

Key Assumptions in AGE Trade Models:

An Assessment using the *Mirage* Model

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This version: April 30, 2002 - Preliminary and incomplete

1 Introduction

AGE models are among the main tools for assessing trade policies, but the adequacy of a model and the relevance of the results it delivers are wholly dependant on the analytical framework and on the parameters chosen. Based on the newly-built model *Mirage* (Modeling International Relationships in Applied General Equilibrium, a model built by the Cepii, with the collaboration of the ITC, Geneva), this paper discusses the main aspects of these choices, and illustrates their consequences for trade policy assessment through various sensitivity analysis exercises, for scenarios designed on purpose. The aim is both to reach a better understanding of underlying mechanisms, and to provide a greater transparency to the analysis of trade policies through AGE models.

The simulations are carried out using the multinational model *Mirage*, calibrated with the GTAP5 database, except for protection, where the *MAcMaps* database (Market Access Maps developed by ITC and CEPII on the basis of UNCTAD-*TRAINS*, *AMAD*, UNSD-*COMTRADE* and WTO notifications) is used.

The topics discussed include:

- Product demand, with emphasis on the difference between quality ranges according to the country of origin;
- Imperfect competition and product differentiation, for which a new calibration procedure is proposed, in order to take more consistently advantage of the results of econometric studies, for a rather standard model of horizontal product differentiation under oligopolistic competition à la Cournot;
- Foreign direct investments, with an effort to reach theoretical consistency in the modeling of domestic and foreign investment, but also to obtain realistic orders of magnitude for the determinants of FDIs;

Each of these three topics is illustrated through simulations using alternative assumptions. The aim is to assess how relevant each aspect is for trade policy analysis, and how robust its modeling is. The structure of the paper is as follows. The standard model is presented in Section 2. Then the calibration procedure and specific application hypotheses are described (Section 3). In section 4, alternative specifications regarding the key assumptions identified above are used to assess the same shock, in order to evaluate the robustness of the results.

2 The model *Mirage*

A detailed presentation of the technical aspects of *Mirage* is available in Bchir et al. (2002) This Section proposes a presentation of the model *Mirage*. Deliberately, it is rather brief on several aspects, in order to focus on a few key assumptions, namely those dealing with products quality ranges, imperfect competition, FDI, and dynamic aspects.

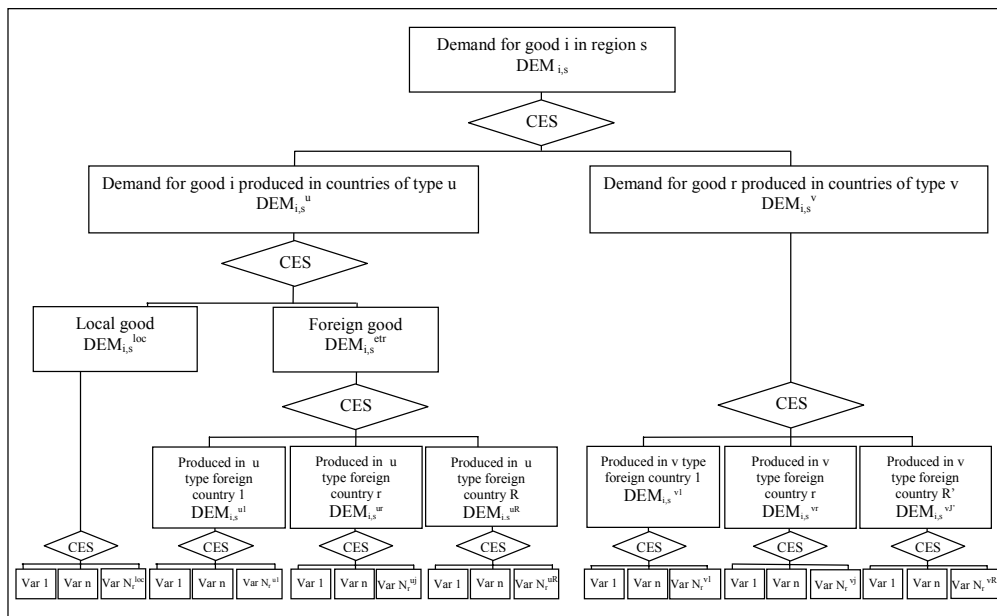
2.1 Demand

The demand side is modeled in each region through a representative agent, whose utility function is intratemporal, with a fixed share of the regional income allocated to savings, the rest used to purchase final consumptions. Below this first-tier Cobb-Douglas function, the preferences across sectors are represented by a nesting with a LES-CES function between sectors, in order to be able to account, without excessive complexity, for the evolution of the structure of demand with the region's income level. Each sectoral subutility function is a nesting of CES comparable to the standard nested Armington – Dixit-Stiglitz function, with two exceptions. Product differentiation according to geographical origin is indeed more complex than the mere Armington hypothesis. This is intended to reflect two facts:

- Products originating in developing countries and in developed countries do not belong to the same quality range. Their substitutability is therefore far weaker than can be the substitutability between products from the same quality range, that is for products from developed (developing) countries between each other;
- Domestic products benefit from a specific status for consumers, making them less substitutable to foreign products than foreign products between each other, within a given quality range.

Figure 1: The sectoral subutility function

Comment [SJ1]: rajouter un étage Cobb-douglas savings-consumption en haut.



The importance of vertical differentiation in international trade is now extensively illustrated, as is the link between per capita income or factor endowment and specialization by quality range (see for instance Abd-El-Rahman, 1991, Fontagné and Freudenberg, 1997, Greenaway and Torstensson, 1999). Incorporating this dimension in applied models can contribute

significantly to a better assessment of the causes and consequences of international trade. Although in a rudimentary way, the nesting used here is a first step in this direction.

Empirical evidence is lacking about the corresponding elasticity of substitution between quality ranges. This elasticity is chosen, in each sector, such that its difference to one is half the difference to one of the elasticity of substitution between domestic and foreign goods within the same quality range.¹ As is well known, simulation results are generally rather sensitive to the value of elasticities of substitution between goods. Assuming a low substitutability between quality ranges is thus likely to influence significantly the results. For instance, offering a low-income region a preferential access to a given market will exert, in this market, a direct competition effect on other low-income regions, while the competition effect will be far weaker for developed countries, since their products do not belong to the same quality range.

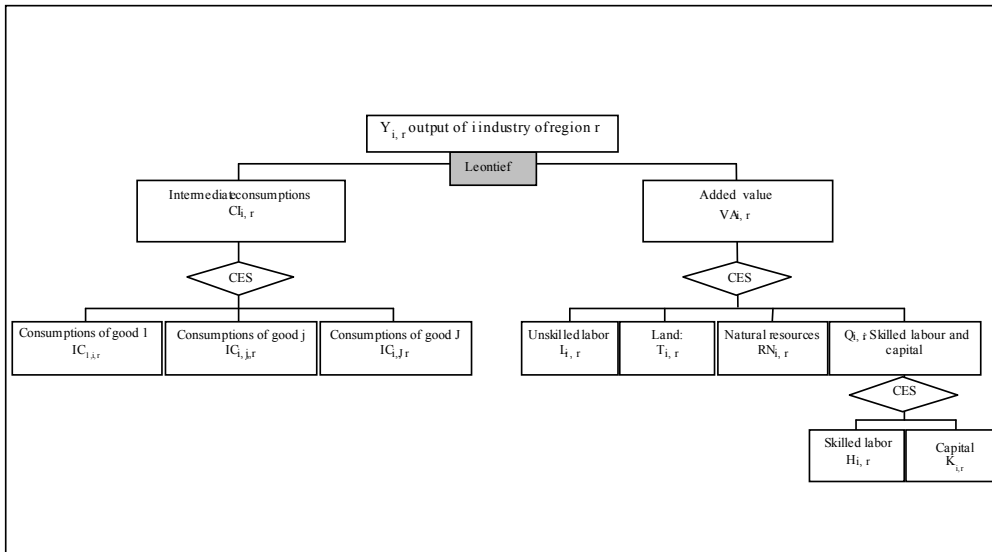
2.2 Supply

Production makes use of five factors: Capital, Labor (skilled and unskilled), Land and Natural Resources. The first three factors are generic factors, whereas the last two are specific ones.

The production function is described in Figure 3. In a standard fashion, perfect complementarity is assumed between value added and the intermediate consumptions. The sectoral composition of the intermediate consumptions aggregate stems from a CES function, with the same elasticity as in the corresponding CES-LES for final consumption. For each sector of origin, the nesting is exactly the same as for final consumption, meaning that the sector bundle has the same structure for final and intermediate consumption.

¹ That is, $(\sigma_{\text{quality}} - 1) = (\sigma_{\text{dom-foreign}} - 1) / 2$, where σ is the elasticity of substitution, between quality ranges for the subscript "quality", and between domestic and foreign goods within the same quality range, for the subscript "dom-foreign".

