GENERAL EQUILIBRIUM ASSESSMENT OF TRADE LIBERALIZATION EFFECTS UNDER COURNOT OLIGOPOLY MARKET STRUCTURES: THE CASE OF TUNISIA*

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Abstract

In this paper we simulate the impact of removing all tariffs on imports under both competitive and Cournot oligopoly market structures with and without barriers to entry and exit. We find that trade liberalization induces welfare gains equal to 1 percent with perfect competition and 0.9 percent with increasing returns to scale, oligopoly and barriers to entry and exit, but welfare losses equal to 0.4 percent with free entry and exit. Sensitivity analysis shows that welfare losses depend on elasticities of substitution between imported and domestic goods and cost disadvantage ratios.

1. Introduction

During the first half of the 1980s, Tunisia registered large current account deficits, induced by the deterioration of world oil prices, the decline of petroleum production and exports, poor agricultural harvest and a fall of tourism receipts. The balance of payments difficulties culminated in 1986 and obliged the country to introduce a far-reaching stabilization and structural adjustment program, under the auspices of the IMF and the World Bank.

The program aimed to initiate a wide range of reforms to reduce government intervention in the economy and strengthen market forces. The inward-oriented import substitution strategy has been replaced by an outward-oriented export-promotion strategy. Accordingly, trade liberalization has been a kingpin of the program.[1] Since quantitative import restrictions no longer play a significant role, tariffs, which have been lowered, represent the principal instrument of protection. The progress achieved towards trade liberalization allowed Tunisia to join the GATT in 1990, participate, and sign the Uruguay Round agreement in 1993, become a member of the WTO in 1994 and sign a FTA with the European Union in 1995. The latter arrangement provided the impulse to the elaboration of studies assessing the general equilibrium impact of the FTA with Europe on the whole economy (see Rutherford et al., 1995 and Brown et al., 1997) and on agriculture (see Decaluwé et Souissi, 1996 and Chemingui and Dessus, 1999).

In spite of the theoretical indeterminacy of the trade liberalization impact under increasing returns to scale, little emphasis has been given to the estimation of economies of scale and representation of market structures in Tunisian manufacturing sectors. Therefore, since there is no empirical evidence in Tunisia on the existence of such market distortions we must explore as many variants of market structures as possible. Our purpose in this paper is to assess the effects of complete trade liberalization under alternative oligopoly market structures. We have already investigated in Chatti (1999) the role of horizontal product differentiation and monopolistic competition in a single-country setting, as did Brown et al. (1997) in a multi-country setting.[2]

The paper is organized as follows: In the first section we describe the model of oligopolistic market structures. Then, we provide in the second section an overview of the Tunisian sectoral features in the reference year and list and analyze the simulation results of trade liberalization in the third section. We conclude in the fourth section.

2. The Model

The static applied general equilibrium model of oligopolistic market structures is closely related to Devarajan and Rodrik (1991) and de Melo and Tarr (1992).

We consider a representative household who receives income from wages, capital revenue, lump-sum government transfers from tax collection, foreign capital inflow and pure profits. Given this income, the representative household decides how to allocate its budget between the different composite goods in order to maximize a Cobb-Douglas utility function.

Producers also demand composite goods for intermediate use, according to a Leontief input-output technology; that is, the coefficients of intermediate goods in production are fixed.

Following the Armington assumption, each composite good is a CES aggregation function of imported and domestically produced goods. Therefore, foreign and domestic goods are imperfect substitutes in use, and there is product differentiation at the sectoral level. Import supplies are, in addition, assumed to be infinitely elastic, so that the world prices of imported goods are exogenous.

Producers take a multiple-step supply decision. First, they decide on the optimal levels of primary factor services to hire and intermediate goods to purchase, so as to minimize production costs given the technology of production constraints. The technology of production is described by a Leontief aggregation function of two

[1] The program also called other major reforms. See GATT (1994) and the World Bank (1995) for details. But for our purposes we shall focus on trade liberalization.

[2] Our results are different from those of Brown et al. (1997). We always found welfare losses, while they found welfare gains except in the case of sector specific capital. This difference is mostly explained, in our sense, by our specification of perceived elasticities of export and domestic demands. We assumed low elasticity of domestic demand and high elasticiy of export demand, whereas they considered nearly equal elasticities of export and domestic demands.

composites: a composite of primary factors of production and a composite of intermediate goods. The composite of intermediate goods is also a Leontief aggregation, whereas the primary factors of production composite is a CES function of variable capital and labor; the latter factors are also assumed mobile between sectors.

As in Harris (1984), further to variable costs, we distinguish in the case of increasing returns to scale (IRTS) a set-up fixed costs component, representing the amounts of fixed capital and labor necessary to start up the production process. The larger the share of fixed costs in total costs, the higher are unrealized economies of scale and the gap between average and marginal costs. Also, we consider that the share of each fixed primary factor in total sectoral fixed costs is equal to the share of each total primary factor in sectoral value added.

