Agricultural Technological Progress and the Regional Dimension of Potential Multimarket Effects: a General Equilibrium Analysis for Mercosur.

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ABSTRACT

This paper analyses the potential multimarket effects arising from the technological progress (TP) in agriculture in Mercosur integration process. The study is carried out with the aid of an Applied General Equilibrium Model designed for trade analysis, the GTAP model, in a 10-region/10-commodities aggregation. The major focus of the analysis is in the agricultural and agroindustrial sectors. Several hypotheses about the Hicks-neutral type technological progress are analyzed, for Brazil, Argentina and Chile. Results show that Brazil would take in a greater percentage of the surplus generated by TP than Argentina and Chile. In the same way, being technologically behind appears to have a significant cost for Brazil, especially in the GRAINS production sector. This situation would also generate a relatively smaller decrease in sectoral employment level, when compared to the other hypothesis, but this would happen at the expense of reducing wages in the whole economy. The study concludes that the inevitable release of labor out of agriculture in the presence of Hicks-neutral TP is associated to an increase in wages and welfare improvement to the society.

Key words: Technological change, agriculture, Mercosur, applied general equilibrium models.

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1. Introduction

A decisive step for Brazil, Argentina, Paraguay and Uruguay in the consolidation of the South Cone Common Market (Mercado Comum do Cone Sul) – Mercosur, was the constitution of a free trade area and of a partial customs union on January 1, 1995. This process is the materialization of a late Latin-American integration project, pursued since the fifties, when CEPAL introduced the concept that a trade preferences system would improve the regional economic development (Rego, 1995).

The regional integration will have important economic effects upon the participating countries that will be gradually felt during the consolidation process that must be completed by the year 2.006. Mercosur will be, then, a global market made out of about 200 million people, and producing more than a US$1 trillion GDP.

The elimination of the traditional mechanisms of trade restrictions among countries will not, of course, eliminate the competition between them. Other mechanisms will surely arise. Such mechanisms must be market oriented, and not subject to the control of Mercosur agreements, which rely heavily on commercial trade measures.

In this sense, technological progress will assume a prominent feature that has not yet been addressed in Mercosur discussion. Considering the impossibility of raising commercial barriers inside the block, gains in productivity turn out to be one of the main mechanisms of competition to member countries.

2. Objective

The objective of this paper is to analyze the potential multimarket effects arising from technological progress in agriculture in Mercosur integration process. The study will be carried out with the aid of an Applied General Equilibrium Model designed for trade analysis, the GTAP model (Hertel, 1997). The aim of the study is keeping track of the potential multimarket effects of technological progress, at different regions and market levels.

3. The database[1]

The GTAP (that stands for Global Trade Analysis Project) is an AGE model designed for global trade analysis. It was developed by the Center for Global Trade Analysis, by the GTAP Consortium, in the University of Purdue. The Center has also developed the databases for the model.

The GTAP database used is version 3, that distinguishes 30 countries/regions and 37 commodities (McDougall, 1997). The data is about bilateral trade, transport and protection data covering those regions. Regional data are derived from input-output matrix. Database version 3 refers to 1992, and all values are listed in million dollars of 1992. The tariff structure considered, however, is based on 1989. For this study, regions and commodities were aggregated in 10 regions/countries and 10 commodities, and the model was solved by the software GEMPACK. The tables below show the aggregation strategy chosen for the study.

[1] The data and the aggregation used in this study can be obtained with the author, under request.

Table 1. Commodities aggregation strategy.

Code	Aggregated commodities
GRAINS	Grains production: rice, wheat, corn, other grains.
OTHCROPS	Other crops: non-grain crops, including coffee, oranges, soybeans, vegetables, etc.
LIVESTOCK	Livestock production and wool.
FOOD	Processed food: fisheries, processed rice, other Food products, beverages and tobacco.
MEATPROD	Processed meat
MILKPROD	Processed milk and milk products
FORESTRY	Forestry: forestry, lumber, pulp paper etc.
NRMANUF	Natural resources intensive manufactures: coal, oil, gas, other minerals, textiles, wearing apparels, leather, etc, lumber, pulp paper, etc, petroleum and coal, nonmetallic minerals, primar ferrous metals, nonferrous metals, fabricated metal products.
MANUFACT	Manufactures: chemicals, rubbers and plastics, transport industries, machinery and equipment, other manufacturing.
SERVICES	Services: electricity water and gas, construction, trade and transport, other services (private), other services (govt.), ownership of dwellings.