Figure 2: The production function



The structure of value added is intended to take into account the well-documented skill-capital relative complementarity. These two factors are thus bundled separately, with a lower elasticity of substitution (0.6), while a higher substitutability (elasticity 1.1) is assumed between this bundle and all other factors.²

The introduction of a specific and non-accumulated factor –Natural Resources– in some sectors like mining and agriculture is necessary to take into account the decreasing global productivity of the accumulated factors in those sectors.

The Global Transport sector (aggregate of the four transportation sectors described in GTAP 5) has a specific role: this sector covers both internal domestic transport activities, but also international transport services. As such, it includes the services that account for the difference between fob and cif values for a particular commodity shipped along a specific route. Global Transport services are provided via a Cobb-Douglas production function using as inputs services exports from each region (we do not have detailed information to link exports of transport services to specific routes for varying commodities). This sector is perfectly competitive and has a common price: the composite is employed in fixed proportions with the volume of a particular good shipped along a particular route. Those last technical coefficients are given in the calibration phase. The transport sector otherwise considered is treated as a normal sector for all other purposes (uses in intermediate, final and capital consumption).

² According to many studies (see Hamermesh, 1993, or Cahuc and Zylberberg, 1996 for extensive surveys), using a Cobb-Douglas function would not be unrealistic, but using a CES preserve the possibility for sensitivity analyses.

2.3 Competition

The importance of imperfect competition and economies of scale in assessing the consequences of trade liberalization episodes has been widely documented. Aside competitive, constant returns to scale sectors, rather well suited to describe agricultural sectors, in particular, the model also includes oligopolistic sectors. Perfectly competitive sectors face constant returns to scale (CRTS) in production.

In oligopolistic industries, firms face a constant marginal cost and a fixed cost, expressed in output units. Firms compete à la Cournot, with zero conjectural variations, no Ford effect, and no strategic interaction.³ This is rather standard in AGE models, since Smith and Venables (1988). The mark-up is then given by the Lerner formula:

$$\mu = \frac{P}{MC} = \frac{1}{1 - \frac{1}{EP}} \quad (1)$$

Where P is the price of the good, MC is the marginal cost and EP is the perceived price-elasticity of demand. Thus, the price-elasticity of demand is not the real one, nor the substitution elasticity between varieties (as it would be under the chamberlinian large group assumption). It is the elasticity perceived by the firm, which assumes here that her decision has no influence on other firms' decision, nor of the sector-level demand in value. This elasticity can be expressed as a function of the elasticities used in the sector subutility function, and of the market share of the sector's representative firm (see Annex for details).

As far as the dynamics of market structure is concerned, two kinds of oligopolistic sectors are considered, fragmented and segmented ones. This taxonomy (see Table 2.2) is based on the works of Sutton (1991), Schmalensee (1992) and Oliveira-Martins et al. (1996). The difference between these two sector classes lies in the number of firms evolving more slowly in segmented sectors than in fragmented ones. Practically this is done by assuming, for each new period, that profits are lowered by 20% in segmented sectors and by 50% in fragmented ones, compared to the level they would have reached, had the number of firms been constant.⁴ The zero-profit assumption is thus the long-term target, but the sticky entry-exit of firms makes the adjustment progressive, with longer delays in segmented sectors.

2.4 Capital and investment

Capital, whatever its provenance, domestic or foreign, in a given region, is assumed to be obtained by assembling intermediate inputs with the same nesting as in intermediate consumption. Only the share coefficients differ, and no factor service is needed. The capital good is the same whatever the use sector.

³ However, the same price is assumed to apply, within a given region, for use of a given good as final consumption, intermediate consumption or capital good.

⁴ This hypothetical level of profit is in fact assessed first through a separate simulation, assuming the number of domestic firms to be constant in each sector. However, even in this case, FDI may modify the number of firms.

Installed capital is considered to be totally immobile. This putty-clay hypothesis is very important, because it implies that the adjustment in the capital stock is gradual. As a consequence, capital stock allocation may be under-optimal, and capital reward may differ between sectors. In addition, the capital market clearing only concerns new capital.

This gives investment an important role, as the only adjustment device for capital stock. As soon as trade policies are concerned, investment is also important through its cross-border component, that is FDI. As is well known, a large part of trade policies consequences can stem from their impact on FDI. However, FDI determinants are seldom modeled in a way that is at the same time theoretically consistent and empirically realistic. Typically, for example, models relying on interest rates parity (including a risk premium) are satisfying theoretically, but they obtain unrealistically large capital movements.

The investment description in *Mirage* intends to propose a generic model for domestic and foreign investment, that is coherent with a rational behavior of investors. The basic principle is that the allocation on investment across sectors stems from sectoral capital rates of return.⁵

Each regional agent allocates the savings of the region among the possible investments. We assume that the production functions do not depend on the origin of the investor, and thus neither do the return rates. Since capital mobility is imperfect and investment is risky, the rates of return do not equalize instantly after a shock. Investment thus not only depends on the current capital stock in the sector, it is also assumed to depend on sectoral rates of return, with an elasticity α :

$$\frac{PK_s I_{irs}}{S_r} = \frac{A_{irs} PK_s K_{is} e^{\alpha w k_{is}}}{\sum_{i,s} A_{irs} PK_s K_{is} e^{\alpha w k_{is}}} \quad (2)$$

Equivalently it is possible to add an endogenous variable B_r and to re-write the problem as:

$$\begin{aligned} I_{irs} &= B_r A_{irs} PK_s K_{is} e^{\alpha w k_{is}} \\ \sum_{i,s} PK_s I_{irs} &= S_r \end{aligned} \quad (3)$$

B_r can also be written:

$$B_r = \frac{S_r}{\sum_{i,s} A_{irs} PK_s K_{is} PK_s I_{irs}} e^{-\alpha R_r} \quad (4)$$

Where R_r is the shadow price of capital (including the depreciation rate) which ensures the balance between credit supplies and demands.

Since α cannot be calibrated, two static models were built, corresponding to a short run and a long run version of *Mirage*. We applied the same shocks to both of them and chose α so that

⁵ For the time being, tariffs jumping issues are left aside, because this mechanism cannot be modelled consistently without relying on a model of the multinational firm (see for instance Markusen and Venables, JIE, 2000).

half the adjustment of capital stocks towards the long run would be made in around 4 years, for a variety of small commercial shocks. It gave the value $\alpha = 40$.

Two types of FDI are looked at. The first one corresponds to the purchase of foreign firms by investors, whereas the second one is the building of new firms (greenfield investment). Both have the same objective but their consequences regarding the short run dynamics of the model are not exactly the same: purchasing an existing firm has no effect on the number of varieties, contrarily to creating a new firm. Based on long-term statistics on FDI, two thirds of FDI were assumed to be an existing firm purchasing (increase in the capital stock of individual firms) and one third corresponds to the creation of new ones (increase in the number of firms).

It should be noted that foreign owned firms are treated as domestic firms in all respects. The only difference is that the capital revenue goes back to the source country. Under these hypotheses, FDI are not vectors of technology spillover. Nevertheless, the resulting evolutions in the number of firms present in a given market will have an impact on the efficiency of the sector (and of the economy through intermediate consumption and capital goods production).

2.5 Closure and markets clearing

Product markets clearing is obtained by equating, for each variety, output to the three kinds of uses, namely intermediate consumption, final consumption, and part of capital good.

The full employment of resources hypothesis is made. However, imperfect mobility of some production factors is assumed so as to better take into account the problems caused by massive reallocation effects.⁶ As outlined above, installed capital is immobile, and market clearing only concerns savings and investment. Natural resources are also perfectly immobile and may not be accumulated. The prices of those last two factors may thus differ among sectors of use. The two forms of Labor, as well as Land, are perfectly mobile among sectors⁷. Except capital, all factors are immobile internationally.

The macroeconomic closure is obtained by assuming that for capital movements other than FDIs (that could be called the purely financial component of capital movements, as opposed to the industrial motivation of FDIs), the net balance is exogenous (and equal to its initial value). As a result, the current balance of each area only depends on net FDI flows. And of course, the revenue of capital accrues to the source country's income.

2.6 Dynamic issues

Dynamic gains from trade have been the object of many debates. While there are many theoretical links between trade and growth⁸, few empirical studies reach conclusive results.

⁶ The program checks that the Walras' law is always respected.

⁷ The stickiness of some factor markets may strongly modify the impacts of liberalisation episodes. For tractability sake, we however decided to leave aside considerations of short-run unemployment and wages rigidities.

⁸ See Fontagné and Guérin (1997) for a survey of those links.

