also proceed to a decomposition of TFP growth into individual factor productivity growth rates: those of labor, decomposed into five types, of capital and of the allowable trade deficit. We find that potential TFP has grown by 0.4 percent per year over the whole period. But, it is especially after 1991 that TFP has grown. Before that, it tended to display negative growth rates. Labor turns out to be the most important contributor to total factor productivity growth. Only in the last period did capital play an important role. The Solow residual was the main driver of TFP growth. Changes in the terms of trade and demand composition were detrimental to TFP growth.

1. Introduction

Over the last twenty years Tunisia has adopted some significant policy measures to open its economy to world trade. In 1987 it introduced the structural adjustment program aimed at reducing market distortions; in 1996 it put in place an industrial restructuring program to help Tunisian enterprises to acquire necessary equipment and know-how to be competitive in an open market. In July 1995 it was the first country of the Maghreb to sign a free trade agreement with the EU. This paper seeks to ascertain and quantify the impact these policy measures had on the performance of Tunisian economy.

The usual measure of performance is the growth in total factor productivity (TFP). Conventionally, TFP is defined as the ratio of an output index to an input index (see Diewert, 1992). Its growth therefore represents the growth of output that goes beyond what can be explained by the growth in the inputs. Under certain conditions, among which constant returns to scale, optimal factor holdings and marginal cost pricing, TFP growth as measured by the Solow residual captures the technology shift.[1] It is however debatable whether these restrictive conditions hold. In an open economy it makes sense to redefine productivity with respect to final demand achievable with the domestic resources and the extent of trade deficit (Diewert and Morrison, 1986). Another strand of literature around the Malmquist index distinguishes movements of and towards the frontier, splitting TFP growth into efficiency change and technology change (Caves, Christensen and Diewert, 1982).

The debate about how TFP should be measured and what it actually means is far from being closed (see Lipsey and Carlaw, 2001, for a list of alternative interpretations). We shall adopt a new approach at measuring and interpreting TFP, entrenched in a general equilibrium model of an open economy, that does not rely on observed market prices to infer marginal productivities, but only on the fundamentals of the economy, that is, technologies, preferences and endowments. The approach was developed by Ten Raa & Mohnen (2002). We apply it to the case of Tunisia, over the period 1983-1996.

We shall proceed as follows. In section 2 we briefly review the various measures and interpretations of TFP. In section 3, we present an extension of the ten Raa and Mohnen (2002) model. We then turn to the application of this model to the Tunisian economy. We present the data in section 4 and the results of our analysis in section 5. We conclude by summarizing our main findings and suggesting further lines of research.

2. The Measurement and Meaning of TFP

TFP has been measured and interpreted in many different ways (for some surveys, see Diewert (1992), Balk (1998), Grosskopf (2001)). The first choice if with respect to the number of inputs. Materials are sometimes ignored or factored out by an assumption of separability of materials and primary inputs so that output is defined as value-added. Each of the inputs might itself result from the aggregation of many heterogeneous parts. If the input components are given the same marginal productivities in the face of heterogeneity, we have a measurement error, akin to the measurement error due the non-accounted for quality change. Our model has many intermediate inputs and five different types of labor.

Most of the time TFP is measured in closed economies, ignoring possible substitutions between domestically produced and imported inputs. In an open economy it is possible to increase output without producing more inputs, simply by increasing the amount of imported inputs. It is therefore important in open economy models to adjust TFP to allow for imports, by redefining it as the growth in final domestic demand minus the growth of the primary inputs, which now include the trade deficit. As a result, TFP can now be affected by changes in the terms of trade. TFP accounting in open economies have been handled by Diewert and Morrison (1986) and Kohli (1991). Our model recognizes the openness of the Tunisian economy.

In the TFP literature there are two ways to measure marginal productivities and hence also TFP. The first is the index number approach where observed prices are supposed to equate marginal values. The second estimates marginal productivities directly by choosing a functional form for the production function or a dual representation of it. TFP measurement in the former rests on the assumption of constant returns to scale, optimal factor holdings and marginal cost pricing. The latter approach in principal eschews these restrictions, although in practice it rarely happens that all three assumptions are relaxed at the same time. On the other hand, the latter approach requires the use of specific functional forms whereas the former approach does not, unless it seeks index numbers that are exact for specific functional forms.

A third strand of literature, starting with Farell (1957), distinguishes between technology shifts and changes in efficiency by using the concept of a distance function. Output distance function measures the greatest expansion of output possible given the inputs, and the input distance function measures the greatest possible contraction in inputs to still be able to produce the same output. The distance function and the resulting Malmquist productivity index can again be obtained non-parametrically by using linear programming techniques, known as

[1] The Solow residual is defined as : $\frac{\dot{A}_t}{A_t} = \frac{\dot{Q}_t}{Q_t} - S_{K_t}\frac{\dot{K}_t}{K_t} - S_{L_t}\frac{\dot{L}_t}{L_t}$

where K, L and t represent respectively capital, labor and disembodied technical change, S_K and S_L are respectively the elasticities of output with respect to capital and labor, and A_t measures the shift of the production function (here specified in terms of value added, Q).

«Data Envelopment Analysis» (DEA) or be estimated through a stochastic frontier with an asymmetrical random error term (for a recent example of DEA and stochastic frontier analysis, see Färe, Grosskopf, Norris and Zhang (1994) and Fuentes, Grifell-Tatjé and Perelman (2001) respectively).

We shall depart from all four approaches: the index-number approach, the parametric production function with technology shift specification, the DEA approach and the estimation of a stochastic frontier specification. We follow the approach proposed by Ten Raa and Mohnen (2002), which combines input-output analysis and linear programming. It is close in a sense to the DEA approach, except that it defines a frontier for the entire economy, given its interrelationships in sectoral production, sectoral technologies, final demand preferences and the endowments of primary inputs. Using this approach we can follow the evolution of (in) efficiency in the use of primary inputs and factor allocations (the distance to the frontier) and the evolution of production possibility frontier, in other words the potential of the Tunisian economy.

Besides measuring correctly TFP, it is of course also rewarding to be able to explain the fluctuations of TFP. Senhadji (1999), for instance, defines five types of determinants: 1) the endowments in labor, capital and human capital ; 2) the terms of trade; 3) the macroeconomic environment ; 4) the trade regime ; and 5) the political stability. There are many ways to decompose TFP growth. We propose two decompositions, one in terms of the individual productivities of the primary inputs and one in terms of technologies (Solow residual), preference shifts and terms of trade.

