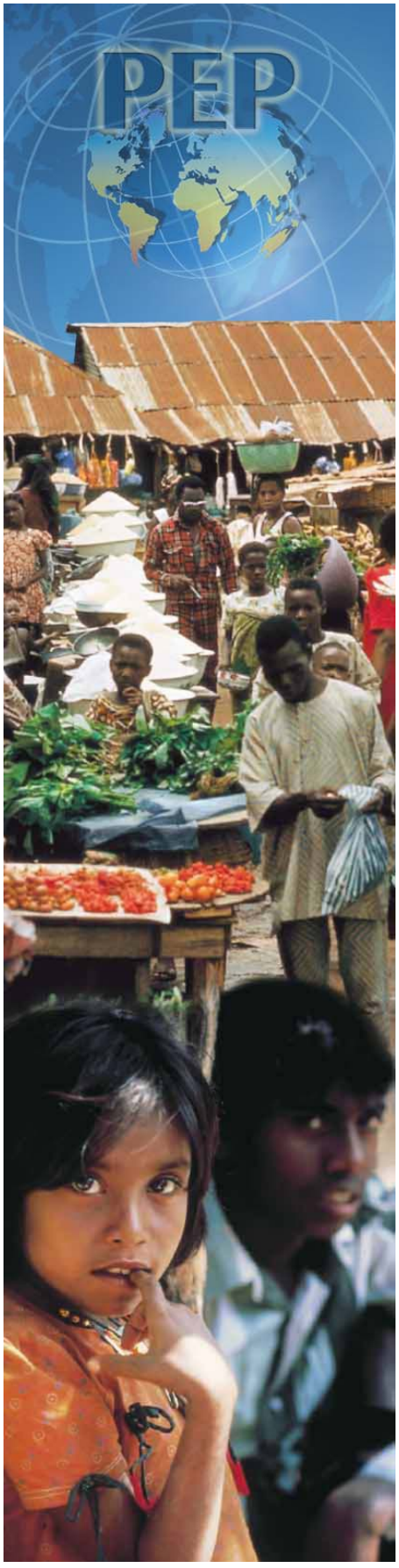


IDRC photo: N. McKee

POVERTY
& ECONOMIC POLICY
RESEARCH NETWORK

MPIA Working Paper 2008-16

Trade Openness and Gender in Uruguay: a CGE Analysis

María Inés Terra
Marisa Bucheli
Carmen Estrades

November 2008

María Inés Terra (Universidad de la República, Uruguay)
iterra@decon.edu.uy
Marisa Bucheli (Universidad de la República, Uruguay)
marisa@decon.edu.uy
Carmen Estrades (Universidad de la República, Uruguay)
carmen@decon.edu.uy

Abstract

Survey results from Uruguay show that there is gender discrimination in the private labor market, and that women spend more time than men doing domestic work and less time in the labor market. We take these and other features of the survey into account to build a gender aware CGE model with endogenous labor supply and a home production function. This kind of model is a useful tool to evaluate the impact of different policies, in particular those relating to gender. In this paper we analyze the gender-differentiated impacts of trade openness in Uruguay on employment, wages and time allocation. We simulated different scenarios of tariff changes. Greater trade openness improved the situation of women in terms of employment and wages, but the impact on gender gaps depends on how trade openness affect trade flows. If net exports to Argentina increases, demand for female labor increases and the gender gap goes down. However, if net exports to Brazil and the rest of the world increase, unskilled male demand expands. When considering time distribution, the impact also depends on the elasticity of labor supply, which differs by skill.

Keywords: trade openness, gender, general equilibrium model, home production, leisure, wage curve

JEL classification: D68, D13, J16, J22, F16

This work was carried out with financial and scientific support from the Poverty and Economic Policy (PEP) Research Network, which is financed by the Australian Agency for International Development (AusAID) and the Government of Canada through the International Development Research Centre (IDRC) and the Canadian International Development Agency (CIDA). The authors acknowledge the collaboration of Rodrigo Ceni who participated in different phases of the study.

1. Introduction

Uruguay is a small Latin American country that has a strong comparative advantage in agricultural production. In the 1990s unilateral trade liberalization and integration with MERCOSUR partners led to a significant reduction in protection for the domestic market. As a consequence, there was a change in relative prices and a reallocation of resources from manufacturing to the services sector. Women's participation in the labor market increased, but there is evidence that in 2003 women still assigned less time to the labor market than men and carried out a disproportionate amount of domestic work. Additionally, some studies conclude that gender discrimination in the labor market persists (Rivas and Rossi, 2000; Amarante; Bucheli and Sanroman).

In principle, a country may benefit from trade openness because it causes an increase in trade and productive specialization. Productive efficiency increases due to better resource allocation, which in turn improves consumption possibilities. Furthermore, when imperfect competition exists, openness may bring additional benefits through access to a larger variety of consumption goods, greater economies of scale and a fall in prices induced by the decline of monopoly rents. International trade also leads to changes in relative prices of goods and in relative demand and remuneration for productive factors. This means that we may expect changes in income distribution. In particular, trade openness may have gender-differentiated effects.

There are three different mechanisms through which trade openness has gender-specific effects on the labor market. First, the gender distribution of the impact on employment depends on the intensity of male and female labor in a sector. If trade openness benefits sectors intensive in male (female) labor, men's (women's) employment will improve. This leads to the second effect whereby changes in the relative demand by gender affect the gender wage gap. We may expect that growth in female intensive sectors decreases the gender wage gap. Meanwhile, labor discrimination either widens or reduces the effect on gender gaps, depending on the direction of the initial effect. A third source comes from the change in labor supply induced by changing employment opportunities and wages. This may lead to an intra-household reallocation of time in the labor market, domestic work and leisure. The supply of child care services affects the possibility of expanding time assigned to the labor market.