There are however some dynamic effects that can be taken into account by AGE models. Their study by Francois et alii (1995) in the Uruguay Round framework shows the importance of these effects: dynamic effects are larger in scope than static effects but may also be negative.

- Openness to trade can entail an evolution of the rental rate of capital, which can modify the savings rate, but also the neo-classical medium-run equilibrium towards which the economy converges (Baldwin 1989, 1992).

- Openness to trade and to foreign investment enables countries to benefit from technological externalities (see Baldwin and Forslid 1999, World Bank 2001); in the same way human capital formation incentives may be modified; finally, negative effects could appear in the poorest countries with the disappearance of the technological and innovative sectors following specialization according to comparative advantages. However, the endogenous growth framework used for these methods and the long run nature of the gains considered make this kind of effects very difficult not to treat in an ad-hoc manner.

- Finally, openness to trade does affect the degree of competition in the various markets. This idea is already present in monopolistic trade models, although in a comparative static framework, via the evolution of the number of firms. However, this link is not always monotonous.

An important difficulty in assessing the magnitude of these effects is that static and the dynamic gains interact continuously with each other. It is therefore necessary (even using Baldwin's method) to describe the adjustment speed of the economy, that is to define the relative speeds of realization of the static and the dynamic gains.

This is possible using *Mirage*, since the immobility of installed capital and the inertia in the adjustment of the number of firms allow a realistic description of the adjustment process to be proposed. As the dynamic setting is recursive, the time scope can be freely chosen⁹ (here, 12 years), and a shock can be introduced at each period. The reallocation of either totally or partially mobile factors is complete between each considered period. Factor endowment evolutions and training (the transformation of unskilled labor into skilled labor) between periods are given. Total factor productivity gains are not included in this version of the model: they can however easily be simulated given the structure of demand and production trees. *The continuous liberalization does impact the various sectoral rental rates of capital: this in turn does lead to an impact on investment (and FDI) allocation.* At the same time, the profit rate and the number of firms in imperfectly competitive sectors do also evolve toward the long run conditions under free entry of firms.

2.7 Data and calibration

To use *Mirage* in a particular setting, we first have to define specific hypotheses. Calibration will then give required information, which will be used in the resolution phase.

⁹ This may change the time spend in solving the model, but it has no impact on the feasibility.

2.7.1 Choice of regional and sectoral aggregation

For this study, five regions and eleven sectors are taken into account. The choice was made so as to enable to see asymmetric trade relations (for example the strong dependence of the European Periphery towards Europe). Details of the aggregates can be found in the annex.

Geographic aggregation is described in Table 2.1, which links countries available in GTAP5 to the regions studied, and also gives their group of development (North or South) and their economic weight.

Table 2.1 : Geographical aggregation

Region	<i>Mirage</i> Nomenclature	Level of development	Relative weight in world GDP in 1997
Europe	EUR	North	%
European Periphery	PER	South	%
Other Industrialised Countries	RPI	North	%
Developing Asia	AED	South	%
Other Developing Countries	AFA	South	%

Source: GTAP5 database.

Sectoral aggregation is described in Table 2.2, which links GTAP 5 sectors to our sectors. The choice was made according to their economic weight but also to their capital intensity. We keep eleven groups of sectors among which two primary, eight industrial and four services sectors. These sectors differ by the nature of competition prevailing (perfect or imperfect competition) and their speed of adjustment (segmented or fragmented adjustment). This classification is based on Sutton [1991] and Schmalensee [1992].

Table 2.2 : Sectoral classification

	<i>Mirage</i> Nomenclature	Type de concurrence	Type of adjustment
Agriculture	Food	Perfect competition	-
Primary products	Primary	Imperfect competition	fragmented
Industry	Clothes	Imperfect competition	fragmented
	Manuf	Imperfect competition	fragmented
	Chemical	Imperfect competition	segmented
	Vehic	Imperfect competition	segmented
	Equipment	Imperfect competition	fragmented
Services	EGE	Imperfect competition	segmented
	Houses	Imperfect competition	fragmented
	AutreSer	Imperfect competition	fragmented

Global Sector	TrT	Perfect competition	-
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The bilateral sectoral level protections rates are measured using the *MAcMaps* database. The sectoral bilateral flows of foreign direct investment are also measured for the given aggregation.

2.7.2 A new calibration procedure under imperfect competition

The calibration procedure is fairly standard, as far as the coefficients of utility and production functions are concerned. In *Mirage*, this is done in a static fashion for the benchmark equilibrium, on the basis of GTAP5 database. However, departing from the pure neoclassical framework raises less clear-cut issues for calibration.

As outlined above, horizontal product differentiation, economies of scale and imperfect competition are important devices for a model to describe accurately trade policies potential consequences. However, they need to be adequately parameterized. This requires choosing, for each sector, three parameters:

- The elasticity of substitution between goods. In fact, as soon as a nested sectoral subutility function is used, various such elasticities need to be chosen, at least the "Armington elasticity", describing substitutability between geographical origins, and the "Dixit-Stiglitz elasticity", for the substitutability between variety. In *Mirage*, two more elasticities are introduced: a lower elasticity of substitution between the two quality ranges (goods from a low-income and from a high-income area), and the substitutability between domestic and foreign goods is assumed to be inferior to that between different foreign origins among a given quality range. Nevertheless, these elasticities cannot be chosen independently one from another. Most of the time, only one degree of freedom is used for the choice of elasticities of substitution between goods for each sector. This means that, if there are various elasticities, choosing one of them is enough to set all the elasticities for the sector. This is in particular the case in *Mirage*, where a linear relationship is assumed between the various elasticities used for a given sector;
- The parameter characterizing economies of scale can be the scale elasticity, the cost-disadvantage ratio, or the unit fixed cost, depending on the form of the production or cost function. Under the zero-profit assumption, the mark-up ratio can be used as the primary information, as it is univocally linked to the cost-disadvantage ratio;
- Competition intensity has to be characterized through the degree of concentration (generally measured by an Herfindhal index), or by an equivalent number of symmetric firms. Note, however, that a given sector in the database can include various competition fields (that is the firms/products that are indeed directly in competition with each other), often named subsectors.

No information can be inferred directly from the data about the three corresponding sets of parameters, but the zero-profit assumption made in the benchmark provides a consistency constraint to be respected in their choice.

This has been used so far to calibrate one of these three sets of parameters. For instance, Smith, Venables and Gasiorok (1992) use scale elasticities and equivalent numbers of firms to calibrate elasticities of substitution. Mercenier (1992) uses elasticities of substitution and equivalent numbers of firms to calibrate the fixed costs. Cortes and Jean (1996) calibrate the equivalent number of firms, based on the values of elasticities of substitution and of mark-ups. Even though sectoral classifications do not overlap exactly, the results obtained are significantly different, even for similar sectors.

As illustrated by the diversity of methods used, some information is available on each of the three sets of parameters. Given their feeling about the relative reliability of the information on the corresponding parameters, the authors decide, for each sector, to use directly this information for two of them, in order to calibrate the third one. This approach is not fully consistent: The available information is only used for two out of three sets of parameters, and it is ignored for the third one. The consistency of the results is only assessed ex-post, through the credibility of the results obtained for the calibrated parameter. Moreover, there is no place for taking into account the information possibly available about the variance of the estimates used for the parameters.

Our approach here is to use all the available information, both on the level of the parameters and on the reliability (inverted variance) of the estimates, for the three sets of parameters. This information is interpreted in terms of estimates of the parameters and of variance of these estimates. For each sector, the values to be used in the model are then chosen so as to minimize the distance from these estimates, weighted by the inverted variance of the logarithm of estimates, subject to the consistency constraint given by the zero-profit assumption:

$$\begin{aligned} \{\sigma_i, CDR_i, n_i\} = \underset{\sigma_i, CDR_i, n_i}{ArgMax} & \left\{ \frac{1}{V(\ln \hat{\sigma}_i)} \left(\ln \left(\frac{\sigma_i}{\hat{\sigma}_i} \right) \right)^2 + \frac{1}{V(\ln \hat{CDR}_i)} \left(\ln \left(\frac{CDR_i}{\hat{CDR}_i} \right) \right)^2 + \frac{1}{V(\ln \hat{n}_i)} \left(\ln \left(\frac{n_i}{\hat{n}_i} \right) \right)^2 \right\} \\ s.t. & \begin{cases} \sigma_i > 1, CDR_i > 0, n_i > 1 \\ \pi_i(\sigma_i, CDR_i, n_i) = 0 \end{cases} \end{aligned} \quad (5)$$

Where, for sector i , σ is the Armington elasticity of substitution, CDR is the cost-disadvantage ratio, and n refers to the number of (symmetric) firms. A hat denotes an estimate, and V refers to the variance. The constraint is the zero-profit condition which, given the benchmark database (and the relationships set between the various types of elasticities within each sector), depends only these three parameters, according to the model.