In a second step, producers choose the optimal amount of output to produce. In the case of constant returns to scale (CRTS) and perfect competition, the optimal production level is determined by equating marginal costs to marginal revenue, where the marginal revenue is the dual to the constant-elasticity-of-transformation aggregation or equally the composite producer price. However, when we depart from the competitive setting and consider IRTS and oligopolistic market structures, the marginal costs pricing rule induces losses, since average costs exceed marginal costs. Thus producers enjoy market power and are price makers. We consider nevertheless that firms benefit from market power only on the domestic market, since the demand for locally produced goods is decreasing whereas the export demand is perfectly elastic. Denoting PD_i, PE_i, DD_i and EX_i respectively the prices and quantities of locally produced goods and exports, the firm profit π_i is equal to:

$$\pi_i = (1 - tx_i) \times (PD_i DD_i + PE_i EX_i) - MC_i X_i - FC_i$$

where MC_i and FC_i represent respectively marginal and fixed costs, tx_i is the indirect tax rate on gross output and X_i is the composite production level. The first-order condition for profit maximization is the markup of price over marginal costs, i.e.,

$$(1 - tx_i) PD_i \left[1 - \frac{1}{N_i \varepsilon_{d_i}} \right] = MC_i$$

where N_i is the number of firms in the industry, which is equivalent to the inverse of the Herfindhal concentration index in the case of symmetric firms, and $\varepsilon_{d_i} \equiv -\frac{dDD_i}{dPD_i} \frac{PD_i}{DD_i}$ is the perceived elasticity of domestic demand, which equation is given in the appendix.

Following Dixit (1988) and Devarajan and Rodrik (1991), we consider here Cournot oligopoly behavior with a conjectural variation equal to zero, i.e., each firm believes that the other firms' choice is independent from its own, whereas de Melo and Tarr (1992) specify a conjectural variation different from zero.

The consideration of the conjectural variation approach, which is a dynamic concept, into a static framework is not theoretically satisfying. Also there is no available data about the extent of industry concentration in the different manufacturing sectors in Tunisia, as measured by the Herfindhal index. This is why we will calibrate this number. Then we endogenize it, in the case of free entry and exit, and fix simultaneously the pure profits π_i equal to zero. In the case of barriers to entry and exit, the number of firms in each sector is fixed to its initial calibrated level and pure profits are no longer exogenous and equal to zero.

In a final step, producers allocate their output between export and domestic sales according to a constant-elasticity-of-transformation function. The implementation of the latter specification allows us to incorporate product differentiation at the national level, since exported and locally produced goods are imperfect substitutes, while keeping the small country assumption for Tunisia on the world markets. Indeed, analogously with imports supplies, export demands are infinitely elastic and the world prices of exports are fixed; terms of trade are thus exogenous.

All demand and supply functions are homogenous of degree zero in prices. Hence, only relative prices matter and we should choose a numéraire to evaluate prices. We choose the weighted average of all domestic goods prices as numéraire.

In equilibrium, all prices adjust such that excess demands equal zero for all goods and factors, household income is equal to total expenditures and total imports net of total exports are equal to the exogenous value of net foreign capital inflow.

By Walras' law, all the equilibrium conditions are not independent. Thus we must omit one redundant condition to close the simultaneous equations system, which set of equations and variables is contained in the appendix.

The above model of oligopolistic market structures has been implemented to replicate the observed data for Tunisia in the base year 1990 and then analyze the impact of full tariff elimination on welfare and sectoral adjustments[3].

3. The Structure of Tunisian Production and Trade

The benchmark year of experiments is 1990, the year Tunisia joined the GATT. The economy is disaggregated into sixteen tradable sectors, of which thirteen are in manufacturing. The sectoral features of the economy in 1990 are described in Table 1.

The first three columns of Table 1 indicate the production characteristics of each sector. As we can see, the sectoral share in total gross output (column (1)) and the share of sectoral value-added in GDP (column (2)) reveal that agriculture and services dominate the production side of the economy, providing 49.7 percent of gross domestic production and 71 percent of value-added, whereas manufacturing sectors contribute 35.3 percent to output and only by 16.2 percent to total value-added.

Within manufacturing, textiles, food processing, chemicals and wood products dominate, accounting respectively for 9 percent, 8.4 percent, 5.4 percent and 4.1 percent of total output and 3.8 percent, 3 percent, 2.1 percent and 2.2 percent of GDP.

The importance of primary factors vs. intermediate goods for each sector is indicated in column (3) by the share of value-added in gross output. Except for agriculture and services where the shares of primary factors in production are greater than 70 percent, all the remaining sectors show strong inter-industry linkages, with intermediate goods shares in total production exceeding 50 percent. We expect that resource reallocation in the latter sectors to play a relatively weak role in affecting output levels.

[3] The Tunisian SAM has been constructed using the unpublished input-output table built by the Institut d'Economie Quantitative (IEQ). The CGE models have been written and run using the NLP solvers of GAMS software, which implementation is described in Brooke et al. (1992).

The next four columns in Table 1 provide information about the trade orientation and protection of each sector. We can see that the most important sectors in the economy, i.e., agriculture and services are not the most trade oriented in spite of low average nominal and effective rates of protection. Indeed, import shares in demand are less than 10 percent while the export share in output is equal to 3.7 percent for agriculture and 21.5 percent for services. Manufactures show, however, high trade shares. These shares increased over time starting in 1986 and following the trade liberalization measures that have been undertaken within the structural adjustment program.

The share of imports in aggregate composite expenditures is equal to 66.3 percent in textiles, 53.4 percent in chemicals, 52.4 percent in rubber and plastics, 64.9 percent in non-ferrous metals, 90.2 percent in non-electrical machinery, 81 percent in electrical machinery, 84.5 percent in transport equipment and 62.2 percent in miscellaneous manufactures. These eight sectors are the most import-oriented in the economy and represent 65.6 percent of total imports.

Six of the thirteen manufacturing sectors are the most export-oriented sectors in the economy. Indeed, the export share in sectoral output is equal to 68.8 percent in textiles, 42.7 percent in chemicals, 43.4 percent in non-electrical machinery, 37 percent in transport equipment, 45.8 percent in miscellaneous manufacture. Together these sectors account for 42.8 percent of total exports.