Agricultural primary activities were aggregated in GRAINS (rice, heat, other grains, corn), OTHCROPS (other crops, including soybeans and tree crops, like coffee and oranges), LIVESTOCK (primary animal production). The agroindustry sectors are FOOD (food industry, excluding meats and milk products), MEATPROD (meats and meat products), MILKPROD (milk and milk products), FORESTRY (forestry, including pulp and paper). The other sectors are NRMANUF (natural resources intensive manufactures), MANUFACT (all other manufactures), and SERVICES. The regional aggregation chosen is showed below, in Table 2.

Table 2. Regional aggregation.

Code	Aggregated countries/regions
ROW	Rest of the World: Australia, New Zealand, Japan, Republic o Korea, Indonesia, Malaysia, Philippines, Singapore, Thailand China, Hong Kong, Taiwan, India, Rest of South Asia.
CAN	Canada
USA	United States of America
MEX	Mexico
LAM	Central America and Caribbean, Rest of South America
ARG	Argentina
BRA	Brazil
CHI	Chile
EU	European Union 12
REU	Austria Finland and Sweden, CEA, European Free Trade Area (res of Europe)

Source: GTAP

The GTAP version 3 database does not show data for Paraguay and Uruguay, the two other countries in Mercosur separately. This experiment, thus, will be conducted simulating the effects of technological progress in Brazil, Argentina and Chile, as a proxy for the whole Mercosur process, in a scenario that comprises the full Mercosur agreement implementation, in 2006. Due to the relative size of the economies, however, this experiment is expected to be a reasonable proxy for Mercosur as a whole.

4. The model

The GTAP model is designed specifically for the analysis of international trade issues. The calibration database of the model comprises the circular flow of income for the world as a whole, as seen above, and this is its main distinctive feature, which makes it suitable to the present study. A full description of the GTAP model can be found in Hertel (1997). The central aspects of the model, however, will be presented here, in order to give a resumed outlook of its main mechanisms.

In the production side, the model uses a "technological tree" that has widespread use in AGE models, and can be seen in Figure 1. It is a separable technology with constant returns to scale.

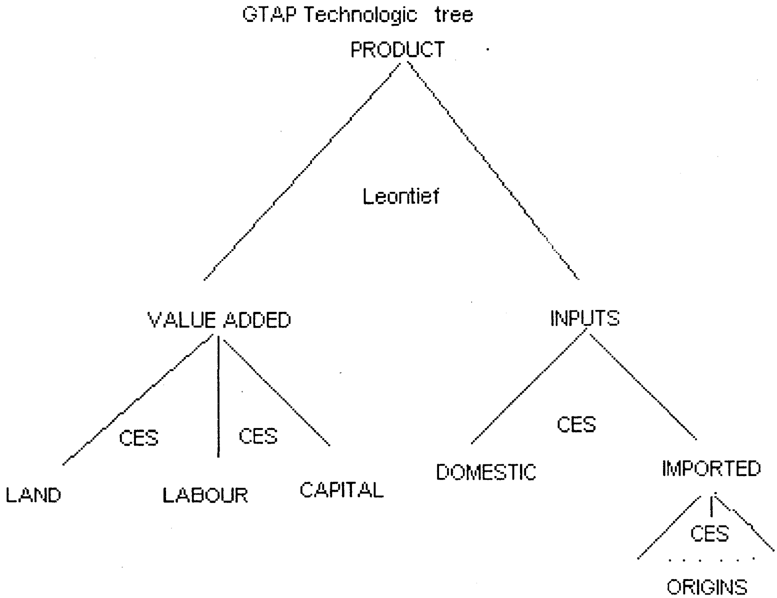

Figure 1. GTAP production structure.

The highest level of the technological tree shows that firm's production follows a Leontief production function, which combines aggregate primary factors (value added) and a composite intermediate input, in fixed proportions, what means a null elasticity of substitution between them. Being the function separable between those two arguments, the mix of primary factors is independent of the input prices. Yet, the elasticity of substitution between each primary factor and the intermediate input is the same.