Note that this general procedure includes those used previously: Calibrating one out of the three parameters is equivalent to setting an infinite variance for the estimate of the calibrated parameter in (5).

The initial and calibrated values of elasticities, mark-up ratios and equivalent number of firms for base year are presented in Annex. Data sources are the following:

Comment [SJ2]: comment : uneven adjustment across variables,

(i) *Elasticities of substitution*: The sectoral subutility function used in Mirage is a nesting of four constant elasticity of substitution (CES) functions. In this study, Armington elasticities

are drawn from GTAP5 database,¹⁰ and are assumed to be the same across regions. The other elasticities used in the nesting for a given sector are linked to the Armington elasticity by a simple rule: The distance to unity ($\sigma-1$) is divided by two when moving upward in the nesting and is multiplied by two when moving downward. Finally, the elasticity of substitution in the LES-CES function is fixed at 0.6.

(ii) *Mark-up ratios*: As outlined above, the cost-disadvantage ratio can be found directly from the mark-up ratio, using the zero-profit condition. Mark-up ratios are therefore taken as the source data here, because an extensive literature has led to robust and precise estimates. The values chosen are based on estimates by Oliveira-Martins and Scarpetta (1999) for industrial sectors, and by Oliveira-Martins, Pilat and Scarpetta (1996) for services sectors, using Werner's (1995) method in each case. Given the geographical aggregation used here, the European values are used for high-income areas, and the difference between the mark-up ratio and unity is multiplied by 1.5 for low-income countries.

(iii) *Concentration*: At first glance, concentration, or the number of firms, may seem to be the easiest parameter to assess among the three necessary here, since industrial statistics by size categories are available. Assuming that firms are symmetric within each category (except for the upper one, where for instance a Pareto distribution can be postulated, as in Gasiorek, Smith and Venables, 1992) is a priori likely to provide a rather good estimate of the Herfindhal index for the sector. But the real problem is elsewhere: A sector is not necessarily a competition field. Generally speaking, the sectoral breakdown used in CGE models implies obviously that firms are not all direct competitors to each other within a sector. A sector thus includes various competition fields, but it is very difficult to evaluate how many. As a consequence, sectors are generally divided in subsectors on a rather ad-hoc basis. This is indeed what is done here, by assuming that a competition field has the same size whatever the sector. The estimates by Davies and Lyons (1996) was thus used as a first estimate for the number of firms by sector in Europe. The number of subsectors within each sector was then assessed in order to average 5, and to be proportional to the value of output in the EU. The equivalent number of firms (which only matters in the model as the inverse of firms' average market share) is then computed as the first ("gross") estimate of the number of firm, divided by the number of subsectors.¹¹ The number of firms in other areas is then assumed to be the same than in Europe.

The log-variance of estimates should ideally be drawn directly from an econometric study. However, this information is not always available. Here, the values used (superior for the number of firms than for the two other parameters) reflect mainly the idea that the numbers of firms have the most uncertain estimates, due to the difficulty in assessing the number of subsectors.

¹⁰ The only exception is the textile and clothings sector. As North-South trade is dominant in this sector, the GTAP5 Armington elasticity was assumed to reflect the substitutability between quality ranges, rather than between countries within a quality range.

¹¹ This is very similar, for example to the procedure used by Smith and Venables (1988), but the way it is done here does not make it necessary to model explicitly subsectors: The average firm size in a sector in "artificially" multiplied by the number of subsector, but this does not modify the results.

3 Scenarios definition and results

The aim of the paper is to underline the resulting impacts of the major hypotheses done when defining the structure of MIRAGE.

Each hypothesis of course has an impact on the results; there are however some major points which need to be closely looked at, and among which the importance of some has already been stressed by the literature (see for example Francois et al. 1995).

To better understand those points, the same liberalization shock was simulated under those major alternative frameworks:

- Standard *Mirage model*;
- *Mirage*, assuming perfect competition in all sectors;
- *Mirage*, without any Foreign Direct Investment
- *Mirage*, dropping the assumption of lesser substitutability between quality ranges.

3.1 Liberalization hypotheses

The liberalization scenario studied is the lowering of barriers to trade between Europe and its periphery. This choice was made as EUR and PER are regions belonging to different zones but also with strong trade and investment linkages. It was therefore hoped that such a liberalization scenario would entail strong trade diversion effects, real exchange rate evolution impacts and big reallocation effects in the periphery zone, thus highlighting dynamic effects.

The formula used to describe the liberalization process is pretty straightforward: barriers to trade are linearly lowered to zero over the first four years of the study. The following years are looked at so as to study the spread over time of reallocation effects.

The following table gives the initial levels of protection between the two partners as computed by the MAcMaps database (ad-valorem tariffs equivalents levels are in %):

Table 3.1: Initial level of protection between the EU and its periphery

	Barriers of EUR to PER products	Barriers of PER to EUR products
Food	12.7%	21.4%
Primary	1.5%	4.3%
Chemical	3.3%	5.0%
Clothes	9.6%	8.0%
Equipment	2.7%	4.3%
Manuf	3.4%	7.4%
Vehicles	2.9%	17.0%

Source: MAcMaps database.

3.2 Results

The liberalization process between Europe and its periphery (PER) affects both parties, as well as their partners.

The direct impact of a liberalization agreement is on bilateral trade flows. As expected, the simulation shows a noticeable increase of European exports to its periphery (19%) and a noticeable increase of European periphery's exports to Europe (18.4%). The quasi symmetry of results is essentially due to the symmetry of the agreement (total liberalization of the two markets in four years).

The improvement of market access for both regions exerts a pressure on the demand faced by producers from the EU and its periphery. Under the stability of current account hypothesis (excepted FDI), this pressure implies a real appreciation for both regions, as witnessed by average production price index changes. As a result, the exports of these two regions to third areas decrease. On the imports side, these real exchange rate effects add up to standard trade diversion effects: Imports from directly competing regions (i.e. RPI for EUR and AED/AFA for PER) are adversely affected.

At a sectoral level, the total liberalization of the food sector, which includes agriculture and agro-food sectors, implies the strengthening of trade links in both directions (Europe to periphery and periphery to Europe). Simulations indicate that the increase of European food exports to periphery reaches 48% and 47% for periphery to Europe exports. This phenomenon is due to the relatively important level of trade barrier applied initially by the two regions (13% imposed by Europe and 21% by its periphery). A strong increase in European exports is registered in the vehicle sector, reaching 47%. This is also due to the important initial barrier level. For European periphery, the clothes sector registers the most important increase despite the weak initial level of protection. This is due to the high level of the substitution elasticity used in *Mirage* for this sector (see Table ...).

The spread over time of re-allocation effects is well illustrated by the evolutions of the Clothes sectors. One year after the end of the liberalization process, exports from Per to EUR are already increased by 58%. Ten years later, the adjustment of capital stock and the evolution in the number of firms make this increase reach 68%.

Service sectors register insignificant loss or gain. This is due to the very low or null level of protection imposed initially to these sectors. That is why they do not gain additional competitiveness from the agreement, and in addition they suffer from the real appreciation that creates additional difficulty to compete with third regions.

The evolution of macro-economic variables is very moderate because of the limited volume of the commercial flows (and for the EU, because of the weak relative size of PER). The EU wins from this agreement, both in terms of welfare and of GDP. For PER, results are dissimilar: Despite nominal gains for all variables, they suffer a slight decrease in utility.

4 Sensitivity to key assumptions

A few key assumptions have been identified above in the structure of *Mirage*. In order to illustrate their possible consequences, the same shock as previously is now simulated, dropping alternatively each of these key assumptions, namely the lesser substitutability

between quality ranges, imperfect competition and non-constant returns to scale, and FDI. In each case, the results are compared to those obtained with the standard version of *Mirage*.

4.1.1 *Quality ranges*

At a macro-economic level there is no great difference between results obtained with the standard version of *Mirage* and those obtained when not taking into account the lesser substitutability between quality ranges. Nevertheless there is some noticeable difference in the structure of bilateral trade (table 3.2 and 3.3).

The most important effects induced by the "quality-range assumption" lie in the structure of trade flows changes. Three effects can explain the evolution of imports in a given market. A revenue or market-size effect, a real exchange rate effect and a competition effect. The first effect has a low impact and is not strongly differentiated geographically between providers. The last two effects shape the relative evolution of imports across providers, and the last one is very sensitive to assuming a lesser substitutability between quality ranges. In the standard version of *Mirage*, the European market share gain in PER (an increase of 18% of European exports to its periphery) is largely obtained at the expense of other industrialized countries (RPI region which is the unique developed region other than Europe in the adopted aggregation) that lose 14% of its exports to PER. This differs from simulation results when quality differences are not taken into account. In this case, the loss is more uniformly distributed (-1.5% for AED, -0.1% for AFA and -0.3% for RPI), while export creation is higher for Europe (+24%).