Most of the empirical work focuses on whether trade policies affect women's employment relative to men or the gender wage gap. However, evidence about the effects of trade policies on time allocation among household members is less common. Some gender-aware CGE models can be used to measure these three types of impacts by incorporating a

home production function and three activities that time is allocated to (market work, domestic work and leisure), as proposed by Fontana and Wood.

Following this strategy, different results were obtained for Nepal (Fofana, Cockburn and Décaluwé), South Africa (Fofana et al), Pakistan (Siddiqui), Bangladesh and Zambia (Fontana, 2003), when simulating an abolition of tariffs. Women increase their time in the labor market in all five countries, but the gender wage gap decreases in only three of them. The effect on both domestic work and leisure is not conclusive. For example, in Bangladesh, the increase in the opportunity cost of not working for women – due to the decline of the gender wage gap - leads to some substitution of male and female in home production. In Nepal, despite a decline in the gender wage gap, women do not benefit from a reduction in time spent doing domestic work. In fact, female entrance to the labor market is accomplished by a decrease in leisure time, while men's leisure time rises. It seems that trade openness has more equitable effects in Bangladesh.

The aim of this paper is to analyze the gender-differentiated effects of a total abolition of tariffs applied to goods in Uruguay, following the methodological strategy pursued by the above mentioned literature. Specifically, we study the effects on wages, employment, and allocation of time between the labor market and domestic work, using a gender-aware CGE model. We also discuss the extent to which trade liberalization in the 1990s can explain the stylized facts about the labor market and gender in Uruguay.

The paper is organized as follows. First, we describe the Uruguayan economy in general, paying particular attention to the labor market. Secondly, we present the model and the data that is used. Then, we analyze the results of different trade policy scenarios and their sensibility to changes in key parameters of the model. Finally, we draw some conclusions.

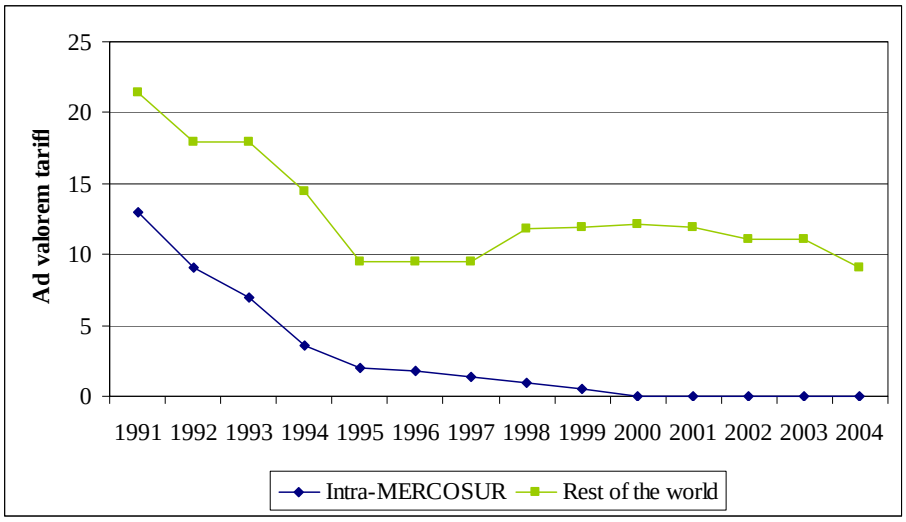
2. The Uruguayan Economy

2.1. Trade openness

Uruguay is a small country of about 3.4 million (in 2005), with a largely urban population (92%). Traditionally, production and exports have relied on agriculture, animal husbandry and meat processing. As many Latin American countries did in the 1990s, Uruguay went through an important process that increased trade openness. From 1990 to 1995 there was a significant tariff reduction as a result of unilateral trade liberalization and trade integration within MERCOSUR (Common Market of the South). The two processes can be easily identified in figure 1, which presents the average tariff protection within MERCOSUR and the average tariff applied to the rest of the world. As we can see, average protection declined significantly until 1995. In the last ten years the average tariff applied to

imports from the rest of the world has not substantially changed, while the intra-MERCOSUR tariff has been practically zero since 2000.

Figure 1: Uruguay: average tariff protection, 1991- 2004



Source: Secretaría del MERCOSUR

Greater trade openness affected the labor market in many ways. First of all, there was an important restructuring of employment. Manufacturing lost importance in terms of both GDP and employment: while the sector employed 23.3% of workers in 1990, this fell to 15.9% by 1999. On the other hand, the share of services and traditional export activities in employment gained importance.

Second, the dispersion of labor earnings increased. One of the main reasons was rising returns to education. Since unemployment and shifts to the informal sector mainly affected unskilled workers, it can be said that the relative demand for skilled labor increased. Casacuberta and Vaillant argue that this rise was due to complementarity between skilled labor and the adoption of new technologies induced by trade liberalization.

2.2. Gender in the Uruguayan economy

Since the middle of the 1980s, women's participation in the labor market has had an upward trend, compared to a slight decline for men. Table 1 shows this evolution for the 18 to 54 year old category: the female participation rate rose from 62% in 1986-1990 to 72% in 2001-2004, while the male rate decreased from 94% to 92% over the same period.