3. The Model

We adopt the measure of TFP growth borrowed from Ten Raa and Mohnen (2002) and we apply it to the model used in Ghali and Mohnen (2002). On the basis of the fundamentals of the economy, that is, sectoral technologies, preferences, endowments of labor and capital, where labor is decomposed into five categories, and world prices of tradable commodities (as we assume that Tunisia is a small open economy), we set up a linear programming problem or activity analysis model designed to maximize domestic final demand given those fundamentals. For each year we solve such a linear programming problem, which determines the optimal allocation of resources among various sectors of the economy, the optimal production pattern and optimal trade of tradable commodities. In this general equilibrium shadow prices support the optimal quantities. In this way we trace the economy's frontier in terms of possible production and consumption and its evolution over time. From these optimal quantities and shadow prices we measure potential TFP growth and we decompose it in its constituent parts. Observed prices and quantities do not enter the TFP expression directly. They serve as basic inputs into the computation of the economy's efficiency frontier which corresponds to a hypothetical competitive world where technology, preferences and endowments are given. Hence it corresponds to a short-term optimum. Adjustment costs from the observed to the optimal allocation of resources are not taken into account. In this sense, it is a long-run optimum. Formally, the efficient state of the economy is obtained by solving the following linear programming problem:

$\max_{t,s,g} \; (DFD\;)t$ subject to the following constraints:

$$(V'-U)s \geq ft + Jg \quad (1)$$

$$(L_1 + L_2 + L_3 + L_4 + L_5)'s + (l_1 + l_2 + l_3 + l_4 + l_5)t \leq N_1 + N_2 + N_3 + N_4 + N_5 \quad (2)$$

$$(L_2 + L_3 + L_4 + L_5)'s + (l_2 + l_3 + l_4 + l_5)t \leq N_2 + N_3 + N_4 + N_5 \quad (3)$$

$$(L_3 + L_4 + L_5)'s + (l_3 + l_4 + l_5)t \leq N_3 + N_4 + N_5 \quad (4)$$

$$(L_4 + L_5)'s + (l_4 + l_5)t \leq N_4 + N_5 \quad (5)$$

$$L_5's + l_5 t \leq N_5 \quad (6)$$

$$\hat{K}\hat{C}s \leq K \quad (7)$$

$$-\pi' g \leq D \quad (8)$$

$$s \geq 0$$

Where

$$DFD = \tilde{P}' f + \tilde{w}' l$$

t = (Scalar) level of domestic final demand;

s = (nx1) vector of activity levels, where n is the number of sectors;

g = (m_Tx1) vector of net exports, where T indices tradable commodities

V =make matrix (nxm), indicating how much of each commodity is produced in each sector

U =use matrix (mxn), indicating how much of each commodity is used in each sector as intermediate inputs;

J = (nxm_T) matrix selecting the tradables;

L_i =employment of labor type i, i=1,….,5, where manual workers/trainees are indexed by 1, machine operators by 2, foremen by 3, technicians by 4, and engineers/administrators by 5;

N_i = labor force type i, i=1,….,5,

K = (nx1) vector of available capital stocks in each sector;

C = (nx1) vector of capacity utilization rates

π =(m_Tx1) vector of world price for tradable commodities relative to a domestic final demand weighted average of world prices;

D = observed trade deficit $= -\pi'(V'e - Ue - f)_T$

e = unity vector of appropriate dimension;

^ =diagonalization operator applicable to a column vector

$\tilde{P}$ =(mx1) vector of observed commodity prices, where m is the number of commodities;

f =(mx1) vector of domestic final demand;

l_i =(5x1) vector of employment in the non-business sector for each labor type;

$\tilde{w}$ =(5x1) vector of annual labor earnings per worker by qualification in the non-business sector

The decision variables are the level of domestic final demand (t), the sectoral activity levels (s) and net exports (g). They are determined so as to maximize domestic final demand subject to three sets of constraints. The first set are the commodity balances (1) which stipulate that net production in each sector has to be sufficient to satisfy domestic final demand and net exports. The second set, (2) to (7), state that the inputs used in each sector may not exceed total disposable inputs. Capital is taken to be sector-specific. In other words, we assume putty-clay technologies. Once installed in one sector, capital cannot be disassembled and affected somewhere else. A sectoral capital constraint is binding when a sector reaches full capacity utilization. For labor, we distinguish five different types, each corresponding to a certain level of qualification and expertise. Workers can always be affected to jobs requiring lower but not higher qualifications. Part of the labor force is affected to the non-business sector, which essentially comprises services directly consumed by final demand (government services, services provided by non-profit institutions). The last constraint (8) posits that the trade deficit at optimal activity levels may not exceed the observed trade deficit. To increase their level of consumption, Tunisians can import from abroad, but only up to a certain level, which is conservatively taken to be the observed trade deficit. Without constraint (8), Tunisia could reach an infinite value for its objective function by importing without limits. The assumption of a small open economy with exogenous world prices for the tradable commodities is not unrealistic in the case of Tunisia. The observed activity levels correspond to the following values: t=1, s=e, and D = $-\pi'(V'e\text{-}Ue\text{-}f)_T$. The observed state of the economy is thus our point of reference. Efficiency derives from full capacity utilization, optimal factor allocations across sectors, and international specialization.

The prices sustaining this general equilibrium resource allocation are best derived from the dual program:

$\min_{p,w,r,\varepsilon} \; w'N + r'K + \varepsilon D$ subject to the following constraints:

$$p'(V'-U) \leq w'L' + r'\hat{K}\hat{c} \quad (9)$$

$$p'f + w'l = DFD \quad (10)$$

$$p'J = \varepsilon\pi' \quad (11)$$

$$p \geq 0, \quad w_5 \geq w_4 \geq w_3 \geq w_2 \geq w_1 \geq 0, \quad r \geq 0, \quad \varepsilon \geq 0$$

where p, w, r and ε are respectively the shadow prices of commodities, of the five types of labor, of the sectoral capital stocks, and of the trade deficit.[2] By the theorem of complementary slackness, a shadow price is positive only if the corresponding constraint in the primal is binding. The shadow prices w and r denote the marginal values of an additional unit of the respective inputs. If at a certain level of qualification the labor constraint is tight, it earns a markup over the previous level of qualification. A sector with less than full capacity utilization earns a zero rate of return on a marginal capital investment, for the very simple reason that it is in no excess demand, as unused capital is still available. The shadow price ε of the trade balance indicates the marginal value in terms of attainable domestic final demand of an additional allowed dinar of trade deficit. By the complementary slackness conditions, it can also be said that a sector is active only if it makes no loss. The inequalities (9) indicate that at the optimal solution of the linear program the prices of active sectors equal average cost, and