This difference is due to the fact that quality differentiation modifies competition intensity. Europe and RPI are the only two competitors in high quality market. In that context, the higher exports of European producers to PER market is essentially gained at the expense of RPI producers. Without any quality effect, all regions compete in the same market and the European exports increase damages all third regions' sales. That is why the increase of European exports is more important and trade diversion affects all regions.

The same mechanisms are observed on the European market: Trade diversion is essentially suffered by less developed regions (AED who loses 4.8% of its exports to Europe and AFA, 2.7%). At the same time, RPI exports to Europe increase by 0.9% due to the pro-competitive effect induced by the real appreciation of the European exchange rate. Without quality effects, the gain of PER is more important (increase of 24.4% of its exports to Europe) and the loss is suffered by all regions (even RPI loses 0.23% of its exports).

4.1.2 *The effect of taking into account imperfect competition.*

Results with and without imperfect competition are rather similar for Europe: the differences do not exceed 10% (Table 3.5). This is due to the differences in sizes between the two partners. This is however not the case for the smaller PER southern zone, where competitive effects lead to the disappearance of the losses resulting from the agreement. The most important differences lie however with sectoral level results: exports from PER to EUR are for some sectors strongly affected.

The mechanisms induced by imperfect competition can be described as follows. Since the number of varieties is rather large except in sectors unaffected by the trade agreement in our simulations, changes of markup rates remain small. The perceived elasticity of demand is very

close to the elasticity of substitution among varieties, which does not change after a shock. Since profits tend to come back to zero in the long run, the size of each variety also come back to its original value.

As a consequence an increase in the size of the global market—local + foreign—means an increase of the number of varieties. Therefore sectors that produce more (less) after the agreement are even more (less) favored when imperfect competition is taken into account. These sectors are those for which exports is a great part of production and the agreement means a significant change of protection levels.

They are mainly clothes and vehicles in the periphery. Clothes production would be favored by an agreement with Europe whereas vehicle production would be reduced because of the rise of imports from Europe. After 12 years the number of varieties in the clothes sector would rise by 16% compared to the reference path in the imperfect competition model. On the contrary the number of varieties would decline by 5% in the vehicle sector. As a consequence clothes exports from the periphery rise by 72% after 12 years instead of 60% with the perfect competition hypothesis, and vehicle exports rise by only 14% instead of 21%.

4.1.3 *The effect of taking into accounts FDI*

The description of FDI is one of the main specificities of the model. However, dropping it does not seem to lead to important variations in the aggregate results. There are several reasons for that. First of all, the PER region is not an important destination for European FDI; secondly, at this stage of the modeling, there are no technical externalities linked to FDI; third, some specific capital-related variables are nevertheless affected. For example, the increase in the real reward to capital in the EUR zone more than doubles (from 0.6% to 1.3%) when FDI is not considered (see Table 3.4).

5 Conclusion

Applied general equilibrium models are the most useful tools for studying impacts of trade negotiations episodes. The literature has made great progress over the last decade, especially in the field of modeling imperfect competition. Computing process capacities increase have enabled the taking into account of “new issues”. The aim of the article was to study the relative importance of some key hypotheses made when developing *Mirage*. This model was designed with the special attention devoted to the three following points: dynamic evolutions, quality differentiation and Foreign Direct Investment.

The modeling of the dynamic process enables to study the interaction between factors re-allocation and accumulation, market structures evolutions and trade negotiations implementation. Combined with the use of the *MAcMaps* database, this specification gives great latitude to analyze in detail the impacts of various and realistic liberalization schemes (differing by delays and spreads over time of implementation). It also gives an idea of the magnitude of the re-allocative shocks.

Differentiation at the level of the product’s quality was introduced as North/South products substitutability was felt to be inadequately modeled under standard Armington specifications.

This specificity of MIRAGE is still under development with the aim of better taking into account technical barriers to trade and quality standards.

The inclusion of Foreign Direct Investment in the model was shown to be non negligible and constitutes a promising research path towards a better modeling of the multinational firm. The growing perplexity towards trade liberalization benefits underlines the need for an increased understanding of the mechanisms at work. In this perspective, the specific impacts of FDI and more broadly of multinational firms need to be further investigated.

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ANNEX 1: Parameters and calibration

Table A1.1 : Elasticities and mark-ups per sector

Sectors	Food	Primary	Clothes	Manuf	Chemical	Vehict	Equipment	EGE	Houses	AutreSer	TrT
Armington Elasticities	2.3	4.54	4.06	3.27	4.09	3.95	4.19	4.55	4.35	4.45	1.9

Source: See text.

Table A1.2 Equivalent number of firms per sector

	Europe	European Periphery	Other Industrialised Countries	Developing Asia	Other Developing Countries
Primary	27.44	7.40	23.41	11.15	6.09
Clothes	433.68	195.43	485.57	123.84	317.48
Manuf	106.90	109.25	152.34	87.97	127.08
Chemical	51.74	48.54	55.90	45.57	51.80
Vehic	28.95	46.73	27.89	40.59	62.11
Equipment	11.49	17.70	10.50	11.32	27.88
EGE	22.06	8.74	15.11	16.81	12.60
Houses	3.92	4.23	2.93	3.78	3.91
AutreSer	26.15	42.75	28.37	57.63	40.42

Source: See text

Table A1.3 : Mark-ups

Sector	Producer	Market				
		RPI	EUR	AED	PER	AFA
Clothes	RPI	1.085	1.082	1.083	1.082	1.082
	EUR	1.082	1.085	1.082	1.083	1.083
	AED	1.087	1.085	1.096	1.084	1.085
	PER	1.082	1.083	1.082	1.090	1.082
	AFA	1.082	1.082	1.082	1.082	1.086
Primary	RPI	1.157	1.083	1.090	1.077	1.082
	EUR	1.082	1.153	1.079	1.089	1.086
	AED	1.088	1.080	1.189	1.077	1.079

	PER	1.079	1.098	1.080	1.224	1.087
	AFA	1.111	1.106	1.098	1.093	1.293
Manuf	RPI	1.132	1.113	1.115	1.112	1.113
	EUR	1.116	1.146	1.115	1.122	1.122
	AED	1.121	1.117	1.155	1.115	1.117
	PER	1.112	1.114	1.112	1.142	1.113
	AFA	1.112	1.112	1.113	1.112	1.131
Vehic	RPI	1.285	1.119	1.141	1.115	1.150
	EUR	1.114	1.289	1.112	1.161	1.139
	AED	1.117	1.101	1.248	1.100	1.104
	PER	1.095	1.114	1.101	1.242	1.098
	AFA	1.097	1.098	1.098	1.099	1.211
Chemical	RPI	1.130	1.088	1.093	1.084	1.087
	EUR	1.088	1.133	1.086	1.098	1.095
	AED	1.090	1.087	1.133	1.085	1.087
	PER	1.084	1.089	1.085	1.132	1.085
	AFA	1.086	1.085	1.086	1.086	1.130
Equipment	RPI	1.319	1.132	1.172	1.110	1.141
	EUR	1.118	1.324	1.117	1.198	1.180
	AED	1.150	1.127	1.319	1.107	1.119
	PER	1.090	1.105	1.097	1.276	1.095
	AFA	1.091	1.094	1.098	1.095	1.237
Houses	RPI	1.199	1.087	1.086	1.086	1.089
	EUR	1.086	1.199	1.090	1.090	1.087
	AED	1.082	1.082	1.199	1.083	1.084
	PER	1.089	1.092	1.084	1.200	1.082
	AFA	1.083	1.081	1.081	1.082	1.199
EGE	RPI	1.435	1.098	1.087	1.088	1.000
	EUR	1.098	1.439	1.119	1.119	1.119
	AED	1.097	1.092	1.438	1.094	1.088
	PER	1.099	1.107	1.093	1.442	1.092
	AFA	1.088	1.087	1.086	1.086	1.440

AutreSer	RPI	1.468	1.107	1.110	1.112	1.124
	EUR	1.105	1.472	1.114	1.115	1.111
	AED	1.105	1.106	1.474	1.098	1.100
	PER	1.099	1.101	1.095	1.482	1.092
	AFA	1.098	1.095	1.095	1.091	1.476

Source: See text

For the production function, the elasticity between factors at the first level of value added is set at 0.6. The elasticity of substitution between human and physical capital is set at 1.1. The part of incompressible consumption in total consumption is fixed at 1/3 for developed countries and 2/3 for developing countries.