The primary factors in the model are agricultural land, labor and capital. Land is used only in the agricultural activities (GRAINS, OTHCROPS, LIVESTOCK), and has imperfect mobility between them. The degree of mobility of this factor can be adjusted through the parameter choice. More precisely, the elasticity of transformation value in a CET (constant elasticity of transformation) function defines the supply of agricultural land for each activity. In the case of imperfect mobility of factors, different prices will be possible across uses, according to the relative profitability of each sector.

In the second level of the "tree", the way that aggregated primary factor and inputs are produced can be seen. The aggregated primary factor is produced through a CES (constant elasticity of substitution) function that assembles land, labor and capital. Land, however, is utilized just in the agricultural activities, as noted before. The elasticity of substitution is the same between each two factors, a restrictive formulation.

The technology for intermediate inputs is similar to that explained above, "*mutatis mutandis*". The intermediate aggregated input is produced by combining domestic produced intermediate inputs and imported ones, through a CES function. The optimal combination of those two types of inputs is independent of the prices of the primary factors. Domestic and imported inputs are then separable in production. The imported input is a composite of imports from many sources. Separability in production, then, means that producers decide first the optimal composition between domestic and the composite imported input, and then, based on the resulting composite price, the quantity to be imported from each source.

The economic behavior of the agents in each region of the model is governed by an aggregated utility function, that distinguishes between consumption of composite goods by families and the government, and savings. The final regional income is thus distributed according to a "per capita" Cobb-Douglas utility function, defined in terms of the three possible forms of final demand: private consumption, government consumption, and savings.

This makes the share of each item of final demand in total income constant, a well-known property of the Cobb-Douglas function. Once specified the share of income to be spent with each item of final demand, the next step consists of allocating this share to each composite good. Here, the treatment given to the private sector and to the government is different.

For the government, the Cobb-Douglas hypothesis is again used, making the share of each good constant in the government budget. For the private sector, the hypothesis of non-homothetic consumption is made. Private consumption is allocated to each good through a "Constant Difference of Elasticities" (CDE) formulation. This formulation allows model calibration according to chosen values of price and income elasticities of demand. In the CDE model, those elasticities are not constant, varying with relative prices and expense shares. The model, then, recalculates the value of the elasticities at each iteration of the equations solving process.

Finally, in terms of its macroeconomic closure, the model is neoclassical, with investment adjusting to equate savings. Instead of imposing the neoclassical closure at regional level, however, the GTAP model has a "global bank mechanism", that equates savings and investment all over the world, and distributes savings according to its rates of return in each region.

5. An analysis of the effects of technological change in Mercosur's integrating countries

As follows, several hypotheses about technological progress in Mercosur countries will be analyzed. The study will concentrate on the effects of technological progress over agriculture and agroindustry in Mercosur countries, and on the way that general equilibrium gains from agricultural research in an open economy arises.

As noted by Frisvold (1997), this approach differs from most traditional studies about research returns that, in general, focus in just one product, and in a partial equilibrium environment. First, because those studies assume those prices and the production of all other products are fixed. As an example, in partial equilibrium, it is assumed that changes in cost of production of corn would not change the prices of wheat or chicken. The general equilibrium model permits endogenous changes in prices and quantities produced by all sectors, in response to technological change in one sector.

Second, Frisvold (1997) points out that most studies assume that technological progress in one region does not affect the productivity in other regions, not taking into account the spillover of technology. Again, a general equilibrium enables the relaxation of that hypothesis. Moreover, the AGE model makes it possible to keep track of horizontal linkages (between activities in the same level in the productive chain), as well as of vertical linkages (between activities chained at different levels, as in the case of agriculture and agroindustry), through input-output relations in the economy, allowing for the inclusion of factors markets in the analysis.

6. The experiment

As noted before, in the experiment, the effects of technological progress in Mercosur's member countries will be analyzed, under different hypothesis. The experiment refers to an exogenous technological shock in the agricultural activities (GRAINS and OTHCROPS) in Mercosur' s countries. Note that the LIVESTOCK sector is not included in the shock, an option due to the relatively higher share of agriculture in the total production, and to the necessity to choose sectors that are more homogeneous in technological terms.