Table 1: Labor characteristics for the 18-54 age group

	1986-1990	1991-2000	2001-2004
Women			
Participation rate	61.7	68.4	71.9
Unemployment rate	12.3	13.5	19.9
Employment rate	54.1	59.1	57.2
Men			
Participation rate	94.1	93.3	92.1
Unemployment rate	6.2	7.5	12.0
Employment rate	88.2	86.3	80.9
Wage gap (log difference) *			
All	0.146	0.098	0.009
Private sector	0.273	0.160	0.074
Public sector	-0.170	-0.086	-0.178

* Only employees (self-employment excluded)
Source: Continuous Household Survey

There are several empirical works focusing on female participation in the labor market in Uruguay that conclude that it increases with the education level and decreases with household income and age. It is also lower for married women and for women with young children, although the likelihood of participation increases as children grow (Diez de Medina; De Soria, Rivas and Taboada). In a study restricted to couples, Bucheli found that labor market participation is more likely when women live with inactive elderly people, who presumably take an active role in domestic tasks, thus allowing women to assign more time to working in the labor market. Bucheli also found that women's participation is higher when living with an unemployed. This result is consistent with added worker behavior, i.e., a reaction to changes in household income. As unemployment changes over the business cycle, we could say that women enter and exit the labor market following changes in their partner's income, and thus do not belong to the core labor force. However, if each of them have similar labor vulnerability, more specifically a similar probability of being unemployed, evidence based on cross-sectional information shows a positive relationship between women's participation and partner's unemployment. Thus, this relationship would not stem from the transitory behavior proposed by the added worker hypothesis. Piani found relatively high level of educational homogamy in Uruguay, giving support to the last argument.

Obviously, time spent in the labor market also depends on the likelihood of being employed. As shown in table 1, the female unemployment rate has been persistently higher than for men despite the increase in female labor market participation. Unemployment is particularly high for non-skilled women who also suffer a relatively high duration of unemployment. Since men and women face similar risks of losing their job, the higher female unemployment rate is likely due to longer periods of unemployment (Bucheli and Casacuberta). In the context of job search models, we could interpret this as a result of women having higher reservation wages and have a lower probability of accepting a job offer

that is, of waiting longer while unemployed. Additionally, we expect that the rate of job offers and the wages offered are lower for women because of labor market discrimination. Note that this argument shows the difficulty in drawing a line between unemployment and non-participation. In fact, long term unemployment frequently ends in an exit from the labor force.

Table 1 also reports the raw gender wage gap measured as the difference between the male and female mean log hourly wage. The gap was positive in 1986-90 and has had a decreasing trend since then. In recent years, its value has been close to zero. Despite these figures, several studies point out the presence of gender discrimination in the labor market. Indeed, some Uruguayan literature follows the spirit of Oaxaca's proposal to measure gender discrimination. According to this proposal, the raw gender gap may be decomposed in two terms. One term stems from the gender difference in endowments and the other one from the gender difference in the returns on endowments. The latter is a measure of gender discrimination[1].

The broad conclusion of Uruguayan studies is that the raw gap cannot be totally explained by endowments. This can be interpreted as labor market discrimination. Rivas and Rossi (2000) find that the declining raw gap over the 1990s in the private sector was mainly due to an improvement of women's human capital and, to a lesser extent, to a change in the return on endowments. They conclude that at the end of the decade, discrimination took account for more than 100% of the raw gender gap in the private labor market. This differs for public wage earners. Rivas and Rossi (2002) compare private and public wage earners in the nineties and conclude that gender discrimination increased for the former but decreased for the latter. Furthermore, Amarante finds that at the end of the 1990s, there was no evidence of discrimination in the public sector.

Employed women and men are distributed differently among occupations and industries. In general, women tend to be concentrated in fewer fields than men. According to Amarante and Espino, this gender distribution among occupations reflects a phenomenon of segregation that had an increasing trend among private wage earners labor market. In contrast, segregation has been lower and stable in the public sector. However, Amarante and Espino remark that their measure of segregation does not fully take into account the hierarchical position of the worker. Bucheli and Sanromán analyze this subject by estimating discrimination throughout the wage distribution. They found a sharp acceleration in the upper tail of the wage distribution that affects women in the private sector. They interpret this

[1] More specifically, the strategy consists in fitting a wage equation for men and women, separately. The discrimination measure is the difference between the estimated coefficients weighted by the female average characteristics. It indicates the wage gain that an "average" woman would have if she was paid with the pay structure of men.

finding as evidence of a glass ceiling, that is, the presence of barriers to promotion for women.

Time spent in non-remunerated work is not as well studied as time in the labor market. There is a single survey in Uruguay that collected information about time use, carried out in 2003. Its main characteristics are presented in Annex 1. It reports individual characteristics such as sex and age, labor market information such as participation and occupation, and time allocation for people over 14 years old. Of particular interest is that it inquires about time spent in the labor market or doing specific domestic tasks such as buying food, feeding children, giving medicine to the elderly, etc. The characteristics of the main variables collected in the survey are described by Aguirre and Batthyány, who find that women assign more time to domestic work than men, whereas men spend more time in the labor market.

In table 2, we show the estimation of time allocation for women and men between 14 and 65 years old according to their level of education[2]. We suppose that people – regardless of their sex or education level - assign 10 daily hours to personal care, that is, a minimum time needed for sleeping, feeding, hygiene and health care. Thus, we calculate daily leisure time as the difference between 14 and total (market and domestic) work time.

The total work burden for women is only slightly larger than men's: 27% compared with 26%. The main difference is in the distribution of work between System of National Accounts (SNA) work and non-SNA work. Women spend 16% of their time doing domestic work and 11% working in the labor market. The distribution is quite different for men: the figures are 6% and 20%, respectively. These findings are consistent with evidence in many other countries, both developing and developed (for example, see data reported in the 1995 UNDP Human Development Report). In contrast, the gender difference in time assigned to leisure is not so significant.

We also report time allocation according to the worker's level of education. Regardless of the level of education, women assign more time to domestic work and men spend more time working in the labor market. Skilled women assign more time to market work than unskilled women, but instead of reducing domestic work time, they reduce leisure time.