Tunisia is most protectionist against imports of glass and ceramic products, electrical machinery, non-electrical machinery and transport equipment with nominal tariffs (column (6)) equal respectively to 53.7 percent, 53.1 percent, 38 percent and 31.7 percent.

When we take account of intermediate goods protection, our calculations of the effective rates of protection reveal in column (7) that non-ferrous metals and rubber and plastics sectors have the highest effective protection, which is respectively equal to 422.1 percent and 165.1 percent, in spite of low nominal tariff rates (10 percent and 10.3 percent). The glass and ceramic sectors together with electrical machinery follow with effective rates of protection reaching respectively 128.8 percent and 101 percent.

It also appears from our calculations that beverages and tobacco, miscellaneous manufactures, services and non-electrical machinery have negative effective rates of protection and thus are the less protected sectors in the economy.

To run simulations, further to social accounting matrix, we need external estimates of the elasticities of substitution and transformation and cost disadvantage ratios in the IRTS sectors. The parameters chosen to calibrate the model so as to replicate 1990 Tunisian data are provided in Table 2. They rely upon Reinert et al. (1994) and Cox (1994). Given the lack of econometric estimates of elasticities of substitution and scale, we will explore the sensitivity of welfare results to different values of these parameters.

4. Trade Liberalization Simulations Results

In this section we provide results based on a counterfactual tariff elimination experiment undertaken under three alternative pricing rules. As a point of reference, we consider a framework of CRTS and perfect competition, where prices are equal to marginal costs. The only distortion in the economy is thus due to taxes that introduce a gap between supply and demand prices. Therefore, tariffs create a wedge between the world and domestic prices of imports. Since the import supply is perfectly elastic, the tariffs are completely borne by Tunisian demanders of imported goods, i.e., household and firms.

When we consider IRTS and oligopoly market structures, we have to take account of two additional distortions. One is due to the gap between average and marginal costs, while the other is explained by the existence of a positive markup over prices and market power.

Rodrik (1988) shows that trade liberalization will be welfare enhancing, if it allows each firm's output to expand in sectors with price exceeding marginal costs and barriers to entry and exit and also increases the number of firms in sectors with price exceeding average costs and positive pure profits, of course in the case of free entry and exit.

Denoting X_i, N_i and x_i, respectively, the industry output, the number of oligopolistic firms and the output per firm, we have:

$$x_i = \frac{X_i}{N_i}$$

Differentiating the above equation and multiplying by the level of output per firm, produces:

$$\frac{dx_i}{x_i} = \frac{dX_i}{X_i} - \frac{dN_i}{N_i}$$

In the case of barriers to entry and exit, $\frac{dN_i}{N_i} = 0$ and the firm's output expansion is equivalent to the industry output expansion. Therefore, trade liberalization will improve welfare, if it increases both imports and industry output. This will be possible, if goods are not strongly substitutable. In the case of free entry and exit, however, the output per firm will expand if the industry output growth is greater than the increase of the number of firms.

Our results show that Tunisia experiences welfare gains equal to 1 percent of 1990 GDP in the case of CRTS.[4] These gains are the result of significant increase of imported goods (24.9 percent) whose prices decrease following tariff elimination, as we can see from column (1) of Table 3. Domestic goods became less attractive after trade liberalization and producers reorient their sales toward exports, which expand by 28.9 percent.

Welfare gains are equal to only 0.9 percent of 1990 GDP in the case of oligopoly market structure and barriers to entry and exit. Imports increased by 9.4 percent and thus prevent Tunisian firms in IRTS sectors from realizing economies of scale. Indeed, import expansion takes place at the expense of domestically produced goods, since they are substitutable. There is little scope for realizing economies of scale, because the share of fixed costs in total costs is on average low and equal to 12.4 percent (see Table 2, column (4)). The output per firm indeed increases only by 4.4 percent in the manufactures sectors.

Once we assume free entry and exit, trade liberalization induces welfare losses equal to 0.4 percent. Given that the ratio of fixed costs to total costs is assumed to

[4] The welfare change is measured by the equivalent variation as a share of 1990 GDP.

be low (12.4 percent) in the reference year, fixed costs do not act as an obstacle to entry. Thus firms are attracted by the opportunity to realize pure profits in manufactures, and we observe a large inflow of new firms (27.9 percent) that prevent incumbent firms from moving down their unit cost curve. The average output per firm decreases by 10.9 percent in manufactures.

Looking at the sectoral level, we see from Table 4 that output produced with CRTS technology (column (4)) diminishes in agriculture by 5.7 percent, services by 5.5 percent, food processing by 4.5 percent, beverages and tobacco by 3.65, cement and quarrying by 7.5 percent, glass and ceramics by 14.1 percent, and non manufactured products by 3.7 percent. These are the most inward-oriented sectors in the economy (see column (4) of Table 1), and they release primary factors toward the other most import-oriented sectors.

Except for cement and quarrying, non-manufactures and services, where output increases respectively by 0.25 percent, 0.99 percent and 0.16 percent, we find for the other IRTS sectors and in the case of no entry and exit, the same result as for CRTS (see column (8) of Table 4). Nevertheless, the intensity of change is not identical. Indeed, output expands (decreases) less with imperfect competition, because import competition acts as a brake to substitutable output expansion.

A similar impact on output is observed in the case of free entry and exit, (see column (2) of Table 4). Nevertheless, industrial output expansion in nine manufacture sectors, i.e., textiles, chemicals, rubber, non-ferrous metals, wood, non-electrical machinery, electrical machinery, transport equipment, miscellaneous manufacture, results from new entry and as we can see from column (13) output per firm decreases in the latter sectors.