While dealing with technological change effects in prospective terms, choosing the kind of technological change is always a difficult matter, specially if one is interested in distribution issues, since the type of bias present (if any) will affect the results. There is no easy answer for which type to choose. We have avoided this discussion here, since our main interest is in the global aspects of TP related to the integration in Mercosur. We have, thus, chosen Hicks-neutral type of TP for the simulation, that is, a kind of TP that does not change the relative quantity of factors in use. In a vector of inputs consisting of labor and capital, technical change is defined as neutral in Hick's sense if at points on the expansion path the marginal rate of technical substitution is independent of time (Chambers, 1988).

In the model, this TP is done by changing the value of an "increasing" parameter in the production function. The shock to be implemented here consists of a 5% increase in the Total Factor Productivity (TFP) in agriculture[2] (GRAINS and OTHCROPS sectors). This increase must be viewed as a differential growth in productivity in relation to other sectors and regions, that is, the simulation refers to a 5% TFP above the TFP growth in other sectors and regions. Particularly, this represents a 5% increase in relation to the LIVESTOCK in each region. This is emphasized due to fact that the LIVESTOCK sector is the only one sector that makes use of land other than GRAINS and OTHCROPS, in the production process.

In terms of the hypothesis to be here utilized, there are three situations, as in Frisvold (1997):

a) **Experiment 1 (E1)** -Tecnnological progress occurring in only one country at each time. This means applying the 5% TFP growth in agriculture to each country.

b) **Experiment 2 (E2)** - Technological progress with spillovers. In this case, the 5% rate of TP is applied to the agriculture of all the three countries (Argentina, Brazil and Chile) simultaneously.

c) **Experiment 3 (E3)** - Technological progress occurring in

2 Bonelli et al (1998) found, for the agricultural sector in Brazil, a yearly 1% increase in TFP, for the period 1975-1996.

two countries at each time, with the third country falling down technologically. This will permit analyze the consequences of falling technologically behind in Mercosur.

Table 3 shows some selected results related to this experiment. In the table, results in the columns refer to the impacts in each region as a consequence of each technological progress hypothesis. As an example, the first column refers to the impacts on Argentina of technological progress in Argentina, the second column to the impacts on Brazil of technological progress in Brazil, and so one. The last three columns show the effects in each region of falling down technologically in relation to the others.

In an open economy, the distribution of technological progress gains among economic agents depends crucially upon the hypothesis of the analysis. Thus, under the "small country hypothesis", the country faces a perfectly elastic demand curve, being a price taker in international trade. Under these conditions, producers would appropriate all the gains originating from the change, since the extra production would be absorbed with no price changes. This hypothesis, however, is usually not realistic.

The GTAP model deals with this problem through a formulation that makes goods in international trade imperfect substitutes. It is the so-called Armington formulation. The demand curve, then, will never be perfectly elastic for any good, even for commodities and countries with small shares in international trade (Frisvold, 1997)[3] . The consequence is that, in the model, producers will never appropriate all the gains from the innovation.

[3] Note that the export demand for the product of a country is the sum of the import demands of all other countries, and that it is regulated by the elasticity of substitution between domestic products and the import composite, as well as by the elasticity of substitution between the various origins in the composition of that composite.

Table 3 - Impacts (percentage variation) in each region of Hicks neutral technological progress.

	E1			E2			E3		
	ARG	BRA	CHI	ARG	BRA	CHI	ARG	BRA	CHI
Production									
Grains	6.6	2.6	2.5	5.6	1.3	1.9	-1.0	-1.3	-0.6
Other cultures	3.3	2.6	8.3	3.1	2.5	7.7	-0.2	-0.1	-0.6
Livestock	0.2	0.6	0.2	0.2	0.3	0.3	0.1	-0.0	0.1
Food	1.1	1.6	1.2	1.1	1.6	1.1	-0.0	0.0	-0.1
Meats	0.2	0.4	0.2	0.2	0.5	0.3	0.1	0.0	0.1
Milk products	0.4	0.5	0.2	0.4	0.5	0.3	0.0	0.0	0.1
Product prices									
Grains	-4.3	-5.2	-4.6	-4.7	-5.3	-4.8	-0.3	-0.1	-0.2
Other cultures	-4.7	-5.2	-4.0	-4.9	-5.2	-4.2	-0.2	-0.0	-0.2
Livestock	0.1	-0.3	0.3	-0.0	-0.3	0.1	-0.2	-0.0	-0.2
Food	-0.7	-1.4	-0.5	-0.8	-1.5	-0.6	-0.1	-0.1	-0.1
Meats	0.3	-0.1	0.4	0.2	-0.1	0.2	-0.1	0.0	-0.1
Milk products	0.5	-0.0	0.3	0.4	-0.0	0.1	-0.1	0.0	-0.2
Factor prices									
Land									
Grains	1.0	-3.2	1.8	-0.2	-4.2	0.6	-1.2	-1.1	-1.2
Other cultures	-1.2	-3.1	5.9	-1.9	-3.5	4.6	-0.7	-0.4	-1.2
Livestock	0.1	-3.4	3.8	-0.4	-1.7	3.0	-0.5	-0.3	-0.7
Wages	0.8	0.7	0.6	0.7	0.7	0.6	-0.1	0.0	-0.0
Capital	0.8	0.6	0.5	0.8	0.6	0.5	-0.0	0.0	0.0