[2] The survey does not specify educational level. We estimate the figures presented in table 2 after matching the Use of Time Survey and the Household Survey. The methodological aspects about this are presented in the Annex 1.

Table 2: Weekly time assignment of population between 14 and 65 years old by gender and level of education – in percentage

	All			Less than 12 years of schooling			12 years of schooling or more		
	Men	Women	All	Men	Women	**All**	Men	Women	**All**
Market work	20.2	11.1	15.4	19.2	9.3	**14.1**	23.5	15.3	**18.7**
Domestic work	5.6	16.2	11.2	5.5	16.7	**11.2**	5.9	15.1	**11.3**
Leisure	32.5	31.0	31.7	33.7	32.3	**33.0**	28.9	27.9	**28.3**
Personal care	41.7	41.7	41.7	41.7	41.7	**41.7**	41.7	41.7	**41.7**
Total	100.0	100.0	100.0	100.0	100.0	**100.0**	100.0	100.0	**100.0**

Source: Own estimations based on Survey on the Use of Time and CHS

3. Model and Calibration

The effects of trade liberalization on macro and microeconomic variables are estimated using a CGE model. In this section we present an overview of the model and its calibration. Finally, we discuss the extent to which our model and its calibration represent the gender features of the Uruguayan labor market.

3.1. Model

The core model is based on Laens and Terra (1999, 2000) and Terra et al (2006). We maintain its structure in terms of the analysis of trade-related issues but we work with alternative specifications regarding the labor market in order to take into account gender issues. Specifically, we use three different versions of the model: first, we disaggregate demand for male and female labor (model 1), second, we consider male and female labor supply as endogenous (model 2) and third, we incorporate domestic work into the model (model 3).

The general structure of the CGE model is quite conventional. Uruguay is assumed to be a quasi-small economy (following Harris) with three trading partners: Argentina, Brazil and the rest of the world. The Uruguayan economy is explicitly modeled, while import demand from the trading partners is assumed to be perfectly elastic, and export demand presents a downward slope that is a negative function of export prices in Uruguay. We assume perfect competition in all sectors, and goods are differentiated by geographic origin (Armington). There are ten representative households according to income. The government collects taxes, pays transfers to households and buys goods. Government savings are obtained as a residual. The complete core model and equations are presented in Annex 2.

The model presents two distinctive features. In the first place, the labor market module follows a wage curve behavior specification, introducing unemployment for unskilled workers, whether male or female. There are different interpretations about the existence of a negative relationship among wages and unemployment (Blanchflower and Oswald). The efficiency wage model, which argues that firms need to pay a wage premium for efficiency

reasons, seems to offer the most attractive explanation. When unemployment rises, the premium needed to promote workers' effort and to retain them declines. In this paper we use different wage curves for women and men. Specifically, we use Bucheli and González's estimations, which found a stronger curve for women. In the context of efficiency wage models, this may be due to gender-differentiated levels of investment in specific human capital. The higher the investment level, the more costly it is to dismiss the worker and to recruit and train a new worker. That is, firms tolerate more shirking among workers. Thus, when unemployment rises, the required wage premium will not decline as much as for workers with low specific human capital. It is usually argued that the level of specific human capital is lower for women. Additionally, Bucheli and González remark that the wage curve would become steeper when more females choose to join the labor market. Indeed, the labor supply increase coming from this behavior would push down female wages, strengthening the "primary" wage curve effect.

Secondly, we extend the model in order to allow the introduction of gender differences. The previous versions of this CGE model did not disaggregate labor by gender and assumed labor participation to be exogenous. We relax these assumptions by steps as in Fofana et al (2003, 2005).

First, in model 1 we disaggregate female and male labor. This relaxes the assumption of perfect substitution between men and women in production. Gender segmentation in the labor market allows an assessment of gender-specific impacts on wages and employment resulting from changes in sectoral structure. Following Fontana (2001), we assume identical elasticity of substitution for all sectors. However, in the public sector we assume fixed employment and one wage for both female and men labor, i.e., perfect substitution among female and men labor[3]. We maintain the assumption of fixed public sector employment.

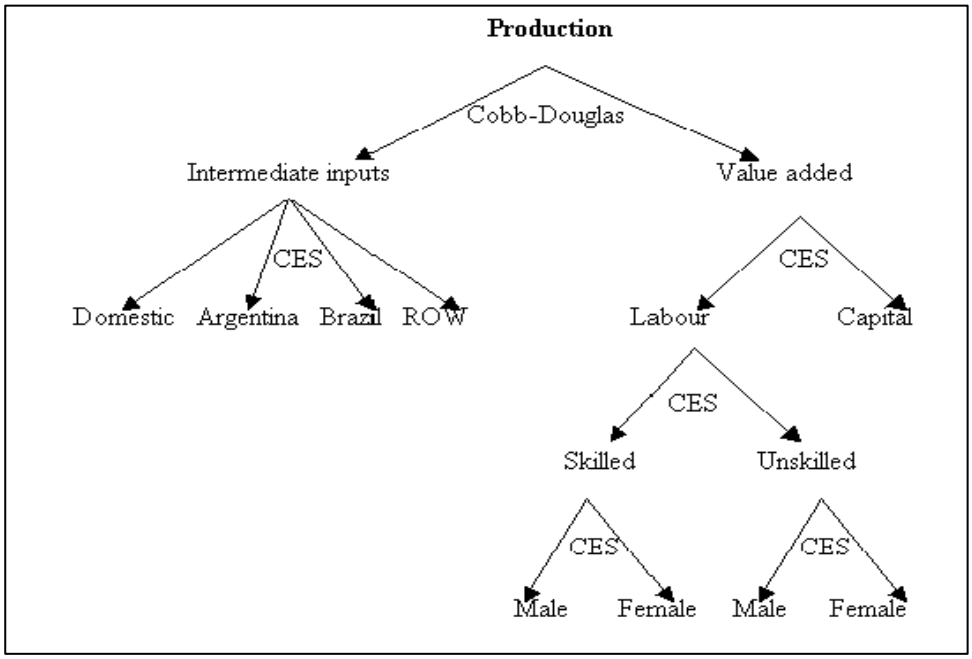
There are six factors of production: skilled female labor, skilled male labor, unskilled female labor, unskilled male labor, public labor and capital.