[2] Notice that the shadow price of the highest qualified labor type is the sum of the shadow prices of constraints (2) to (6).

hence that the optimal solution can be obtained as a competitive equilibrium. Condition (10) is a normalization condition akin to the choice of a number. By equality (11) domestic prices for tradable commodities may differ from world prices only by a certain constant ε, which can be interpreted as the exchange rate compatible with the purchasing power parity. All quantities are expressed in constant dinars, except labor, which is denoted in man-years. Hence, all shadow prices are relative constant prices, except the shadow prices of labor, which are in constant dinars per man-year.

We define TFP growth by starting from the first theorem of linear programming, which posits that the optimal value from the primal is equal to the optimal value of the dual:

$$DFDt = w'N + r'K + \varepsilon D \qquad (12)$$

If we totally differentiate (12), using the normalization equation (10) and the following definitions of factor shares:

$$\alpha^* = \frac{w'N}{w'N + r'K + \varepsilon D}, \quad \beta^* = \frac{r'K}{w'N + r'K + \varepsilon D}, \quad \gamma^* = \frac{\varepsilon D}{w'N + r'K + \varepsilon D}$$

we obtain the two equivalent definitions of TFP proposed by Ten Raa and Mohnen (2002):

$$\left(p'\frac{\dot{f}/f}{p'ft + w'lt} + w'\frac{\dot{l}/l}{p'ft + w'lt}\right) -$$

$$\left(\alpha^*\frac{\dot{N}/N}{w'N + r'K + \varepsilon D} + \beta^*\frac{\dot{K}/K}{w'N + r'K + \varepsilon D} + \gamma^*\frac{\dot{D}/D}{w'N + r'K + \varepsilon D}\right) =$$

$$\left(\alpha^*\frac{\dot{w}/w}{w'N + r'K + \varepsilon D} + \beta^*\frac{\dot{r}/r}{w'N + r'K + \varepsilon D} + \gamma^*\frac{\dot{\varepsilon}/\varepsilon}{w'N + r'K + \varepsilon D}\right) -$$

$$\left(f'\frac{\dot{p}/p}{p'ft + w'lt} + l'\frac{\dot{w}/w}{p'ft + w'lt}\right) - \frac{\dot{t}}{t} \qquad (13)$$

On the left-hand side we have the definition that frontier TFP growth is equal to the growth in domestic final demand minus the growth in the primary inputs. On the right-hand side, we have frontier TFP growth as being equal to the weighted sum of the marginal productivities of the individual inputs, net of the growth in the price of output, plus efficiency change. Notice that the last term is positive if t declines, that is, when the economy moves closer to the efficiency frontier.

After some manipulations, making use of equality (11) we obtain a four-way decomposition of frontier TFP growth:

$$T\dot{F}P = SR + TT + EC + SL \qquad (14)$$

where

$$SR = [p'(ft + \dot{J}g) - w'(L'\dot{s} + lt) - r'(\hat{K}\dot{\hat{c}}s)]/(p'ft + w'lt)$$

$$TT = \varepsilon\dot{\pi}g/(p'ft + w'lt)$$

$$EC = -\dot{t}/t$$

$$SL = [w'(L'\dot{s} + lt) - w'\dot{N} + r'(\hat{K}\dot{\hat{c}}s) - r'\dot{K} + \varepsilon'(\dot{\pi}g) - \varepsilon'\dot{D}]/(p'ft + w'lt)$$

The first term is the Solow residual, that is, the usual measure of TFP growth (value added growth minus the growth in the conventional inputs, labor and capital), except that here it is measured at optimal activity levels and shadow prices. The second term represents the terms of trade. An appreciation in the terms of trade gives the economy the chance to increase final demand without augmenting the use of primary inputs. The third term is the efficiency change: a decrease in the expansion factor of final demand implies an increase in efficiency and translates into higher TFP growth. The last term is the slack factor: an increase [decrease] in slack, that is, less than full resource utilization, decreases [increases] TFP growth.

This decomposition of TFP growth, and in particular the Solow residual portion of it, is a macroeconomic one, in a general equilibrium context. However, we can define sectoral Solow residuals consistent with the macroeconomic Solow residual by the Domar aggregation rule (see Hulten (1978)). Let j stand for sectors, i for commodities, and k for groups of sectors. The Solow residual for sector-group k can then be written as:

$$SR_k = \frac{\sum_{j\in k}\sum_i p_i v_{ji} s_j\left(\frac{\dot{v}_{ji}}{v_{ji}}\right)}{\sum_{j\in k}\sum_i p_i v_{ji} s_j} - \frac{\sum_{j\in k}\sum_i p_i u_{ji} s_j\left(\frac{\dot{u}_{ji}}{u_{ji}}\right)}{\sum_{j\in k}\sum_i p_i v_{ji} s_j} - \frac{\sum_{j\in k} w L_j s_j\left(\frac{\dot{L}_j}{L_j}\right)}{\sum_{j\in k}\sum_i p_i v_{ji} s_j} - \frac{\sum_{j\in k} r_j c_j K_j s_j\left(\frac{(c_j\dot{K}_j)}{c_j K_j}\right)}{\sum_{j\in k}\sum_i p_i v_{ji} s_j}$$

Notice that when k = j, we get the Solow residual for sector j.

According to the Domar aggregation rule:

$$SR = \frac{\sum_{k}\sum_{j\in k}\sum_{i} p_i v_{ji} s_j}{\sum_{i} p_i F_i} SR_k \qquad (15)$$

4. The Evolution of Tunisia's Economic Potential

4.1 Description of the Data

The basic data used in this paper are the input-output tables of Tunisia for the period 1983-1996. Labor is disaggregated into five levels of qualification: manual workers and trainees, machine operators, foremen, technicians, and engineers and administrators. Data on the quantity and remuneration of labor are taken from the national accounts (I.N.S.). Estimates of capacity utilization for manufacturing rates are borrowed from a study performed by the «Institut d'Economie Quantitative» (1996). For more details on the data sources and constructions the reader is referred to Ghali & Mohnen (2002).