The rate of depreciation of capital is set equal to 4%. Dynamic evolution rules (factor accumulation, speed of adjustment and of evolution of profits) are specified at this stage. We do not consider technical progress. The demographic growth rate is null in the North and equal to 1.5% in the South. The shares of skilled and unskilled workers in the labor force are assumed to be invariant over time.

Table 3.2: Results using the standard version of *Mirage*

Macroeconomic variables

	EU				EU periphery			
	t+1	t+3	t+7	t+12	t+1	t+3	t+7	t+12
Welfare	0.1%	0.2%	0.2%	0.2%	0.0%	-0.2%	-0.2%	-0.1%
GDP (volume)	0.0%	0.1%	0.2%	0.2%	0.2%	0.5%	0.8%	0.8%
Dual price index of utility					-0.2%	-0.7%	-0.8%	-0.7%
Unskilled real wages	0.1%	0.2%	0.2%	0.3%	0.3%	1.0%	1.5%	1.5%
Skilled real wages	0.0%	0.1%	0.2%	0.2%	0.2%	0.7%	0.8%	0.8%
Capital real reward	0.0%	0.1%	0.1%	0.1%	0.3%	1.0%	1.3%	1.3%
Natural resources real reward	0.0%	0.1%	0.2%	0.3%	0.4%	1.0%	1.1%	1.1%
Land real reward	0.2%	0.7%	0.9%	0.9%	0.1%	0.4%	0.7%	0.7%
Exports	0.4%	1.4%	2.2%	2.4%	2.2%	7.3%	10.6%	10.8%
Imports	0.5%	1.7%	2.3%	2.3%	1.8%	6.1%	9.0%	9.2%
Tariff revenue	-3.1%	-10.7%	-15.4%	-15.3%	-11.1%	-37.3%	-52.2%	-51.3%
Tax revenue	-0.2%	-0.6%	-0.8%	-0.8%	-3.0%	-10.1%	-14.0%	-13.6%

Bilateral external trade, for the whole economy

	EU					EU periphery				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Exports to:										
Developing Asia	18.38	-0.7%	-2.1%	-2.7%	-2.6%	2.30	-0.7%	-2.2%	-3.4%	-3.5%
Other Developing Countries	13.82	-0.5%	-1.5%	-1.9%	-1.8%	1.78	-0.6%	-1.8%	-2.4%	-2.3%
Europe						17.74	3.7%	12.2%	17.9%	18.4%
European Periphery	20.69	3.9%	12.8%	18.5%	19.0%					
Other Industrialised Countries	50.73	-0.4%	-1.2%	-1.5%	-1.5%	5.62	-0.6%	-1.7%	-2.4%	-2.4%

	EU					EU periphery				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Imports from:										
Developing Asia	19.49	-0.9%	-3.1%	-4.7%	-4.8%	2.48	-0.0%	-0.3%	-0.8%	-1.0%
Other Developing Countries	10.31	-0.7%	-2.1%	-2.8%	-2.7%	1.38	-0.2%	-0.6%	-0.3%	-0.1%
Europe						20.69	3.9%	12.8%	18.5%	19.0%
European Periphery	17.74	3.7%	12.2%	17.9%	18.4%					
Other Industrialised Countries	48.92	0.2%	0.7%	1.0%	0.9%	6.37	-3.8%	-11.0%	-14.3%	-14.4%

Production price index

	t+1	t+3	t+7	t+12
Developing Asia	-0.23%	-0.64%	-0.77%	-0.71%
Other Developing Countries	-0.18%	-0.53%	-0.64%	-0.60%
Europe	0.02%	0.05%	0.07%	0.07%
European Periphery	-0.11%	-0.27%	-0.19%	-0.12%
Other Industrialised Countries	-0.10%	-0.31%	-0.40%	-0.38%

Bilateral trade, by sectors

	Trade From EU to periphery					Trade from periphery to EU				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Food	1.83	9.4%	32.3%	47.2%	47.8%	0.88	10.1%	34.2%	47.4%	46.9%
Clothes	1.61	5.8%	18.6%	25.2%	24.9%	2.25	10.0%	36.6%	64.8%	72.1%
Primary	0.80	3.6%	11.1%	15.4%	15.9%	3.92	1.4%	4.2%	5.4%	5.2%
Manuf	1.46	3.6%	11.4%	15.9%	16.2%	1.36	3.6%	11.3%	15.0%	14.8%
Vehic	1.67	9.3%	31.0%	45.7%	46.6%	0.70	4.6%	13.3%	14.1%	14.2%
Chemical	3.20	2.8%	8.8%	12.6%	13.1%	1.71	4.0%	12.5%	16.5%	16.4%
Equipment	5.01	2.1%	6.4%	9.1%	9.5%	1.58	3.8%	11.5%	15.0%	15.0%
Houses	0.15	-0.8%	-2.0%	-1.7%	-1.4%	0.20	0.3%	0.6%	-0.3%	-0.7%
TrT	0.75	0.1%	0.4%	0.9%	1.1%	1.40	0.0%	-0.1%	-0.7%	-0.9%
EGE	0.12	0.3%	1.0%	2.0%	2.3%	0.15	0.1%	0.1%	-1.0%	-1.3%
AutreSer	1.34	0.2%	0.7%	1.5%	1.8%	1.24	-0.1%	-0.6%	-2.2%	-2.5%

source: authors calculation, using *Mirage*

Table 3.3: Results when not taking into account the lesser substitutability between quality ranges

Macroeconomic variables

	UE				PER			
	t+1	t+3	t+7	t+12	t+1	t+3	t+7	t+12
Welfare	0.1%	0.2%	0.2%	0.3%	0.0%	-0.2%	-0.3%	-0.2%
GDP (volume)	0.0%	0.1%	0.2%	0.2%	0.2%	0.5%	0.8%	0.8%
Dual price index of utility					-0.3%	-0.9%	-1.1%	-1.0%
Unskilled real wages	0.1%	0.2%	0.3%	0.3%	0.3%	1.0%	1.4%	1.3%
Skilled real wages	0.0%	0.1%	0.2%	0.3%	0.3%	0.8%	0.9%	0.8%
Capital real reward	0.0%	0.1%	0.1%	0.1%	0.3%	1.0%	1.4%	1.4%
Natural resources real reward	0.0%	0.1%	0.2%	0.3%	0.4%	1.3%	1.6%	1.4%
Land real reward	0.3%	0.9%	1.2%	1.3%	-0.1%	-0.3%	-0.4%	-0.5%
Exports	0.6%	2.1%	3.4%	3.6%	3.0%	10.2%	15.0%	15.2%
Imports	0.7%	2.5%	3.5%	3.5%	2.5%	8.6%	12.7%	13.0%
Tariff revenue	-2.9%	-10.4%	-15.5%	-15.6%	-10.7%	-37.3%	-53.3%	-52.2%
Tax revenue	-0.2%	-0.6%	-0.8%	-0.9%	-2.9%	-10.2%	-14.4%	-14.0%

Bilateral external trade, for the whole economy

	EU					EU periphery				
	Niveau initial	t+1	t+3	t+7	t+12	Niveau initial	t+1	t+3	t+7	t+12
Exports to:										
Developing Asia	18.38	-0.6%	-2.0%	-2.7%	-2.7%	2.30	-0.1%	-0.5%	-1.3%	-1.5%
Other Developing Countries	13.82	-0.5%	-1.6%	-2.1%	-2.1%	1.78	-0.1%	-0.1%	-0.1%	-0.1%
Europe						17.74	4.8%	16.1%	23.7%	24.4%
European Periphery	20.69	5.3%	17.4%	25.5%	26.4%					
Other Industrialised Countries	50.73	-0.5%	-1.7%	-2.3%	-2.2%	5.62	-0.1%	-0.3%	-0.3%	-0.3%
Imports from:										
Developing Asia	19.49	-0.4%	-1.5%	-2.6%	-2.9%	2.48	-2.9%	-9.0%	-12.5%	-12.7%
Other Developing Countries	10.31	-0.3%	-0.9%	-1.3%	-1.3%	1.38	-2.5%	-7.7%	-10.0%	-9.8%
Europe						20.69	5.3%	17.4%	25.5%	26.4%
European Periphery	17.74	4.8%	16.1%	23.7%	24.4%					
Other Industrialised Countries	48.92	-0.0%	-0.1%	-0.1%	-0.2%	6.37	-2.9%	-8.6%	-11.1%	-10.9%