Following Laens and Terra (1999), we assume a nested production function. At the top level, a Cobb-Douglas function combines intermediate inputs and value added. At the second level, value added is comprised of capital and labor. At the third level, labor is comprised of skilled and unskilled labor. Finally, a new equation that combines labor by sex

[3] This assumption is consistent with empirical findings about gender discrimination in the public sector in Uruguay (Amarante).

in order to get a composite labor by education is included in the model[4]. Figure 2 presents the nested production function for this model.

Figure 2: Production function of the firm



Labor by gender is combined in the following CES function:

$$ws_{s,i} = \left[\sum_{g} (wl_{g,s,i}.(1+tfac_{g,s,i}))^{1-\theta g_i} .\xi g_i^{\theta g_i} \right]^{1/(1-\theta g_i)} \quad (1)$$

In which $ws_{s,i}$ is the wage for composite labor by skills, $wl_{g,s\,i}$ are the wages for each labor type respectively, *tfac* is the labor tax rate, ξg is the distribution parameter, and θg_i is the elasticity of substitution between men and women. Subindex *s* refers to a subset that includes labor categories by skills (skilled and unskilled), subindex *g* refers to labor categories by gender (male and female) and subindex *i* refers to sectors.

Then, to get aggregated labor, labor by skills is combined in the firm's production function following the CES function:

$$w_i = \left[\sum_{s} (ws_{s,i}.)^{1-\theta_i} .\xi_i^{\theta_i} \right]^{1/(1-\theta_i)} \quad (2)$$

[4] We adopt this production function in order to consider the evidence that there is segmentation by gender in the labor market in Uruguay.

in which w_i is the wage for aggregated labor, ξ_i is the distribution parameter and θ_i is the elasticity of substitution between skill levels of labor.

In the second step, we relax the assumption of an exogenous labor force and introduce non labor market time, which is composed of both leisure and domestic work (model 2). Men and women spent their time in market work and non-market work. In addition, a minimum required time for subsistence is fixed.

Domestic work at home and leisure time are introduced in the utility function of the households, but we assume them to be perfect substitutes. Each household maximizes its utility subject to a budget constraint, which includes market income earned by the household plus non-labor income.

The utility function is a Cobb–Douglas function that combines consumption of leisure by type of labor (*L*) and of market goods (*C*) for each type of household:

$$U_f = \prod_{lab} L_{lab,f}^{\mu_{lab,f}} \prod_i C_{if}^{\mu_{if}} \quad (3)$$

The budget constraint for each type of household is:

$$\sum_i p_i C_{i,f} + \sum_{lab} w_{lab} L_{lab,f} = FY_f = R_h + \sum_{lab} w_{lab} LM_{lab,f} + \sum_{lab} w_{lab} L_{lab,f} \quad (4)$$

where FY_f refers to the total income of the household (including income derived from leisure) and R_h refers to non-labor income.

Workers also face a time constraint, spending their total time in market labor and leisure:

$$T_{lab,f} = LM_{lab,f} + L_{lab,f} \quad (5)$$

From the optimization of the utility function, subject to the budget and time constraints, we can derive labor supply equations ($ls_{lab,f}$) and final goods demand of households (c_{if}):

$$ls_{lab,f} = \max hs_{lab,f} - \frac{\mu_{lab,f} . y_f (1 - td_f)(1 - msav_f)}{(1 - \sum_{lab} \mu_{lab,f}) . w_{lab}} \quad (6)$$

Where max $hs_{lab,f}$ is the maximum hours available for leisure and work, and is considered a fixed parameter in the model, $y_f (1 - td_f)(1 - msav_f)$ represents households' available income and w_{lab} is the wage for each type of labor. Note that household income

and wage elasticity of supply are different among types of households and categories of labor and are not constant.

$$c_{if} = \frac{\mu_{if}.y_f(1-td_f)(1-msav_f)}{(1-\sum_{lab}\mu_{lab,f}).pf_i} \quad (7)$$

Finally, model 3 considers that households use part of their time to produce goods at home that are consumed by themselves. Thus, we distinguish between leisure and domestic work. Additionally, the model requires fixing an elasticity of substitution between male and female labor in home production. Following Fontana and Wood, we fix it at a lower level than the elasticity of substitution between men and women in labor market, in order to reproduce the rigidity of labor at the household level.

In this case, a household's utility is a function of the consumption of market-produced goods, home goods (*CZ*) and leisure, and the budget constraint includes home goods.

$$U_f = \prod_{lab} L_{lab,f}^{\mu_{lab,f}}.CZ_f^{\mu z_f} \prod_i C_{if}^{\mu_{if}} \quad (8)$$

s.t.

$$\sum_i p_i C_{i,f} + \sum_{lab} w_{lab} L_{lab,f} + pz_f cz_f = FY_f = R_h + \sum_{lab} w_{lab} LM_{lab,f} + \sum_{lab} w_{lab} L_{lab,f} + pz_f cz_f$$

and

$$T_{lab,f} = LM_{lab,f} + L_{lab,f} + LZ_{lab,f} \quad (10)$$

Labor supply is now:

$$ls_{lab,f} = \max hs_{lab,f} - lz_{lab,f} - \frac{\mu_{lab,f}.y_f(1-td_f)(1-msav_f)}{(1-\sum_{lab}\mu_{lab,f} - \mu z_f).w_{lab}} \quad (11)$$

Where $lz_{lab,f}$ is the time used by different categories of labor for domestic work.