4.2 Macroeconomic Decomposition of Tunisia's TFP Growth, 1983-1996

As table 1 reveals, over the whole sample period (1983-1996) frontier TFP growth increased by a mere 0.4 percent per year in Tunisia. This poor global performance is especially due to the negative growth rates over the 1983-1986 period, where frontier TFP actually declined, in other words the economy's potential deteriorated. Frontier TFP still deteriorated slightly in 1986-1991 but then grew at a comfortable 2.9 percent annual growth in 1991-1996. We have checked whether this result is due to the specification of heterogeneous labor by recomputing the linear program for each period with one type of labor only. We can see from the top part of table 1 that the evolution of TFP remains unaffected by this alternative specification. The annual growth rate over the whole period is higher by only a tenth of a percentage point, because homogeneous labor makes the intersectoral allocation of resources more flexible. In the sequel of the paper, we report the results with five levels of labor qualification.

The model proposes two decompositions of frontier TFP growth. The first one decomposes it according to the marginal productivities of the individual primary inputs. The second one decomposes it according to the variations of the exogenous variables in the model.

In the first two sub-periods, corresponding to the 6th and 7th plan of economic development, the least qualified workers contributed 3.8 percentage points to frontier TFP growth, whereas all other workers had no contribution. As shown in table 6, the first three categories of workers earn a higher wage rate at the optimum than the observed wage. Technicians and engineers (L4 and L5, respectively), however, earn a lower wage at the optimal activity levels. Until 1994, all workers earned at the optimal program the same shadow price as the manual workers (L1). It is only in the last three years, that is, from 1994 on (and slightly in 1988), that machine operators earned a shadow wage premium over manual workers, but the last three categories of workers had no reason to earn a higher wage than the machine operators. This switch in scarcity from manual workers to machine operators in 1994 explains the positive contribution of machine operators and the negative contribution of manual workers to TFP growth in the last sub-period. The excessive wage rates for the more qualified workers is not justified according to our activity analysis. It is a fact that qualified labor is in excess supply in Tunisia. In 1996, according to a study of the World Bank (World Bank (2000a), vol II, table 2.3, p.6) 82.4 percent of Tunisian enterprises had less than 6 workers, while only 1.6 percent employed more than 100 workers and a few dozens more than 500.

Capital's contribution to frontier TFP growth went from -6.7 percentage points in 1983-1986 to –4.0 percentage points in 1986-1991, and 2.7 percentage points in 1991-1996. In the 1981-1986 sub-period Tunisia invested heavily in capital goods at an investment rate that was on average as high as 30 percent of GDP, which yielded a growth rate of the capital stock of 4.9 percent against 2.4 percent for labor. In the sub-period 1987-1991 capital growth plunged to 0.7 percent because of the low investment by public enterprises. In 1991-1996 the growth in capital stock took off again, this time driven by private enterprises following the liberalization measures introduced by government in its structural adjustment program. Capital became utilized more efficiently, the capital/labor ratio decreased and consequently the observed rate of return on capital increased by a few percentage points. Table 5 contains the sectoral and aggregate evolutions of the rate of return on capital. Remember that in our model capital is treated as sector-specific. We see that some sectors had better been deactivated according to the logic of our model and their products be imported (such as textile and leather), others had excess capacities even at the optimal activity levels (such as electricity), whereas some sectors (like services) had very high rates of return at the optimal activity levels and yet almost no return at actual levels of activity. It must be recalled that in the period stretching from 1972 to 1985 real interest rates were negative in selected key sectors (Morrisson and Talbi (1995), World Bank (1996)). Investment policy changed in 1987. Investment, which previously had to be approved was now given financial and fiscal incentives in some priority sectors. In 1993 a more unified code of investment was promulgated which was based on export promotion, regional development, and technological development. Before the structural adjustment program, the price-fixing policy (Ghali (1995), Morrisson and Talbi (1996)), which got revised in 1986 and then again in 1991, nevertheless depressed competition in many sectors and discouraged innovation. Protectionism was classified at level 8 out of 10 by the IMF (IMF (1999)).

The last primary input in our open model is the allowable trade deficit. Over the whole period it played a slightly negative but modest role in frontier TFP growth (minus one tenth of a percentage point). The marginal value in terms of domestic final demand of an additional dinar of foreign deficit decreased over time.

We now turn to the decomposition of frontier TFP growth in terms of the growth in the quantities of the exogenous variables. The Solow residual grew by 1.1 percent per year over the whole period. In 1983-1986 it actually regressed but then it rose in the next two sub-periods to reach an annual growth rate of 2.5 percent in 1991-1996. The improvement in the Solow residual coincides with the structural adjustment program started in 1987. This policy aimed at increasing competition, liberalizing prices, the financial sector and foreign trade, reforming public enterprises, and privatizing certain sectors like the textile and the hotel industries.

To contrast our results with other results reported in the literature, we also computed the Solow residual at observed quantities and prices (see table 2). For that we used the utilized capital stock as the capital input. Paquet and Robidoux (2001) have shown with Canadian data that computing TFP growth without correcting for changes in capacity utilization leads to a procyclical Solow residual as compared to the Solow residual based on utilized capital stocks. We first notice that our computed observed Solow is in accordance with those reported in other studies. Only the Solow residuals implicit in the 6th to 8th plans of economic development are somewhat out of line with our computations. Second we notice that the optimal Solow residuals follow over time the same movement as the observed Solow residuals but with greater variation. It is useful to recall here that the optimal Solow residual measures the potential shift of the production possibility frontier, whereas the usual Solow residual, evaluated at observed prices and activity levels, measures the shift of the production function passing through observed points.

What is striking is the strong negative effect the terms of trade exerted on frontier TFP growth in the two sub-periods prior to 1991. In the third sub-period it turned into a positive but minor contribution. Given the structure of Tunisia's net exports, the evolution of world prices was not favorable to Tunisia. On average the price of imported goods rose more than the price of exported goods. In the end the Tunisian economy experienced over the whole period a significant drop in its purchasing power on world markets. The terms of trade effect almost neutralized the Solow residual effect.