Bilateral trade, by sectors

	Trade From EU to periphery					Trade from periphery to EU				
	Niveau initial	t+1	t+3	t+7	t+12	Niveau initial	t+1	t+3	t+7	t+12
Food	1.83	12.2%	42.6%	62.9%	63.2%	0.88	11.4%	39.4%	55.0%	54.4%
Clothes	1.61	9.4%	30.8%	41.2%	40.6%	2.25	11.8%	43.9%	78.6%	86.9%
Primary	0.80	6.0%	18.6%	25.1%	25.2%	3.92	1.8%	5.9%	8.5%	8.5%
Manuf	1.46	5.3%	16.8%	23.6%	24.2%	1.36	4.7%	14.8%	19.5%	18.9%
Vehic	1.67	10.9%	37.5%	58.5%	61.5%	0.70	7.8%	21.7%	18.3%	17.0%
Chemical	3.20	4.1%	13.1%	18.6%	19.3%	1.71	5.8%	18.5%	24.7%	24.3%
Equipment	5.01	2.5%	7.7%	10.9%	11.6%	1.58	5.1%	15.9%	20.5%	19.9%
Houses	0.15	-1.1%	-3.2%	-3.0%	-2.5%	0.20	1.0%	2.7%	1.7%	1.0%
TrT	0.75	0.1%	0.2%	0.5%	0.7%	1.40	0.3%	0.8%	0.6%	0.3%
EGE	0.12	0.4%	1.2%	2.1%	2.6%	0.15	0.6%	1.7%	1.3%	1.0%
AutreSer	1.34	0.2%	0.5%	1.2%	1.5%	1.24	0.5%	1.5%	0.9%	0.4%

Table 3.4: Results when not taking into account FDI

Macroeconomic variables

	EU				EU periphery			
	t+1	t+3	t+7	t+12	t+1	t+3	t+7	t+12
Welfare	0.1%	0.1%	0.2%	0.2%	0.0%	-0.1%	-0.2%	-0.1%
GDP (volume)	0.0%	0.1%	0.1%	0.2%	0.2%	0.5%	0.8%	0.8%
Dual price index of utility					-0.2%	-0.7%	-0.8%	-0.7%
Unskilled real wages	0.1%	0.2%	0.2%	0.2%	0.3%	1.1%	1.5%	1.4%
Skilled real wages	0.0%	0.1%	0.1%	0.2%	0.2%	0.7%	0.8%	0.8%
Capital real reward	0.0%	0.1%	0.1%	0.1%	0.3%	1.0%	1.3%	1.3%
Natural resources real reward	0.0%	0.2%	0.2%	0.2%	0.4%	1.1%	1.2%	1.1%
Land real reward	0.2%	0.7%	0.9%	0.9%	0.1%	0.4%	0.7%	0.7%
Exports	0.5%	1.5%	2.2%	2.2%	2.2%	7.3%	10.5%	10.7%
Imports	0.5%	1.6%	2.3%	2.3%	1.9%	6.2%	8.9%	9.1%
Tariff revenue	-3.1%	-10.9%	-15.8%	-15.6%	-11.1%	-37.5%	-52.7%	-51.8%
Tax revenue	-0.2%	-0.6%	-0.9%	-0.9%	-3.0%	-10.2%	-14.1%	-13.7%

Bilateral external trade, for the whole economy

	EU					EU periphery				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Exports to:										
Developing Asia	18.38	-0.6%	-1.8%	-2.6%	-2.7%	2.30	-0.6%	-1.9%	-3.2%	-3.5%
Other Developing Countries	13.82	-0.4%	-1.4%	-1.9%	-1.9%	1.78	-0.5%	-1.7%	-2.3%	-2.3%
Europe						17.74	3.7%	12.3%	18.0%	18.4%
European Periphery	20.69	4.0%	12.8%	18.3%	18.7%					
Other Industrialised Countries	50.73	-0.3%	-1.0%	-1.5%	-1.5%	5.62	-0.5%	-1.5%	-2.2%	-2.2%
Imports from:										
Developing Asia	19.49	-1.0%	-3.3%	-4.9%	-5.0%	2.48	-0.1%	-0.4%	-0.9%	-1.1%
Other Developing Countries	10.31	-0.7%	-2.2%	-2.9%	-2.8%	1.38	-0.2%	-0.6%	-0.4%	-0.3%
Europe						20.69	4.0%	12.8%	18.3%	18.7%
European Periphery	17.74	3.7%	12.3%	18.0%	18.4%					
Other Industrialised Countries	48.92	0.2%	0.6%	0.9%	0.9%	6.37	-3.8%	-11.1%	-14.4%	-14.5%

Bilateral trade, by sectors

	Trade From EU to periphery					Trade from periphery to EU				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Food	1.83	9.5%	32.3%	46.9%	47.5%	0.88	10.1%	34.2%	47.5%	46.9%
Clothes	1.61	5.8%	18.6%	25.0%	24.6%	2.25	10.0%	36.5%	64.3%	71.3%
Primary	0.80	3.6%	11.2%	15.2%	15.6%	3.92	1.4%	4.2%	5.5%	5.3%
Manuf	1.46	3.7%	11.4%	15.8%	16.0%	1.36	3.6%	11.3%	14.9%	14.8%
Vehic	1.67	9.3%	30.8%	45.1%	46.0%	0.70	4.6%	13.2%	13.9%	14.1%
Chemical	3.20	2.8%	8.9%	12.5%	12.9%	1.71	4.0%	12.4%	16.5%	16.4%
Equipment	5.01	2.1%	6.4%	8.9%	9.2%	1.58	3.7%	11.5%	15.0%	14.9%
Houses	0.15	-0.5%	-1.7%	-1.9%	-1.8%	0.20	0.2%	0.5%	-0.2%	-0.6%
TrT	0.75	0.2%	0.5%	0.9%	1.0%	1.40	0.0%	-0.1%	-0.6%	-0.8%
EGE	0.12	0.4%	1.1%	1.9%	2.1%	0.15	0.1%	0.1%	-0.8%	-1.1%
AutreSer	1.34	0.3%	0.9%	1.5%	1.6%	1.24	-0.1%	-0.6%	-2.0%	-2.2%

source: authors calculation, using Mirage

Table 3.5: Results when not taking imperfect competition

Macroeconomic variables

	EU				EU periphery			
	t+1	t+3	t+7	t+12	t+1	t+3	t+7	t+12
Welfare	0.1%	0.1%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
GDP (volume)	0.0%	0.1%	0.1%	0.2%	0.2%	0.5%	0.8%	0.8%
Dual price index of utility					-0.2%	-0.7%	-0.8%	-0.8%
Unskilled real wages	0.1%	0.2%	0.2%	0.3%	0.3%	1.0%	1.5%	1.5%
Skilled real wages	0.0%	0.1%	0.2%	0.2%	0.2%	0.7%	0.9%	0.9%
Capital real reward	0.0%	0.1%	0.1%	0.1%	0.3%	1.0%	1.3%	1.2%
Natural resources real reward	0.0%	0.1%	0.2%	0.3%	0.4%	1.1%	1.4%	1.4%
Land real reward	0.2%	0.7%	0.9%	0.9%	0.1%	0.5%	0.8%	0.9%
Exports	0.4%	1.5%	2.3%	2.4%	2.2%	7.3%	10.5%	10.6%
Imports	0.5%	1.7%	2.4%	2.3%	1.9%	6.2%	8.9%	9.0%
Tariff revenue	-3.1%	-10.5%	-15.2%	-15.1%	-11.1%	-37.4%	-52.5%	-51.7%
Tax revenue	-0.2%	-0.6%	-0.8%	-0.8%	-3.0%	-10.2%	-14.1%	-13.8%

Bilateral external trade, for the whole economy

	EU					EU periphery				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Exports to:										
Developing Asia	18.38	-0.8%	-2.2%	-2.8%	-2.7%	2.30	-0.7%	-2.0%	-2.9%	-2.9%
Other Developing Countries	13.82	-0.6%	-1.7%	-2.1%	-2.0%	1.78	-0.6%	-1.8%	-2.3%	-2.2%
Europe						17.74	3.8%	12.3%	17.7%	18.0%
European Periphery	20.69	4.2%	13.4%	19.0%	19.4%					
Other Industrialised Countries	50.73	-0.4%	-1.2%	-1.5%	-1.5%	5.62	-0.6%	-1.7%	-2.3%	-2.2%
Imports from:										
Developing Asia	19.49	-0.9%	-3.1%	-4.5%	-4.6%	2.48	0.0%	-0.1%	-0.3%	-0.4%
Other Developing Countries	10.31	-0.7%	-2.2%	-3.0%	-2.9%	1.38	-0.2%	-0.6%	-0.6%	-0.4%
Europe						20.69	4.2%	13.4%	19.0%	19.4%
European Periphery	17.74	3.8%	12.3%	17.7%	18.0%					
Other Industrialised Countries	48.92	0.3%	0.8%	1.0%	1.0%	6.37	-4.2%	-12.3%	-16.0%	-16.0%