The final goods demand of households also changes:

$$c_{if} = \frac{\mu_{if}.y_f(1-td_f)(1-msav_f)}{(1-\sum_{lab}\mu_{lab,f} - \mu z_f).pf_i} \quad (12)$$

And a new equation that determines demand for domestic goods is introduced:

$$cz_f = \frac{\mu z_f.y_f(1-td_f)(1-msav_f)}{(1-\sum_{lab}\mu_{lab,f} - \mu z_f).pz_f} \quad (13)$$

Home goods are produced and consumed by the same family.

Minimizing the cost of production for domestic goods subject to the production function, we obtain the price of domestic goods (pz_f) and labor demand for production of domestic goods ($lz_{lab,f}$):

$$pz_f = \frac{\left[\sum_{lab} \alpha h_{lab,f}^{\,1/\rho_f+1} . wl_{lab}^{\,\rho_f/\rho_f+1}\right]^{(\rho_f+1)/\rho_f}}{AH_f} \quad (14)$$

$$lz_{lab,f} = \left(\frac{pz_f \alpha h_{lab,f}}{wl_{lab}}\right)^{1/\rho_f+1} . AH_f^{\,-(\rho_f/\rho_f+1)} . QZ_f \quad (15)$$

Where $\alpha h_{lab,f}$ is the share parameter in the CES production function, AH_f is the scale parameter and $\rho_f = (1- \sigma z_f)/ \sigma z_f$

σz_f being the elasticity of substitution between different labor categories in the domestic goods production function.

Finally, the equilibrium condition in the domestic good market is:

$QZ_f = cz_f$ (16)

In Annex 2 we present the calibration of parameters of the three versions of the model.

The model is run using GAMS (General Algebraic Modeling System).

3.2. Calibration

We use data from the year 2000 to calibrate the model in the form of a Social Accounting Matrix (SAM). Changes to the original SAM are described in detail in Terra et al (2006). Basically, it has 23 sectors of production, one being an informal sector that only produces for the domestic market and another one being the public sector. Then, it has three factors of production (skilled labor, unskilled labor and capital), two kind of national institutions (households, presented as ten representative household according to income, and government) and three trading partners (Argentina, Brazil and the rest of the world).

For the purposes of this paper, we modified the SAM in order to adapt it to the three specifications of the model, introducing the gender dimension in steps.

As model 1 considers four types of private labor, we distinguished them in the SAM, using data from the Continuous Household Survey for 2001. The share of each labor category in total labor by sectors is the following:

Table 3: Share of labor categories by sector

Sector of activity (SAM)	Skilled female labor	Skilled male labor	Unskilled female labor	Unskilled male labor	Total
Agriculture	3.0	27.6	8.0	61.5	100.0
Husbandry	0.0	0.0	11.5	88.5	100.0
Forestry	13.6	33.7	1.6	51.1	100.0
Other primary	0.5	2.7	3.9	92.9	100.0
Meat processing	4.3	10.4	21.3	64.0	100.0
Dairy products	4.3	10.4	21.3	64.0	100.0
Rice	4.3	10.4	21.3	64.0	100.0
Tanning	2.9	15.6	17.7	63.8	100.0
Wood and paper	0.6	6.8	12.0	80.5	100.0
Chemicals	11.8	33.7	15.6	38.8	100.0
Ceramics	0.0	0.0	1.8	98.2	100.0
Export activities	5.6	11.0	34.3	49.2	100.0
Non tradable activities	8.6	23.6	12.2	55.6	100.0
Import activities	4.5	14.8	11.3	69.5	100.0
Hotels and restaurants	12.8	9.3	27.0	50.9	100.0
Health	38.5	25.3	26.9	9.4	100.0
Other services	36.0	39.3	12.2	12.5	100.0
Construction	3.8	15.9	2.8	77.5	100.0
Refinery	12.1	31.6	6.5	49.9	100.0
Gas	13.5	23.0	6.9	56.6	100.0
Trade and transport	7.6	17.6	17.3	57.5	100.0
Informal activities	0.0	0.0	34.4	65.6	100.0
Average	18.3	22.4	16.6	42.7	100.0

Source: SAM

There are several male-intensive activities, such as agriculture, husbandry and other primary activities, while health, export activities and other services employ a higher percentage of women. Female labor is concentrated in a few sectors, as table 4 shows.

Almost 50% of total female labor is concentrated in "*other services*", which includes private education, services to firms and domestic services. This figure is even higher when we consider only skilled female labor, while unskilled women are employed in more activities, such as informal activities, trade and transport (basically retail) and health. The main activities that employ female labor account for less than 20% of total exports, while this figure increases to almost 39% when we consider only exports to Argentina.

Table 4: Concentration of female labor by sector of activity – in percentage

Sector	Total female labor	Skilled female labor	Unskilled female labor	Share of total exports	Share of exports to Argentina
Other services	49.7	70.8	26.4	5.7	12.0
Health	14.4	16.2	12.4	0.0	0.0
Informal activities	12.3	0.0	25.8	0.0	0.0
Trade and transport	11.0	6.4	16.1	12.6	26.4
Rest of activities	12.6	6.6	19.2	81.6	61.6
Total	100.0	100.0	100.0	100.0	100.0

Source: SAM

Table 5 shows labor income by deciles and types of labor. As we can see, the importance of female labor income is higher in the middle, from the fourth to the ninth decile.