The preference term played a minor role. The composition of final demand was overall not favorable to frontier TFP growth. Tunisians tended to prefer commodities that were intensive in the more scarce primary resources.

The slack effect was positive in each of the three sub-periods. Especially in the first sub-period (1983-1986) Tunisia became more efficient in managing its resources by avoiding slack in the utilization of all its labor and capital.

4.3 Sectoral Decomposition of Tunisia's TFP Growth, 1983-1996

In table 3 we report the sectoral Solow residuals calculated at optimal activity levels and shadow prices and in table 4 we report the Solow residuals calculated at observed activity levels and prices. The observed and optimal Solow residuals follow in the aggregate a similar evolution, but the details are quite different, and reflect the evolution at factor scarcities. The greatest difference is visible in agriculture and fishing. It had the high Solow residual when evaluated at optimal activity levels, but a permanent negative Solow residual when evaluated at observed prices and quantities. Mining had a positive (minor at the end) contribution to the observed Solow residual, but overall a negative one with the optimal prices and quantities. Petroleum and gas, electricity, transport and telecommunications, and other services had a strong positive effect in both cases, even stronger at observed activity levels.

We also notice some significant changes in sectoral productivity performances. The industries of construction materials, textiles and leather, petroleum and gas, construction and public works, transport and telecommunication became more productive in each sub-period, and hotel and tourism and other services substantially in the last sub-period. Negative productivity trends occurred in food processing, chemicals, mining, electricity and water utilities. Tunisia seems to be moving from a resource-based to a services economy.

Tables 3 and 4 also give the weights used in the Domar aggregation of sectoral Solow residuals (at optimal and observed activity levels and prices) to get to the aggregate Solow residual. If we look at the mid sub-period, the greatest weights were attached to other services, agriculture and fishing, construction and public works within the utilities, and food processing within manufacturing. Observed and optimal weights sometimes differ substantially, for example when a sector like textiles and leather becomes inactive in the linear program. Petroleum and gas is a sector that saw a steady decline of its importance over the sample period.

5. Conclusion

In this study we have examined the evolution of frontier TFP in Tunisia over the period 1983-1996 using the framework of Ten Raa and Mohnen (2002). Frontier TFP growth captures the shift in the production frontier of the economy as well as variations in efficiency movements with respect to the frontier. The location of the frontier is obtained by the resolution of a linear program (or activity analysis) at the level of the whole economy, taking into account factor resource constraints, inter-industry linkages, preferences and world prices. We have proceeded to various decompositions of TFP growth. One decomposes it with respect to the individual marginal productivities: capital, labor subdivided into five levels of qualification, and the allowable trade deficit. The second one is with respect to the exogenous variables of the model, yielding four terms: the usual Solow residual (but evaluated at frontier quantities and supporting prices), the terms of trade effect, and the economy's efficiency and the extent of incomplete capacity utilization.

The main results of our analysis can be summarized in the following points:

1. Over the whole sample period (1983-1996) frontier TFP growth increased by a mere 0.4 percent per year in Tunisia. This poor global performance is especially due to the negative growth rates over the 1983-1986 period, where frontier TFP actually declined, in other words the economy's potential deteriorated.

2. In the two sub-periods 1983-1986 and 1986-1991, corresponding to the 6th and 7th plan of economic development, labor was the main contributor to frontier TFP growth, and in particular the least qualified workers. The other worker categories were in excess supply. In the 1991-1996 sub-period capital took over from labor the contribution to frontier TFP growth. The allowable trade deficit played a slightly negative but modest role in frontier TFP growth over the whole period.

3. The Solow residual computed at frontier levels grew by 1.1 percent per year over the whole period. In 1983-1986 it actually regressed but then it rose in the next two sub-periods to reach an annual growth rate of 2.5 percent in 1991-1996. The improvement in the Solow residual coincides with the structural adjustment program started in 1987. What is striking is the strong negative effect the terms of trade exerted on frontier TFP growth in the two sub-periods prior to 1991. Given the structure of Tunisia's net exports, the evolution of world prices was not favorable to Tunisia. In the third sub-period it turned positive but small. Tunisians tended to prefer commodities that were intensive in the more scarce primary resources. But the preference term played only a minor role. The slack effect was positive in each of the three sub-periods. Especially in the first sub-period (1983-1986) Tunisia became more efficient in managing its resources by avoiding slack in the utilization of all its labor and capital.

4. Over the whole period, agriculture and fishing experienced a high Solow residual if evaluated at optimal activity levels. The other strong performers in the frontier allocation of resources are petroleum and gas, electricity and transport and telecommunication. However, we also notice some significant changes in sectoral productivity performances. The industries of construction materials, textiles and leather, petroleum and gas, construction and public works, transport and telecommunication became more productive in each sub-period, and hotel and tourism and other services substantially in the last sub-period. Negative productivity trends occurred in food processing, chemicals, mining, electricity and water utilities. Tunisia seems to be moving from a resource-based to a services economy.

These results while suggestive of changing trends and deep restructurings in the Tunisian economy should nevertheless be taken with some reservations. Nugent (1970) already pointed out that activity analysis models like this one may depend heavily on model and data imperfections. Data on capacity utilizations and labor force by type of qualification are partly constructed and hence particularly subject to measurement errors. Quantities are hard to measure in the service sectors and future studies will certainly improve our measure of productivity in services. The same could be said about quality changes with possible mis-measurement of output, especially in high-tech commodities. It would be more rewarding to have a disaggregation of labor by skills rather than by occupations. To assume sector-specific capitals might be too restrictive. It might be more realistic to assume different types of capital with substitution across industries. At the other extreme it is also too restrictive to assume perfect labor mobility. Finally, time, adjustment lags and expectations are completely absent from this essentially static model. Introducing these elements into the model would call for an intertemporal optimization model.

References

Balk, B. (1998), Industrial Price, Quantity, and Productivity Indices: The Micro-Economic Theory and an Application. Kluwer Academic Publishers, Boston.

Barro, R. J. (1999), “Notes on Growth accounting”, Journal of Economic Growth, 4, 119-137.

Ben Slama et al. (1996), “Relations Technologiques Intersectorielles et Décomposition des Sources de la Croissance”, cahiers de l’I.E.Q., no. 12.

Bosworth, B., S. Collins and Y. C. Chen (1995), “Accounting for Differences in Economic Growth”, Brookings Discussion Papers in International Economics, No 115.