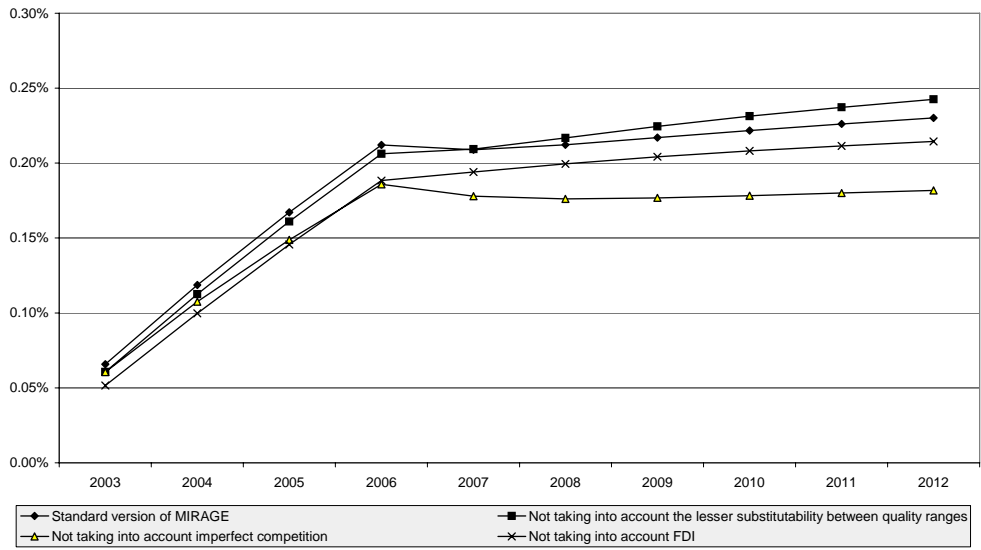
Bilateral trade, by sectors

	Trade From EU to periphery					Trade from periphery to EU				
	Initial level	t+1	t+3	t+7	t+12	Initial level	t+1	t+3	t+7	t+12
Food	1.83	9.5%	32.5%	47.3%	47.9%	0.88	10.1%	34.3%	48.0%	47.6%
Clothes	1.61	6.0%	19.3%	26.8%	26.9%	2.25	9.7%	34.2%	56.0%	60.2%
Primary	0.80	3.7%	11.5%	15.9%	16.2%	3.92	1.5%	4.6%	6.1%	6.1%
Manuf	1.46	3.6%	11.5%	15.9%	16.1%	1.36	3.7%	11.6%	15.6%	15.6%
Vehic	1.67	10.8%	35.0%	49.4%	50.0%	0.70	5.3%	16.7%	21.7%	21.2%
Chemical	3.20	2.9%	9.0%	12.6%	13.0%	1.71	4.1%	12.9%	17.5%	17.6%
Equipment	5.01	2.5%	7.8%	10.9%	11.3%	1.58	4.3%	13.5%	18.3%	18.4%
Houses	0.15	-0.8%	-2.0%	-2.0%	-1.8%	0.20	0.3%	0.6%	0.1%	-0.1%
TrT	0.75	0.1%	0.4%	0.8%	1.0%	1.40	0.0%	-0.0%	-0.4%	-0.5%
EGE	0.12	0.3%	1.0%	1.7%	2.0%	0.15	0.1%	0.2%	-0.5%	-0.6%
AutreSer	1.34	0.2%	0.7%	1.4%	1.6%	1.24	-0.1%	-0.5%	-1.8%	-2.1%

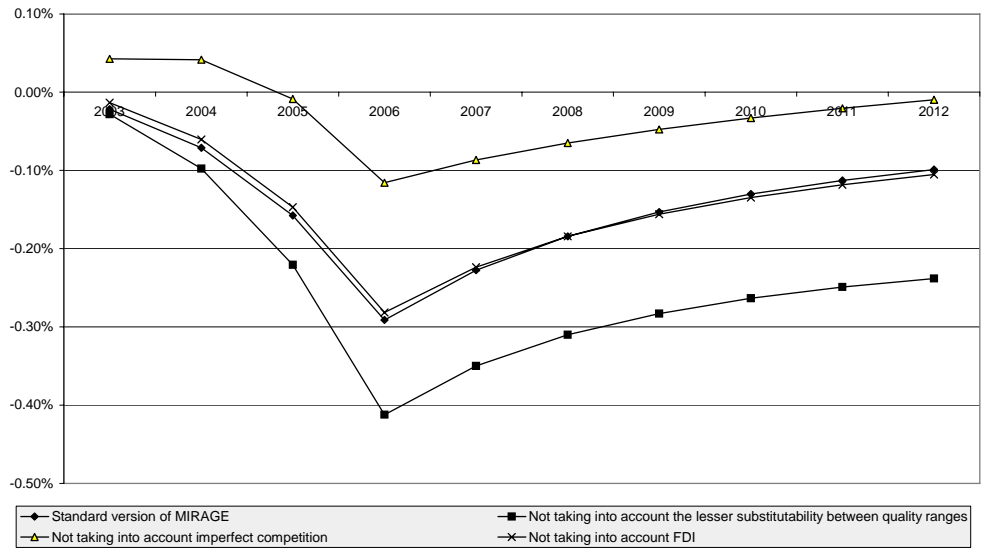
source: authors calculation, using Mirage

Evolution of welfare by scenario

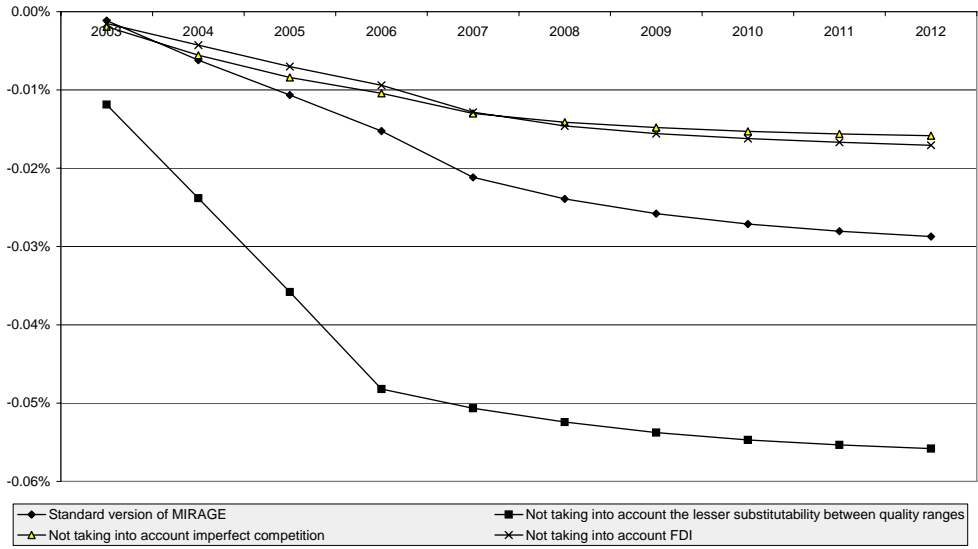
Europe welfare



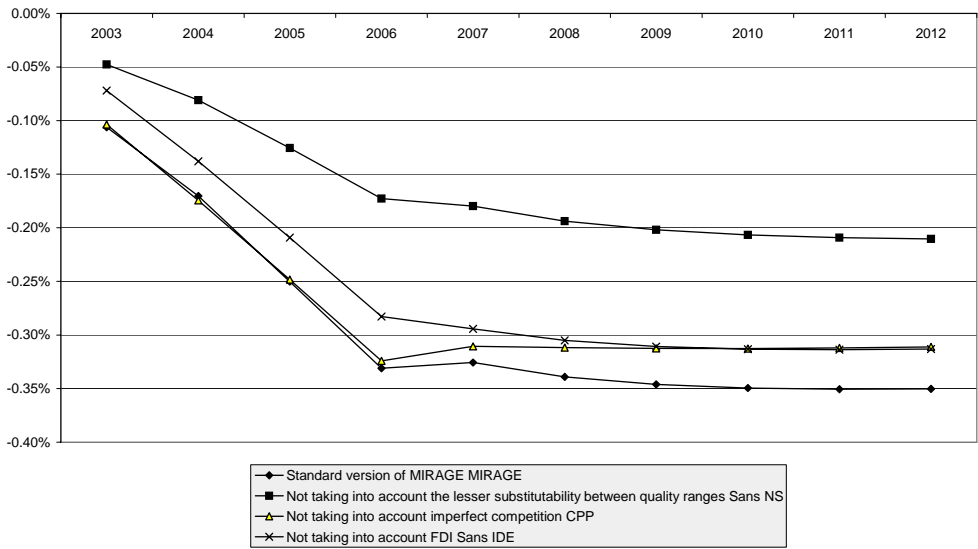
European Periphery welfare



Other Industrialised Countries welfare



Developing Asia welfare



Other Developing Countries welfare