In order to determine the extent to which our results are sensitive to the elasticities of scale and substitution between imported and domestic goods, we conduct sensitivity analysis in which these elasticities are varied separately. The results are reported in Tables 5 and 6 and illustrated in Figures 1 and 2.

As we can see, the higher are the elasticities of substitution, the higher are welfare gains in the case of barriers to entry and exit. When the elasticities are greater than 1.8 times their benchmark levels, we even observe welfare gains in the case of free entry and exit. High levels of elasticities mean an important change in the quantity of imports demanded, which is welfare improving.

Also, the higher is the share of fixed costs in total costs, the higher are welfare gains, because the scope for realizing economies of scales and reducing the gap between average and marginal costs is more important. When the cost disadvantage ratio is equal to 12 percent and there are obstacles to entry and exit welfare gains represent 1.03 percent of 1990 GDP and they are greater to those reached with constant returns to scale and perfect competition. And when the cost disadvantage ratio is equal to 15 percent, fixed costs impose a limit to entry, even when we allow for changes in the number of firms. Any industrial output expansion is thus more aptly explained by incumbent firms' scale efficiency gains rather than by new entry.

In all cases, for an identical uniform cost disadvantage ratio, welfare gains are greater with barriers to entry and exit rather than with free entry and exit. Indeed, the scale efficiency gains are more important in the former case.

6. Summary and Conclusion

In this paper we present a static general equilibrium model of a small open economy with increasing returns to scale and oligopolistic manufacturing industries in order to simulate the impact of removing all tariffs on imports. We also derive results from a standard model with constant returns to scale and perfect competition in order to make comparisons.

We find that trade liberalization induces welfare gains equal to 1 percent of 1990 GDP in the case of constant returns to scale and perfect competition and 0.9 percent in the case of increasing returns to scale, oligopolistic market structures and barriers to entry and exit. Given the low share of fixed costs in total costs in the reference year, trade liberalization does not offer a strong opportunity to realize economies of scale.

When we allow firms to enter and exit, trade liberalization entails welfare losses equal to 0.4 percent of 1990 GDP. This is because fixed costs are low and do not represent a barrier for firms attracted by the opportunity to realize positive profits. New entrants prevent incumbent firms from reducing unit costs. Indeed, output per firm decreases on average by 10.9 percent and the number of firms expands on average by 27.9 percent.

Sensitivity analysis indicates that results depend on the levels of elasticities of substitution between imported and domestic goods and cost disadvantage ratios, especially in the case of free entry and exit. We indeed observe welfare gains, once the share of fixed costs in total costs is greater than 15 percent and elasticities of substitution greater 1.8 times their initial level.

Tunisia is a small country with a tiny domestic market constraining any potential scale efficiency gains. The enthusiasm for trade liberalization is indeed justified and inevitable to promote competition and efficiency, but this policy is more efficient in increasing returns sectors when it is pursued in combination with domestic industrial policy that enhances the realization of economies of scale by preventing excessive entry.

Our study aims to shed light on the importance of studying market structures in Tunisia to design policies accompanying trade liberalization.

Appendix: Model Equations, Variables and Parameters

List of Equations

There are i,j=1,.....,s sectors (and goods), of which p=1,.....,c are competitive and n=c+1,....,s are non competitive.

Leontief Input-Output Coefficients

$$a_{ij} = \frac{CI_{ij}}{X_j}$$

Labor Demand

$$LD_i = \left(\frac{1}{\overline{AX}_i}\right)^{1-\eta_i}\left(\frac{\alpha_i MC_i}{W}\right)^{\eta_i}$$

Capital Demand

$$KD_i = \left(\frac{1}{\overline{AX}_i}\right)^{1-\eta_i}\left(\frac{(1-\alpha_i)MC_i}{R}\right)^{\eta_i}$$

Total Costs

$$TC_i = FC_i + MC_i\ X_i$$

Marginal Costs

$$MC_i = \frac{1}{\overline{AX}_i}\left[\alpha_i^{\eta_i} W^{1-\eta_i} + (1-\alpha_i)^{\eta_i} R^{1-\eta_i}\right]^{\frac{1}{1-\eta_i}} + \sum_j PQ_j a_{ji}$$

Fixed Costs

$$FC_i = N_i\left(R\ \overline{kf}_i + W\overline{lf}_i\right)$$

Average Costs

$$AC_i = \frac{TC_i}{X_i}$$

Cost Disadvantage Ratio

$$CDR_i = \frac{FC_i}{TC_i}$$

Oligopoly Markup Pricing

$$\frac{PD_n(1-tx_n) - MC_n}{(1-tx_n)PD_n} = \frac{1}{N_n \varepsilon_{d_n}}$$

Perceived Elasticity of Domestic Demand

$$\varepsilon_{d_n} = \sigma_n + \frac{PD_n DD_n}{PQ_n Q_n}\left(\frac{C_n}{Q_n} - \sigma_n\right)$$