Cont.

	E1			E2			E3		
	ARG	BRA	CHI	ARG	BRA	CHI	ARG	BRA	CHI
Factor demands									
Land									
Grains	1.4	-0.5	-2.9	0.9	-4.0	-3.0	-0.5	-0.7	-0.1
Other cultures	-0.8	-0.5	1.0	-0.8	-2.0	0.9	0.0	0.0	-0.1
Livestock	0.5	1.3	-1.1	0.7	1.4	-0.7	0.2	0.1	0.4
Labor									
Grains	11.5	-2.7	-2.3	0.4	-3.9	-3.0	-1.1	-1.4	-0.7
Other cultures	-1.9	-2.6	4.0	-2.2	-2.7	3.2	-0.3	-0.2	-0.8
Livestock	0.1	0.1	0.7	0.1	0.1	0.6	-0.0	0.0	0.0
Equivalent Variation(US$ millions)									
World	1213.5	2367.1	352.2	3922.6	3922.6	3922.6	2717.3	1564.6	3573.4
Domestic	789.8	1942.7	194.7	756.2	2008.1	195.6	-30.84	71.63	-3.19
Grains	224.5	270.1	35.7	223.1	268.3	35.11	-	-	-
Other cultures	652.4	1590.8	156.7	651.1	1589.3	156.1	-	-	-

Source: model results.

Beginning the analysis with experiment E1, where Hicks-neutral technological change happens to each country individually, results can be seen in the first three columns of Table 3. The results for Argentina show that TP in this countries' agriculture would have positive effects that transcend the rural environment. Besides increasing production activities, GRAINS production (6,6%) and OTHCROPS (3,3%), that phenomenon would generate a 0,2% increase in the LIVESTOCK production, a sector where, in this experiment, TP has not occurred.

TP in Argentina results, in the model, in two interesting cases described in the literature: the "land price treadmill" (De Janvry, 1973) and the "output price treadmill" (Cochrane, 1958; De Janvry, 1973), also cited by Frisvold (1997), in his study. The first case shows up in the GRAINS production sector in Argentina, where the production increases in a greater proportion than the fall in the market price of the commodity, increasing producers' receipts. This has a counterpart in a greater demand for agricultural land, what generates an increase in its prices, increasing also producer's surplus[4]. The second case is the contrary and can be seen in the OTHCROPS producing sector, where market prices fall in a greater extent than the production increases, reducing producers receipts in this activity[5]. This causes a fall in agricultural land demand in the activity, reducing its price[6]. These are, then, two distinct effects for the same phenomena, a 5% decrease in the cost of production due to TP. As a net result of that fact, there is an elevation in the availability of land for LIVESTOCK production that will increase demand for that factor by 0.5% and production by 0.2%.

This differential impact of TP in both sectors is dictated by a set of essential parameter values in the model that characterizes the position of each sector in the general structure of the economy. In particular, the

[4] McLAREN (1997) argues that the price of the sector specific factor of production, land, can be used as a proxy for the producer surplus in the activity.

[5] The "treadmill effect" is related to the adjustment process that occurs. The first innovators will benefit from the TP, but as far as the innovation is widespread adopted, the farm income is reduced, generating a need for more innovation, in a "treadmill" type process.