Caves, D.W., L.R. Christensen and W.E. Diewert (1982), “The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity”, Econometrica, 50, 1393-1414.

Diewert, W. E. (1976), “Exact and Superlative Index Numbers”, Journal of Econometrics, 4, 115-145.

Diewert, W. E. (1981), “The Theory of Total Factor Productivity Measurement in Regulated Industries”, in Cowing, T. and R. Stevenson (eds.), Productivity measurement in Regulated Industries, Academic Press, New York, 1981.

Diewert, W. E. and C.J. Morrison (1986), “Adjusting Output and Productivity Indexes for Change in the Terms of Trade”, Economic Journal, 96, 659-679.

Diewert, W. E. (1992), “The Measurement of Productivity”, Bulletin of Economic Research, 44(3), 163-198.

Domar, E. (1961), “On the Measurement of Technical Change”, Economic Journal, 70, 710-729.

Färe, R., Grosskopf S., Norris M. and Zhang Z. (1994), “Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries”, American Economic Review, 84, 1, March, 66-83.

Farrell, M. J. (1957), “The Measurement of Productivity Efficiency”, Journal of Royal Statistical Society A, 120, 253-281.

Fuentes, H.J., E. Grifell-Tatjé, and S. Perelman (2001), “A Parametric Distance Function Approach for Malmquist Productivity Index Estimation”, Journal of Productivity Analysis, 15, 79-94.

Ghali, S. (1995), “Régimes des prix et Organisation de la Concurrence”, in Schéma Global de Développement de l'Economie Tunisienne à l'Horizon 2010, Etude stratégique No 3, Vol III, Institut d'Economie Quantitative, Novembre.

Ghali, S. and P. Mohnen (2002), “Restructuring and Economic Performance: The Experience of the Tunisian Economy”, CIRANO Scientific Series, 2002s-26, March.

Griliches, Z. (1996), “The Discovery of the Residual: A Historical Note”, Journal of Economic Literature, 34, September, 1324-1330.

Grosskopf, S. (2001), “Some Remarks on Productivity and its Decompositions”, mimeo.

Hall, R.E. (1988), “Invariance Properties of Solow’s Residual”, in Diamond, P. (ed.), Growth /Productivity/ Unemployment, M.I.T Press, Cambridge, M.A.

Hulten, C. R. (1978), “Growth Accounting with Intermediate Inputs”, Review of Economic Studies, 45, 511-518.

Hulten, C. R. (1986), “Productivity Change, Capacity Utilization and the Sources of Efficiency Growth”, Journal of Econometrics, 33, 31-50.

Hulten, C. R. (1987), “Divisia Index Numbers”, Econometrica, 41, 1017-1025.

Institut d’Économie Quantitative (1996), Étude stratégique No. 8, compétitivité, restructuration, diversification et ouverture sur l’extérieur des industries manufacturières et des services, 8622/96.

Institut National de la Statistique, Les comptes de la nation.

International Monetary Fund (1999), Tunisia: Staff Report for the Article IV Consultation, IMF Staff Country Report No. 99/104, September, Washington D.C.

Jorgenson, D. W. and Z. Grliches (1967), “The Explanation of Productivity Change”, Review of Economic Studies, 34(3), 308-350.

Jorgenson, D. W. and Z. Grliches (1972), “Issues in Growth Accounting: A Reply to Edward F. Denison”, Survey of Current Business, 52, 65-94.

Kohli, U. (1991), Technology, Duality, and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports, Ann Arbor: University of Michigan Press.

Lipsey, G. L. and K. Carlaw (2000), “What does Total Factor Productivity Measure?”, International Productivity Monitor, Fall, 1, 31-40.

Morrisson, C. and B. Talbi (1996), La Croissance de l’économie Tunisienne en Longue Période. Centre de développement de l’OCDE.

Nugent, J. (1970), “Linear Programming Models for National Planning: Demonstration of a Testing Procedure”, Econometrica, 38(6), 831-855.

Paquet, A. and B. Robidoux (2001), “Issues on the Measurement of the Solow Residual and the Testing of its Exogeneity: Evidence for Canada”, Journal of Monetary Economics, 47, 595-612.

Rama, M. (1998), “How bad is Unemployment in Tunisia? Assessing Labor Market Efficiency in a Developing Country”, The World Bank Research Observer, 13(1).

Redjeb, M.S. et B. Talbi (1995), “Performance de l'Economie Tunisienne durant la Période 1961-1993”, in Schéma Global de Développement de l'Economie Tunisienne à l' Horizon 2010, Etude stratégique No 3, Vol II, Institut d'Economie Quantitative, Novembre.

Redjeb, M. S. et L. Bouzaiane (1999), “Contribution du secteur privé à la croissance économique en Tunisie”, in L'entreprise au seuil du troisième millénaire: Défis et Enjeux, Institut Arabe des Chefs d'Entreprises, Novembre.

Senhadji, A. (1999), “Sources of Economic Growth: An Extensive Growth Accounting Exercise”, I.M.F Working Paper, WP/99/77, June.

Solow, R. (1957), “Technical Change and the Aggregate Production Function”, Review of Economics and Statistics, 39, 312-320.

Ten Raa, T. and P. Mohnen (2002), “ Neoclassical Growth Accounting and Frontier Analysis : A Synthesis ”, Journal of Productivity Analysis, 18, 111-128.

Wolff, E. N. (1985), “Industrial Composition, Inter-industry Effects, and the U.S Productivity Slowdown”, Review of Economics and Statistics, 67, 268-277.

World Bank (1996), Tunisia's Global Integration and Sustainable Development, Strategic Choices for the 21. Washington D.C.

World Bank (2000a), Tunisia-Private Sector Assessment Update, Meeting the Challenge of Globalization, report No.20173-TUN, December.

World Bank (2000b), Republic of Tunisia. Social and Structural Review 2000. Washington D.C.