Pure Profits

$$\pi_n = PX_n(1-tx_n)X_n - TC_n$$

Marginal Cost Pricing in Competitive Industries	$PX_p\left(1-tx_p\right)=MC_p$
Government Income	$YG=\sum_i tm_i\,\overline{PWM}_i\,M_i\,ER+\sum_i tx_i\,PX_i\,X_i$
Household Income	$YM=W\,\overline{LS}+R\,\overline{KS}+\sum_n \pi_n+ER\,\overline{B}+YG$
Household Final Consumption	$C_i=\beta_i\,\frac{YM}{PQ_i}$
Demand of Imports	$M_i=AQ_i^{\sigma_i-1}\left(\frac{PQ_i\delta_i}{PM_i}\right)^{\sigma_i}Q_i$
Demand of Domestically Produced Goods	$DD_i=AQ_i^{\sigma_i-1}\left(\frac{PQ_i\left(1-\delta_i\right)}{PD_i}\right)^{\sigma_i}Q_i$
Domestic Sales of Locally Produced Goods	$DS_i=AE_i^{-\omega_i-1}\left(\frac{PD_i}{PX_i\left(1-\gamma_i\right)}\right)^{\omega_i}X_i$
Export Sales	$EX_i=AE_i^{-\omega_i-1}\left(\frac{PE_i}{PX_i\gamma_i}\right)^{\omega_i}X_i$
Composite Consumption Price	$PQ_i=\frac{1}{AQ_i}\left[\delta_i^{\sigma_i}PM_i^{1-\sigma_i}+\left(1-\delta_i\right)^{\sigma_i}PD_i^{1-\sigma_i}\right]^{\frac{1}{1-\sigma_i}}$
Composite Production Price	$PX_i=\frac{1}{AE_i}\left[\gamma_i^{-\varpi_i}PE_i^{1+\varpi_i}+\left(1-\gamma_i\right)^{-\varpi_i}PD_i^{1+\varpi_i}\right]^{\frac{1}{1+\varpi_i}}$
Domestic Currency Price of Imports	$PM_i=\overline{PWM_i}\left(1+tm_i\right)ER$
Domestic Currency Price of Exports	$PE_i=\overline{PWE_i}\,ER$
Labor Market Clearing Condition	$\sum_i LD_i+\sum_i N_i\,\overline{lf_i}=\overline{LS}$
Capital Market Clearing Condition	$\sum_i KD_i+\sum_i N_i\,\overline{kf_i}=\overline{KS}$
Composite Consumption Demand	$Q_i=C_i+\sum_i CI_{ji}$
Trade Balance Constraint	$\sum_i \overline{PWM_i}\,M_i-\sum_i \overline{PWE_i}\,EX_i=\overline{B}$
Numéraire	$\sum_i \phi_i\,PD_i=1$

where $\phi_i=\frac{DD_i}{\sum_i DD_i}$ are the weights for the price index and $\sum \phi_i=1$.

List of Endogenous Variables

X_i	Sectoral composite production
PX_i	Sectoral composite production price
$LD_i\ KD_i$	Sectoral labor and capital demands
$TC_i FC_i\ MC_i\ AC_i$	Sectoral total costs, fixed costs, marginal and average costs
CDR_n	Cost disadvantage ratio; equal and fixed to zero in case of CRTS
ε_{dn}	Perceived elasticity of domestic demand in non-competitive industries
π_n	Pure profits; become exogenous and fixed to zero in case of free entry
N_i	Calibrated number of firms; held fixed in case of barriers to entry and exit
$DD_i\ DS_i$	Demand and supply of locally produced good

M_i EX_i	Import and export volumes
PD_i, PM_i, PE_i	Prices of locally produced goods, imports and exports
Q_i	Composite consumption good
PQ_i	Composite consumption good price
C_i	Household final consumption
CI_{ij}	Intermediate goods consumption by sector i for goods from sectors j
W, R	Labor and capital unit prices
YM, YG	Household and Government incomes
ER	Exchange rate

List of Parameters and Exogenous Variables

a_{ij}	Leontief input-output coefficients
$\overline{LS}$ $\overline{KS}$	Total labor and capital supplies
$\overline{kf_i}$, $\overline{lf_i}$	Fixed capital and labor per firm
$\overline{PWM_i}$ $\overline{PWE_i}$	Exogenous world prices of imports and exports
tm_i, tx_i	Tariff rate on imports and indirect production tax net of subsidies
$\overline{B}$	Net foreign capital inflow
$PINDEX$	Numéraire
CDR_p	Cost disadvantage ratio; equal and fixed to zero in case of CRTS
σ_i	Armington elasticity of substitution between imported and domestic goods
ω_i	Constant elasticity of transformation between exported and domestic goods
η_i	Elasticity of substitution between labor and capital
β_i	Constant expenditure share
α_i δ_i γ_i	Share parameters in the CES value added, Armington and constant elasticity of transformation aggregator
AX_i AQ_i AE_i	Shift parameters in the CES value added, Armington and constant elasticity of transformation aggregators

References

Brooke, A., D. Kendrick and A. Meeraus. 1992. GAMS: A User's Guide, Release 2.25, San Francisco: Scientific Press.

Brown, Drusilla K., Alan V. Deardorff and Robert M. Stern. 1997. "Some Economic Effects of the Free Trade Agreement Between Tunisia and the European Union" in Ahmed Galal and Bernard Hoekman (eds.), *Regional Partners in Global Markets: Limits and Possibilities of the Euro-Med Agreements*. London: Centre for Economic Policy Research.

Chatti, Rim. 1999. "Free Trade Agreement between Tunisia and the European Union: How Do Increasing Returns to Scale and Monopolistic Competition Matter?" Paper presented at the conference on The Dynamics of New Regionalism in MENA: Integration, Euro-Med Partnership Agreements and After. Cairo, 6-7 February.

Chemingui, Mohamed A. and Sébastien Dessus. 1999. "The Trade Liberalization of Tunisian Agriculture and the European Union: A Prospective Analysis." Paper presented at the workshop on The Dynamics of New Regionalism in MENA: Integration, Euro-Med Partnership Agreements and After. Cairo, 6-7 February.

Cox, David J. 1994. "Some Applied General Equilibrium Estimates of the Impact of a North American Free Trade Agreement on Canada" in Joseph F. Francois and Clinton R. Shiells (eds.), *Modeling Trade Policy: Applied General Equilibrium Assessments of North American Free Trade*. Cam. Univ. Press.