[6] Remember that, as a factor with restricted mobility between activities, land will have, in general, a distinct price in each activity, regulated by demand, since the supply is fixed.

price elasticity of demand for the GRAINS production sector in Argentina is -1.333, considerably greater than that in the OTHCROPS sector -0,618 , what determines the results.

In the same way, we must notice that the price elasticities above referred to are general equilibrium elasticities, different in general from the partial equilibrium elasticities more commonly used. These elasticities represent percent variations in quantity caused by optimal adjustments in all variables of the model, that is, with all prices and incomes adjusting to given prices variations. They are non-compensated elasticities, whose value depends on several factors, like the final demand mix, the price elasticities of demand in consumption, the income elasticities, and the many elasticities of substitution in the model.

In the Argentinean case, GRAINS exports accounted for approximately 8% of the world grain trade in 1989, while the OTHCROPS sector accounted for about 2% of the world trade in the same year. Being the elasticities of substitution between domestic and imported products, and between imports from different origins the same for both sectors (respectively 2.2 and 4.4), the greater share of Argentinean GRAINS production sector in world trade will increase relatively more the demand for grains when the price falls, determining the greater general equilibrium price elasticity of demand for that sector.

The results for Brazil and Chile are guided by the same variables. The general equilibrium price elasticities for Brazil are -0.406 (GRAINS) and -0.565 (OTHCROPS), while for Chile those figures are -0.565 and -1.95, respectively. These differences in values are, of course, determined for the different composition of the OTHCROPS aggregate in each country, an aspect that will certainly deserve more attention in future researches.

An important result of the TP in agriculture shows up in the agroindustry. This can be noted by the increase in the production of the three sectors, FOOD, MEATPROD, and MILKPROD. Thus, while the agriculture sector, broadly defined (GRAINS, OTHCROPS, AND LIVESTOCK) reduce their value added in Brazil and Argentina (respectively by -0.48% and -1.55%), the agroindustry of these countries increases its value added in respectively 0.7% and 0.82%. In Chile, the huge increase in the output of the OTHCROPS sector, caused, as seen before, by the high value of the general equilibrium price elasticity of demand in that country, causes a 1.7% increase in the value added of the agricultural sector (broadly defined), while agroindustry value added grows 0.38%.

Table 3 shows the model results in terms of a welfare indicator for the experiments. This is an index of welfare derived directly from the utility function, the Hicksian Equivalent Variation (EV). It also shows its decomposition into its parts. This variable, graphed in millions of US$, is obtained through the product of the initial income times the percent variation in the "per capita" utility, and can be decomposed in two effects: an allocative effect (AE) and a terms of trade effect (TTE). It expresses the size of the Hicksian compensation of a price variation.

As it can be seen, no country takes in all the gains (surpluses) generated from the TP. In the first column of Table 3, it can be seen that TP in Argentina would increase world EV in US$1,213.5 millions, from what US$789.8 (65%) would be appropriated by Argentina itself. In the same way, Brazil would appropriate about 82% of the surplus generated by the TP in its agriculture, while Chile would appropriate about 55% of the total. This result is illustrative of a more "closed" character of the Brazilian economy in contrast with the others under analysis, that is, the smallest relative exposition (the degree of openness) of the Brazilian economy to international trade. This could indicate a greater incentive to investments in agricultural research in Brazil than in other Mercosur's members.

The second situation analyzed, the "spillover" hypothesis (E2), does not change the results substantially in terms of the direction of change of the variables, although some results can change considerably in levels. We must notice the deeper reduction in factor demand in the Brazilian agriculture, mainly in the GRAINS producing sector. This is a logical consequence of the simultaneous increase in productivity in that sector in Argentina and Chile.

Note that the regional EV does not substantially change the results in relation to E1, although the global (world) EV increases significantly in relation to E1. This means a global welfare improvement, and no regional welfare deterioration, a Pareto-superior situation. It is interesting to note, then, that the "spillover" would not reduce the returns to agriculture in each region.

The third hypothesis analyzed, E3, analyzes the consequence for each country of falling technologically behind in relation to the others. As for Brazil, this means a significant cost in terms of sacrificed production in the GRAINS sector that would reduce its production by 1.3% due solely to that effect. This would impact the domestic factor prices, mainly the more sector-specific producing factor, the land, whose price would be reduced by 1.1% in the GRAINS sector, as well as in the other agricultural activities, reducing then the producer surplus in that broad sector. Argentina and Chile would also show negative EV variations as a consequence of falling down technologically.