Table 1: Decomposition of Total Factor Productivity Growth (1983-1996), (in percentages)

	1983-1996	**1983-1986***	**1986-1991****	**1991-1996*****
Homogeneous Labor				
TOTAL	**0.4**	**-3.1**	**-0.3**	**3.1**
Labor	1.8	3.7	4.0	-1.6
Capital	-1.3	-6.7	-4.2	4.7
Trade Deficit	-0.1	-0.2	-0.1	-0.02
--------------------------------	------------	------------	-----------	-------------
Solow Residual	1.2	-0.8	1.0	2.5
Terms of Trade	-1.0	-3.0	-1.3	0.6
Preferences	-0.2	-0.5	0.01	-0.1
Structural Changes	0.4	1.2	0.04	0.2
Observed Solow Residual	**1.4**	**0.2**	**0.5**	**3.0**
Labor decomposed into Five Levels of Qualification				
Total	**0.3**	**-3.1**	**-0.3**	**2.9**
Manual workers and trainees	1.1	3.8	3.8	-3.1
Machine operators	1.3	0.0	-0.004	3.3
Foremen	0.0	0.0	0.0	0.0
Technicians	0.0	0.0	0.0	0.0
Engineers/administrators	0.0	0.0	0.0	0.0
Capital	-2.0	-6.7	-4.0	2.7
Trade deficit	-0.1	-0.2	-0.1	-0.02
----------------------------------	--------------	--------------	------------------	--------------
Solow Residual	---	-----	-	-----
Terms of Trade	1.1	-0.8	0.9	2.5
Preferences	-1.0	-3.0	-1.2	0.4
Structural Changes	-0.2	-0.5	0.0	-0.1
Observed Solow Residual	0.4	1.2	0.05	0.1
	1.2	**-0.05**	**0.3**	**2.8**

Notes:* **=** 6th Economic Development Plan: 1982-1986.

** = 7th Economic Development Plan: 1987-1991.

*** = 8th Economic Development Plan: 1992-1996.

Table 2: Our estimates of TFP growth compared to previous studies (in percentages)

Our results	1982-1988 (1983-1988)	1986-1992	1986-1996	1987-1993	1989-1992	1982-1986 (1983-1986)	1986-1991	1991-1996
Optimal Solow Residual								
Homogeneous Labor	-0.3	1.7	1.8	2.2	4.0	-0.8	1.0	2.5
Heterogeneous Labor	-0.4	1.6	1.9	2.1	4.0	-0.8	0.9	2.5
Observed Solow Residual								
Homogeneous Labor	-0.4	1.3	1.7	2.0	4.0	(0.3)*	0.5 (2.1)*	3.0 (2.6)*
Heterogeneous Labor	-0.6	1.2	1.6	1.8	3.8	-0.05(-0.02)*	0.3(1.9)*	2.8(2.4)*
Bosworth & Al (1995)		1.4						
Redjeb-Talbi (1995)				2.1				
Redjeb-Bouzaiane (1999)				1.9				
Morrisson-Talbi (1996)	-0.2				3.0			
World-Bank (2000b)		1.8	1.2					
VIth Plan (1982-1986)**						-1.7		
VIIth Plan (1987-1991)**							2.2	
VIIIth Plan (1992-1996)***								1.3

Notes:* The numbers in parentheses have been obtained using the total capital stock (not corrected for capacity utilization rate)

** Source: VIII ème Plan de Développement, 1992-1996, Contenu Global, Vol I, Ministère du Développement Economique, République Tunisienne.

*** Source: IX ème Plan de Développement, 1997-2001, Contenu Global, Vol I, Ministère du Développement Economique, République Tunisienne.

Table 3: Solow residual and mean weights in Domar aggregation at optimal activity levels and shadow prices (1983-1996), Annual growth rates (in percentages)

	1983-1996		1983-1986[1]		1986-1991[2]		1991-1996[3]	
	Solow	**Domar**	**Solow**	**Domar**	**Solow**	**Domar**	**Solow**	**Domar**
Agriculture & fishing	1.4	0.22	0.8	0.20	4.2	0.22	-0.9	0.22
Food processing	0.04	0.20	1.5	0.19	-1.3	0.26	0.6	0.15
Construction materials & glass	0.4	0.08	-0.8	0.07	-0.9	0.08	2.4	0.08
Mechanical & electrical goods	1.4	0.15	1.3	0.11	1.3	0.15	1.4	0.17
Chemical & rubber products	1.0	0.12	1.5	0.10	1.6	0.16	0.2	0.09
Textile & leather products	1.3	0.04	1.0	0.00	1.4	0.04	1.5	0.06
Other manufacturing	1.2	0.06	2.0	0.00	0.4	0.07	1.4	0.09
Mining	-1.2	0.01	-1.9	0.02	0.2	0.02	-2.1	0.01
Hydrocarbons	1.8	0.13	1.4	0.24	1.3	0.12	2.5	0.08
Electricity	1.8	0.03	4.3	0.03	0.3	0.03	1.8	0.02
Water	1.1	0.01	3.8	0.01	-1.0	0.01	1.5	0.01
Construction & public works	0.4	0.17	0.2	0.18	-0.9	0.16	1.7	0.19
Transport and telecom.	1.7	0.14	-0.2	0.14	0.3	0.13	4.4	0.15
Hotel & tourism	-0.3	0.11	-2.3	0.11	-2.8	0.11	3.3	0.12
Other services	0.2	0.36	-3.4	0.39	-0.1	0.34	2.6	0.36
Aggregate	1.4	1.83	-0.6	1.78	1.0	1.88	2.9	1.80

Notes: (1)6th Economic Development Plan: 1982-1986
(2)7th Economic Development Plan: 1987-1991
(3)8th Economic Development Plan: 1992-1996

Table 4: Observed Solow residuals (1983-1996) (annual growth rates in percentages) and mean weights in Domar aggregation

	1983-1996		1983-1986[1]		1986-1991[2]		1991-1996[3]	
	Solow	**Domar**	**Solow**	**Domar**	**Solow**	**Domar**	**Solow**	**Domar**
Agriculture & fishing	-1.2	0.20	-1.8	0.18	-0.5	0.21	-1.5	0.20
Food processing	-0.02	0.20	1.6	0.18	-1.3	0.21	0.3	0.21
Construction materials & glass	0.8	0.06	-0.4	0.05	-0.3	0.06	2.6	0.06
Mechanical & electrical goods	1.2	0.11	1.3	0.10	1.0	0.11	1.3	0.12
Chemical and rubber products	1.1	0.12	1.9	0.11	1.5	0.13	0.1	0.10
Textile & leather products	1.1	0.18	1.0	0.12	0.9	0.17	1.4	0.22
Other manufacturing	0.7	0.07	1.6	0.06	0.2	0.08	0.8	0.08
Mining	1.0	0.01	1.0	0.02	1.8	0.02	0.1	0.01
Hydrocarbons	2.0	0.12	1.8	0.15	1.2	0.13	3.0	0.09
Electricity	2.5	0.03	4.5	0.03	1.5	0.03	2.4	0.03
Water	1.4	0.01	2.7	0.01	-1.1	0.01	3.0	0.01
Construction & public works	-0.1	0.17	-1.3	0.19	-1.5	0.15	2.0	0.17
Transport and telecom.	2.1	0.12	0.5	0.11	0.7	0.12	4.4	0.13
Hotel and tourism	-0.7	0.10	-2.3	0.08	-3.3	0.10	2.8	0.11
Other services	1.1	0.31	-2.1	0.26	1.6	0.32	2.7	0.32
Aggregate	1.2	1.79	-0.05	1.63	0.3	1.84	2.8	1.84