Decaluwé, Bernard and Mokhtar Souissi. 1996. *L'Accord de Libre-Echange Entre la Tunisie et l'Union Européenne : le Cas du Secteur Agricole, mimeo*. Quebec, Univeristé de Laval.

Devarajan, Shantanayan and Dani Rodrik. 1991. "Pro-competitive Effects of Trade Reform: Results From a CGE Model of Cameroon." *European Economic Review*, Vol. 35:1157-1184.

Dixit, Avinash K. 1988. "Optimal Trade and Industrial Policies for the US Automobile Industry" in Robert Feenstra (eds.), *Empirical Methods in International Trade*. Cambridge: MIT Press.

GATT. 1994. *Examination of Trade Policies*. Tunisia, Vol. I &II, Geneva.

Harris, Richard G. 1984. "Applied General Equilibrium Analysis of Small Open Economy with Scale Economies and Imperfect Competition." *American Economic Review* Vol. 74:1016-1033.

Melo, Jaime de and David Tarr. 1992. *A General Equilibrium Analysis of US Foreign Trade Policy*. Cambridge: The MIT Press.

Rodrik, Dani. 1988. "Imperfect Competition, Scale Economies, and Trade Policy in Developing Countries" in R.E. Baldwin (eds.), *Trade Policy Issues and Empirical Analysis*. Chicago: University of Chicago Press.

Roland-Holst, David W., Kenneth A. Reinert and Clinton R. Shiells. 1994. "A General Equilibrium Analysis of North American Economic Integration" in Joseph F. Francois and Clinton R. Shiells (eds.), *Modeling Trade Policy: Applied General Equilibrium Assessments of North American Free Trade*. Cam. Univ. Press.

Rutherford, Thomas F., Elisabet E. Rutstrom and David Tarr. 1995. *The Free Trade Agreement between Tunisia and the European Union.* Tunisian Ministry of International Cooperation and Foreign Investment. Unpublished Report.

World Bank. 1995. *Country Economic Memorandum, Republic of Tunisia Towards the 21st Century*. Volume I.

Figure 1: Sensitivity Analysis of Welfare Change to Elasticities of Substitution between Imported and Domestic Goods

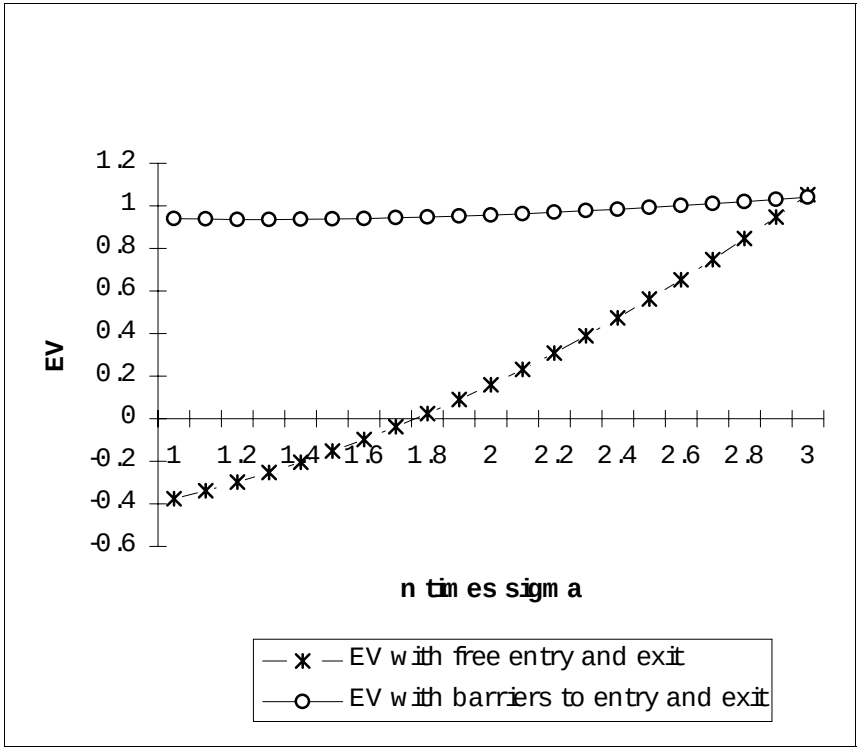

Table 1: Tunisian Sectoral Production & Trade Features in 1990 (%)

Sectors	$X_i/\Sigma X_i$ (1)	VA_i/GDP (2)	VA_i/X_i (3)	M_i/Q_i (4)	EX_i/X_i (5)	tm_i (6)	ERP_i (7)
1. Agriculture, Forestry & Fishing	12.1	17.0	79.2	8.3	3.7	13.6	12.3
2. Food Processing	8.4	3.0	20.3	16.3	9.6	25.9	83.5
3. Beverages &Tobacco	0.8	0.6	39.3	23.6	14.8	24.5	-117.0
4. Textiles, Apparel & Leather	9.0	3.8	24.2	66.3	68.8	6.1	2.7
5. Chemical Products	5.4	2.1	21.6	53.4	42.7	18.4	11.5
6. Rubber & Plastics	0.7	0.3	22.3	52.4	15.7	10.3	165.1
7. Cement & Quarrying Products	1.9	1.1	33.4	11.5	17.6	27.6	37.9
8. Glass & Ceramic Products	0.7	0.5	41.6	34.9	17.8	53.7	128.8
9. Non Ferrous Metals	1.2	0.6	29.2	64.9	18.1	10.0	422.1
10. Wood, Paper & Metals Products	4.1	2.2	30.2	40.1	8.9	8.2	1.3
11. Non Electrical Machinery	1.0	0.5	25.1	90.2	43.4	38.0	-2.8
12. Electrical Machinery	0.9	0.5	32.7	81.0	71.3	53.1	101.0
13. Transport Equipment	0.9	0.3	18.8	84.5	37.0	31.7	72.7
14. Miscellaneous Manufacture	0.5	0.1	12.8	62.2	45.8	6.2	-168.6
15. Non Manufactured Products	15.1	12.8	47.8	18.0	19.2	30.0	39.3
16. Services	37.5	54.7	82.2	8.8	21.5	0.0	-6.3