This experiment shows more clearly the importance of the TP in the inter-block competition, or the importance of not falling technologically behind in relation to the others. Note that the relation food price/wages (or the purchase power of the wage in terms of food, except meats and milk products) **increases** 2.1% in E1 in Brazil (food price increases by 1.4% and wages increases 0.7%), and **decreases** 0.1% in E3. In terms of the welfare indicator, this means a difference in the EV of US$1,936.5 millions in relation to E2 (spillover), and of US$1.870.0 in relation to E1.

In the same way, the model shows the inexorability of the fall in rural employment in the presence of TP Hicks-neutral in agriculture. In Brazil, the smallest fall in rural employment showed up in E3, under the hypothesis of technological fall down in relation to the other Mercosur member countries. Note, however, that this relatively smaller fall in rural employment would happen without any change in nominal wages, while under the other alternative hypothesis the results showed up an elevation in nominal wages in the economy. As also noted by Frisvold (1997), keeping the pace technologically does not necessarily mean to guarantee the employment at sectoral level, as clear here.

The TP in agriculture, then, besides improving the supply of raw agricultural commodities to the other sectors of the economy, also frees labor for the non-agricultural production, a process identified by OWEN (1966) as the double development pressure over agriculture. As noted by Frisvold (1997), this decline in returns to agriculture is not a result specific to AGE models, but a result generated by the shift of the supply curve over a inelastic demand curve. Thus, the release of labor by agriculture to the other sectors (urban) of the economy in presence of TP is related to an improvement of the average wage and to welfare gains in the society.

6. Conclusions

TP in Mercosur's agriculture are to have different effects between countries, due to the different productive structures. Results here found show that Brazil, with a lesser degree of exposition to international trade, would take in a greater percentage of the surplus generated by TP than Argentina and Chile, what would suggest a greater stimulus in Brazil for agricultural research. Moreover, the "spillover" effect of technology does not appear to reduce the welfare gains, when measured by the Hicksian Equivalent Variation, for the countries involved in the process.

Falling technologically behind in relation to the other Mercosur members, however, appears to have a significant cost for Brazil in terms of production, especially in the GRAINS producing sector, as well as in terms of the welfare indicator. It is interesting to note that this would result in a relatively smaller decrease in employment levels, when compared to the other hypothesis. Nevertheless, this would happen at the expenses of reducing wages in the whole economy. The inevitable labor release out of agriculture in the presence of Hicks-neutral technological change is associated to an elevation of wages, and welfare improvement to the society.

7. References

BONELLI, R; FONSECA, R. Ganhos de Produtividade e de Eficiência: Novos Resultados para a Economia Brasileira. IPEA, RJ. Texto para Discussão no. 557. Abril de 1998.

CHAMBERS, R.G. Applied production analysis: a dual approach. Cambridge University Press. 1988.

COCHRANE, W. Farm prices: Myth and Reality. Minneapolis: University of Minnesota Press. 1958.

FRISVOLD, G. B. Multimarket effects of agricultural research with technological spillovers. in: **HERTEL, T.W. (ed.)**. Global Trade Analysis: Modeling and Applications. cap.13. Cambridge University Press. 1997.

HERTEL. T.W. (ed). Global Trade Analysis: Modeling and Applications. Cambridge University Press. 403 p. 1997.

DE JANVRY, A. A Socioeconomic Model of Induced Innovation for Argentina Agricultural Development. **Quarterly Journal of Economics.** 87:410-435. 1973.

MACLAREN, D. An Evaluation of the Cairns Group Strategies for Agriculture in the Uruguai Round. in: **Hertel, T.W. (ed.).** Global Trade Analysis: Modeling and Applications. cap.8. Cambridge University Press. 1997.

MCDOUGALL, R (ed.). The GTAP 3 data base. Center for Global Trade Analysis. Purdue University. 1997.

OWEN, W. The Double Development Squeeze on Agriculture. **American Economic Review.**56:43-70, 1966.

RÊGO, E.C.L. O Processo de Constituição do Mercosul. **Textos para Discussão no.23.** BNDES, 9 p. 1995.