Notes: (1) 6th Economic Development Plan: 1982-1986
2) 7th Economic Development Plan: 1987-1991
(3) 8th Economic Development Plan: 1992-1996

Table 5: Observed and optimal rates of return on capital (1983-1996) (1990 prices)

	1983		1984		1985		1986		1987		1988		1989	
	R. Opt	R. Obs	R. Opt	R. Obs	R. Opt	R. Obs	R. Opt	R. Obs	R. Opt	R. Obs	R. Opt	R. Obs	R. Opt	R. Obs
Agriculture & fishing	0.00	0.42	0.00	0.46	0.00	0.51	0.00	0.39	0.00	0.39	0.00	0.25	0.00	0.27
Food processing	0.63	0.34	0.08	0.45	0.00	0.39	0.44	0.49	0.33	0.38	0.38	0.37	0.34	0.36
Construction materials & glass	0.03	0.03	0.04	0.04	0.00	0.05	0.11	0.05	0.06	0.05	0.07	0.05	0.06	0.04
Mechanical and electrical goods	0.04	0.03	0.04	0.06	0.03	0.09	0.13	0.10	0.17	0.13	0.25	0.15	0.21	0.18
Chemical and rubber products	0.00	-0.10	0.02	-0.09	0.00	-0.09	0.07	-0.04	0.04	-0.02	0.13	0.01	0.17	0.05
Textile and leather products	0.00	0.28	0.00	0.25	0.00	0.29	0.00	0.34	0.00	0.34	0.00	0.35	0.00	0.35
Other manufacturing	0.00	0.12	0.00	0.13	0.00	0.16	0.00	0.21	0.06	0.23	0.12	0.23	0.08	0.21
Mining	0.10	-0.02	0.07	-0.04	0.01	-0.05	0.06	-0.01	0.03	0.01	0.09	0.03	0.11	0.04
Hydrocarbons	0.45	0.20	0.49	0.22	0.41	0.21	0.17	0.22	0.19	0.21	0.15	0.21	0.19	0.23
Electricity	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.00	0.01
Water	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
Construction & public works	0.00	0.47	0.00	0.61	0.00	0.38	0.00	0.68	0.00	0.57	0.00	0.58	0.00	0.51
Transport and telecom.	0.10	0.04	0.08	0.04	0.07	0.06	0.12	0.06	0.11	0.07	0.14	0.08	0.12	0.08
Hotel and tourism	0.58	0.35	0.54	0.33	0.50	0.36	0.40	0.33	0.39	0.34	0.45	0.38	0.31	0.34
Other services	1.28	-0.04	0.95	-0.16	0.63	-0.07	0.71	-0.12	0.49	-0.07	0.80	0.08	0.42	-0.06
Weighted rates of return	0.22	0.16	0.17	0.17	0.13	0.18	0.14	0.18	0.12	0.17	0.16	0.17	0.12	0.16

Table 6: Observed wages and shadow prices of labor for different levels of qualification (1983-1996) (1,000 DT / year, 1990 prices)

	Manual workers		Machine operators		Foremen		Technicians		Engineers/ admin.	
	Obs	**Opt**	**Obs**	**Opt**	**Obs**	**Opt**	**Obs**	**Opt**	**Obs**	**Opt**
1983	1.138	1.609	1.963	1.609	2.946	1.609	4.239	1.609	5.740	1.609
1984	1.112	2.051	1.936	2.051	3.010	2.051	4.123	2.051	5.578	2.051
1985	1.004	2.843	2.021	2.843	2.773	2.843	3.626	2.843	5.122	2.843
1986	1.014	2.271	1.723	2.271	2.671	2.271	3.974	2.271	5.097	2.271
1987	0.889	2.532	1.765	2.532	2.480	2.532	3.334	2.532	4.476	2.532
1988	0.977	1.858	1.615	1.891	2.542	1.891	3.860	1.891	4.898	1.891
1989	0.928	2.219	1.764	2.219	2.504	2.219	3.368	2.219	4.631	2.219
1990	1.025	2.955	1.639	2.955	2.534	2.955	3.836	2.955	5.205	2.955
1991	0.947	3.113	1.812	3.113	2.466	3.113	3.432	3.113	4.753	3.113
1992	1.117	3.142	1.792	3.142	2.770	3.142	4.060	3.142	5.595	3.142
1993	1.045	3.168	1.948	3.168	2.722	3.168	3.652	3.168	5.229	3.168
1994	1.154	3.171	1.782	3.355	2.860	3.355	4.177	3.355	5.792	3.355
1995	1.081	2.498	1.935	3.440	2.950	3.440	3.679	3.440	5.427	3.440
1996	1.214	2.368	1.824	3.412	2.994	3.412	4.287	3.412	6.082	3.412

Table 7: Annual growth rates for labor (by type of qualification), capital and trade deficit (in percentages)

	1983-1996	1983-1986[1]	1986-1991[2]	1991-1996[3]
Manual workers and trainees	1.1	0.4	1.8	1.0
Machine operators	3.1	3.3	3.0	3.2
Foremen	2.4	2.3	3.2	1.8
Technicians	2.5	1.2	2.7	3.1
Engineers/administrators	3.4	6.7	2.6	2.5
Total labor	2.5	2.4	2.6	2.5
Capital	2.2	4.9	0.8	1.9
Trade deficit	-14.3	-12.8	-12.2	-32.3

Notes: (1) 6th Economic Development Plan: 1982-1986
(2) 7th Economic Development Plan: 1987-1991
(3) 8th Economic Development Plan: 1992-1996