Note: Columns (1) and (2) give, respectively, the sector contribution to national production and national value added or GDP, while columns (3) and (4) indicate the share of imports in composite demand of each good and the share of exports in composite production of each good. Column (5) reports the contribution of primary factors to the production of each sector, and column (6) lists the nominal rate of protection for each sector. Finally, column (7) provides the effective rate of protection, where

$$ERP_i = (tm_i - \sum_j a_{ji}\ tm_j) / 1 - \sum_j a_{ji} .$$

Table 2: Parameters Used to Replicate Data

Sectors	σ_i	ϖ_i	η_i	CDR
1. Agriculture, Forestry and Fishing	2.250	3.786	0.680	0.000
2. Food Processing	1.007	0.752	0.710	0.120
3. Beverages and Tobacco	1.008	0.784	0.710	0.184
4. Textiles, Apparel and Leather	1.066	1.164	0.900	0.105
5. Chemical Products	0.702	0.367	0.960	0.059
6. Rubber and Plastics	0.763	0.276	0.960	0.061
7. Cement and Quarrying Products	1.200	1.100	0.900	0.120
8. Glass and Ceramic Products	1.200	1.100	0.900	0.200
9. Non Ferrous Metals	0.663	0.499	0.740	0.140
10. Wood, Paper and Metals Products	0.594	0.541	0.811	0.090
11. Non Electrical Machinery	0.694	0.379	0.740	0.090
12. Electrical Machinery	0.705	0.311	0.740	0.280
13. Transport Equipment	0.679	1.010	0.867	0.104
14. Miscellaneous Manufacture	0.463	0.411	0.740	0.059
15. Non Manufactured Products	1.200	1.100	0.900	0.000
16. Services	1.200	1.100	0.800	0.000

Note: σ_i is the elasticity of substitution between imported and domestic goods, ϖ_i is the elasticity of transformation between exported and domestic goods and η_i is the elasticity of substitution between variable primary factors of production. All elasticities are taken from Roland-Holst et al. (1994). CDR is the cost disadvantage ratio which represents the share of fixed costs in total costs or the extent of unrealized economies of scale. Its value for each sector is taken from Roland-Holst et al. (1994) and Cox (1994).

Figure 2: Sensitivity Analysis of Welfare Change to the CDR

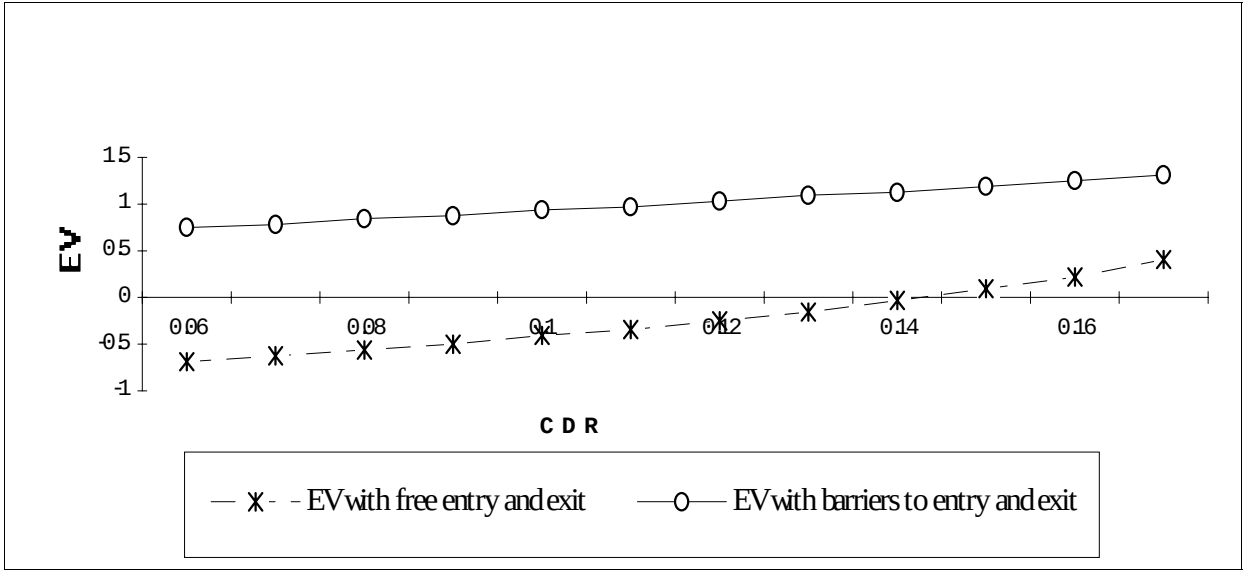

Table 3: Aggregate Results Under Alternative Market Structures ℓ%

	Perfect Competition & CRTS[b]	Cournot Oligopoly with IRTS[b]	
		Barriers to Entry & Exit	Free Entry & Exit
	(1)	(2)	(3)
Welfare change[a]	1.011	0.940	-0.376
Import change	24.863	9.452	13.175
Export change	28.883	9.996	14.718
Output change	6.897	1.353	1.781
-(manufactures)		(4.407)	(11.226)
Number of firms	0.000	0.000	27.938
Output per firm	-	4.407	-10.938
Pure profits	-	256.506[c]	0.000

Notes: [a] The welfare change is measured by the equivalent variation as a share of 1990 GDP. [b] CRTS and IRTS indicate, respectively, Constant Returns to Scale and Increasing Returns to Scale. [c] Since pure profits are assumed to be equal to zero in the benchmark year, they are expressed in millions of Tunisian Dinars.