This is consistent with the fact that unskilled women, concentrated in the first deciles of income, work less, whereas the richest households' income relies more on skilled men. This last fact may be explained by the existence of a glass ceiling for female wages.

Table 5: Households' labor income by deciles

	Skilled women	Skilled men	Unskilled women	Unskilled men	Public labor	Total	Women (%)
First decile	0.4	0.8	21.4	67.2	10.2	100.0	21.8
Second decile	0.8	1.2	20.7	63.1	14.3	100.0	21.4
Third decile	1.2	1.8	20.5	58.7	17.8	100.0	21.7
Fourth decile	2.3	3.2	22.2	53.2	19.1	100.0	24.5
Fifth decile	4.0	5.0	21.5	48.7	20.9	100.0	25.5
Sixth decile	6.2	7.1	18.4	44.7	23.7	100.0	24.6
Seventh decile	7.6	10.5	18.1	37.5	26.2	100.0	25.7
Eighth decile	10.2	12.7	15.2	33.7	28.3	100.0	25.4
Ninth decile	13.6	18.8	11.4	24.8	31.4	100.0	25.0
Tenth decile	15.3	28.8	6.2	14.5	35.2	100.0	21.4

Source: SAM

In model 2, labor supply is endogenous and depends on the wage and on the households' income as shown in equation (6). The wage elasticity of supply is higher for women than for men. The wage elasticity is higher for skilled labor, especially in the case of women. Additionally, the elasticity for women decreases with household income. The same patterns are observed for income elasticity.

Model 2 also includes a new activity: leisure. Following Fontana and Wood, this activity is a fiction, assuming that it "produces" using only labor, "pays" to households and produces one type of good that is consumed only by households. In Annex 1 we explain how we estimate time devoted to leisure by households and labor categories. In order to introduce this data into the SAM, we valuate time spent in leisure as the opportunity cost of not working in the market. For doing so, we calculate the average hourly wage for each labor category and each household. This is important because the average hourly wage depends not only on the worker's qualifications or skills, but also on other variables such as the social network of the household. We assume that there is a minimum time assigned to personal care. Following Fontana and Wood (2000), we fix this minimum time at 10 hours per day.

Model 3 separates leisure activity into leisure and domestic work. Annex 1 also presents the estimation of time spent doing domestic work. In the SAM, domestic work is also valuated as the opportunity cost of not working in the market. The opportunity cost is evaluated for each category of worker and for each type of household (defined by deciles of income).

Table 6 shows the ratio between male and female valuated time assigned to each activity. Women spend more time than men in domestic work while men spend more time in

market work and leisure. The gender gap of time assigned to market work is wider among unskilled workers.

Table 6: Ratio of valuated time (men/women)

	Skilled	Unskilled
Market work	1.8	2.6
Leisure	1.1	1.3
Domestic work	0.4	0.4

Source: SAM

3.3. Model: scope and limitations

In sum, our model and the calibration methodology follows previous works in CGE gender-aware models (Fofana et al, 2003 and 2005; Fontana, 2001; Fontana and Wood). There are two main differences from previous models. First, we assume different behavior in private and public labor markets. This is important in Uruguay because, as mentioned above, empirical evidence suggests that there is gender discrimination in the private sector but not in the public sector. This feature could not be ignored in a model for Uruguay because the public sector accounts for 29% of total wages in our SAM and the level of employment is rigid. In this case, our model assumes that labor is undifferentiated by gender. In contrast, we assume a gender-segmented labor market in the private sector.

Second, we assume ten representative households by level of income. In Uruguay, empirical evidence shows that workers from different socioeconomic levels present different behavior in the labor market. Unlike other developing countries, the rural population is not sizable in Uruguay. Therefore, categorizing households by income level is more appropriate than the usual rural-urban distinction. In fact, the calibrated elasticities of supply in our model decrease with the socioeconomic level of the household.

The model also considers other Uruguayan features. In the case of unskilled workers we consider two different wage curves to incorporate unemployment by gender. This is an important feature of the Uruguayan economy where unemployment among the unskilled is quite high and evidence shows that its relationship with wages differs between sexes. Additionally, we take into account gender segregation in the private sector by assuming that female and male labor are imperfect substitutes in the demand for labor.

Thus, this model incorporates a number of important gender features of the Uruguayan labor market, an improvement on earlier versions of the model. Other gender features may be introduced in future versions. First, it would be worth distinguishing between households of different compositions in order to take into account women's greater tendency to participate in the labor market when they are single parents, have no children, or live with elderly people. Second, it would be interesting to consider the presence of a glass ceiling for women. This phenomenon is not considered in the CGE model literature. Two possible

strategies to incorporate it would be to introduce exogenous wage differentials (wider for higher wages) or to consider a new top labor category (i.e. high management) where substitution between men and women is very low. Finally, another aspect that the model does not explore is the impact of a tariff reduction on the cost of domestic goods production. Our model assumes that these goods are produced only with labor, while in fact goods that are usually imported in Uruguay, such as washing machines or microwaves, could increase home production productivity.

4. Scenarios and Results

4.1. Simulation scenarios

For the purpose of assessing gender-differentiated effects of trade policies we simulate three different scenarios. The first one assumes complete trade liberalization with the rest of the world, implying a null tariff level for imports coming from the rest of the world. In the base year, trade with MERCOSUR is already liberalized, and tariffs to imports from Argentina and Brazil are zero. Although we are aware that this scenario is quite extreme and is not likely to happen in the short or medium term, we think that it might provide interesting insights into the gender-specific effects of trade openness in labor markets and also allows us to compare the conclusions with results from other studies.