Table 4: Sectoral Results Under Alternative Market Structures (%)

Sectors	CRTS and Perfect Competition				IRTS, Oligopoly and Entry-Exit				IRTS, Oligopoly and No Entry-Exit				
	Import (1)	Domestic (2)	Export (3)	Output (4)	Import (5)	Domestic (6)	Export (7)	Output (8)	Import (9)	Domestic (10)	Export (11)	Output (12)	Output per firm (13)
1. Agriculture, Forestry & Fishing	28.20	-5.61	-8.48	-5.71	13.13	-4.29	17.26	-3.47	15.68	-5.41	9.4	-4.86	--
2. Food Processing	19.36	-4.60	-4.02	-4.54	13.52	-3.14	2.32	-2.60	14.07	-4.65	-0.82	-4.27	-1.34
3. Beverages & Tobacco	16.62	-3.95	-1.93	-3.65	12.12	-1.83	5.13	-0.76	12.14	-3.83	1.34	-3.04	-0.9
4. Textiles, Apparel & Leather	57.08	70.18	93.97	90.38	8.67	9.12	17.43	14.90	25.18	30.44	46.16	41.41	-16.49
5. Chemical Products	15.56	15.71	23.19	19.06	4.45	0.61	4.95	2.52	6.4	3.48	8.5	5.70	-33.83
6. Rubber & Plastics	11.03	11.69	14.99	12.23	1.47	2.18	5.24	2.68	3.19	3.98	7.12	4.50	-10.25
7. Cement & Quarrying Products	21.01	-7.80	-6.02	-7.48	17.15	-1.78	9.30	0.25	16.5	-5.61	1.8	-4.27	-2.51
8. Glass & Ceramic Products	36.23	-14.77	-11.00	-14.08	30.91	-10.80	0.72	-8.65	30.72	-14.29	-6.57	-12.87	-7.17
9. Non Ferrous Metals	9.36	7.22	10.97	7.88	2.43	2.90	8.29	3.91	2.12	2.15	7.16	3.09	-1.39
10. Wood, Paper & Metals Products	5.56	2.64	4.39	2.79	0.34	0.47	4.97	0.89	0.55	-0.31	3.22	0.02	0.04
11. Non Electrical Machinery	25.51	33.86	56.65	44.93	17.94	9.02	17.99	13.15	18.61	13.47	25.13	18.91	-40.57
12. Electrical Machinery	35.67	47.78	75.19	68.72	17.94	-3.28	1.17	-0.04	19.64	2.12	8.71	6.95	-21.21
13. Transport Equipment	23.83	17.66	44.03	28.03	16.35	6.83	24.27	13.58	17.45	9.79	31.19	18.15	-21.72
14. Miscellaneous Manufacture	17.18	20.29	26.19	23.08	0.51	1.61	5.14	3.27	5.18	6.95	11.24	8.97	-27.30
15. Non Manufacture Products	28.56	-4.11	-2.22	-3.74	19.18	-1.40	10.55	0.99	20.71	-3.91	4.01	-2.34	--
16. Services	-1.31	-4.81	-7.92	-5.47	-9.55	-1.59	6.32	0.16	-7.91	-4.17	-0.61	-3.39	--

Table 5: Sensitivity Analysis of Welfare Change to the Elasticity of Substitution between Imported and Domestic Goods

n times σ_i	Welfare Change under Cournot Oligopoly and IRTS (%)	
	Barriers to Entry and Exit	Free Entry and Exit
1.1 σ_i	0.938	-0.338
1.2 σ_i	0.936	-0.297
1.3 σ_i	0.936	-0.252
1.4 σ_i	0.937	-0.204
1.5 σ_i	0.938	-0.152
1.6 σ_i	0.940	-0.097
1.7 σ_i	0.944	-0.038
1.8 σ_i	0.947	0.024
1.9 σ_i	0.952	0.090
2.0 σ_i	0.957	0.159
2.1 σ_i	0.963	0.232
2.2 σ_i	0.970	0.309
2.3 σ_i	0.977	0.390
2.4 σ_i	0.984	0.474
2.5 σ_i	0.993	0.562
2.6 σ_i	1.001	0.653
2.7 σ_i	1.010	0.748
2.8 σ_i	1.020	0.846
2.9 σ_i	1.030	0.948
3.0 σ_i	1.041	1.053

Table 6: Sensitivity Analysis of Welfare Change to a Uniform Cost Disadvantage Ratio (CDR)

Uniform CDR	Welfare Change under Cournot Oligopoly & IRTS (%)	
	Barriers to Entry and Exit	Free Entry and Exit
0.06	0.755	-0.702
0.07	0.795	-0.634
0.08	0.838	-0.565
0.09	0.882	-0.493
0.1	0.930	-0.417
0.11	0.977	-0.337
0.12	1.028	-0.248
0.13	1.083	-0.150
0.14	1.139	-0.040
0.15	1.198	0.084
0.16	1.260	0.226
0.17	1.325	0.391