The second and third scenarios are backwards induction experiments that simulate an increase in protection. One of these scenarios simulates the tariff structure of 1994, when an increase in trade openness was starting to be implemented in Uruguay, and the other one also simulates the existence of reference prices in textiles. Reference prices act as tariffs, so we simulate the equivalent ad valorem tariffs associated with these prices, taken from Terra et al (2005). Garments and textiles use female labor intensively, and for that reason we might expect different results on gender parameters when we introduce reference prices in these sectors. These two scenarios are analyzed together in order to compare how reference prices affected the labor market in the 1990s. Table 7 presents the tariff structure applied in 1994 and the tariff structure in the base year (2000) for comparison. Garments and textiles are considered as “export activities” in the SAM used in this work. When we introduce an equivalent tariff to reference prices, the tariff applied to imports from the rest of the world for “export activities” increases to 30.5% while the one applied to import activities increases to 14%.

Table 7: Ad valorem tariffs simulated for each sector of activity

Sector of activity (SAM)	Tariff structure in 1994			Tariff structure in base year
	Argentina	Brazil	ROW	ROW
Agriculture	2.1	2.1	13.7	3.9
Rice	4.5	4.5	17.7	2.4
Ceramics	5.3	5.3	17.6	12.7
Tanning	0.7	0.6	6	0.1
Export activities	6.3	6.4	18.7	12.9
Forestry	0.8	1.1	11.5	7.8
Meat processing	2.5	2.4	15.5	2.0
Husbandry	1.5	1.4	14.2	0.5
Gas	1.7	1.7	15	0.0
Import activities	2.9	2.9	13.9	7.5
Dairy products	5.6	5.6	16.6	3.8
Wood and paper	6.5	6.5	18.2	5.3
Non tradable activities	4.2	4.1	15.2	10.1
Other primary activities	1.1	1.3	12.9	0.2
Chemicals	1.2	1.5	9.3	6.7
Refinery	0.7	1.1	10.7	0.5
Other services	1.1	1.1	13.9	0.0

4.2. Results

In this section we first analyze the impact of total trade liberalization and then we focus on scenarios where trade protection increases.

4.2.1. Total trade liberalization

Complete trade openness to the rest of the world has the expected positive impact on macroeconomic variables. Both exports and imports increase by more than 10%. Meanwhile, real GDP, absorption and investment rise. The impact is higher in the models with endogenous labor supply, especially when we consider model 3, which also introduces domestic work. Since Uruguayan exports are relative labor intensive, trade liberalization leads to an increase in wages and labor supply. GDP and consumption possibilities increase more than in a fixed labor supply scenario.

Table 8: Impact of trade openness on macroeconomic variables – percentage change

	Exogenous labor supply	Endogenous labor supply	Endogenous labor supply and home production
Absorption	0.53	0.54	0.70
Household consumption	0.69	0.69	0.71
Investment	0.16	0.17	1.37
Real GDP	0.78	0.78	0.95
Exports	12.96	12.94	13.28
Imports	10.25	10.24	10.50
Consumer price index	-0.13	-0.13	-0.12

Since tariffs applied to imports from MERCOSUR partners are nearly zero, trade liberalization affects tariffs applied to the rest of the world (ROW) causing imports from the

ROW to increase significantly while imports from Argentina and Brazil fall. Table 8 shows that the former increases by more than 39% and the latter fall by 22% and 25% respectively. The Uruguayan economy benefits from a significant reduction of trade diversion from MERCOSUR partners. At the same time exports to all destinations increase, but the rise is higher for Argentina (almost 15%) and Brazil (around 14%) than for the ROW (less than 12%). This happens because the average price of exports to the region falls more.

Table 9: Impact of trade openness on trade flows

Model	Trade Flow	Argentina	Brazil	Rest of the world
Exogenous labor supply	Exports	14.7	13.9	11.4
	Imports	-22.2	-25.2	39.2
Endogenous labor supply	Exports	14.8	13.9	11.4
	Imports	-22.2	-25.2	39.2
Endogenous labor supply and home production	Exports	14.8	14.2	11.9
	Imports	-22.1	-25.1	39.5

The increase in exports to the three partners generates an increase in labor demand for all categories of workers. In the case of skilled worked, where perfect competition is assumed, wages increase, while employment also increases when labor supply is endogenous. In the case of unskilled workers, for which we assume a wage curve behavior, unemployment falls while wages and employment increase. Reduced unemployment increases wages because firms are willing to increase the wage premium in order to promote efficiency among workers and/or to help retain employees.

Table 10 shows relative intensity in the use of factors and the trade balance for each trade partner for aggregated sectors[5]. As shown, trade patterns with the main commercial partners differ substantially by sector. Uruguay has a trade surplus with Argentina in services, which are highly intensive in skilled labor, especially female labor. On the other hand, the country has a trade surplus with Brazil and the ROW in agriculture and agroindustries, which are intensive in unskilled male labor. However, Uruguay has a significant trade deficit with the three partners in importable manufactures, which is also intensive in unskilled male labor. As a consequence, changing trade flows resulting from liberalization lead to a change in relative factor demand. The increase in net exports to Argentina leads to a relative increase in demand for skilled females compared to men. In the case of unskilled labor, the opposing effects of trade openness on demand for male labor also results in relatively greater demand for unskilled females compared to unskilled men.

[5] There are six aggregated sectors: agriculture and agroindustries, amounting to primary activities and food industry; import substitution manufactures, which encompass chemicals, paper and ceramics; exporting manufactures, including textiles, garments and tanning; tradable services, including services to enterprises and tourist services such as transport, hotels and restaurants; non tradable services, which are mainly health and informal activities; and oil and gas.

Table 10: Trade balance and relative intensity in the use of factors in main sectors in the reference year

Sector	Relative intensity					Trade Balance (millions of dollars)			
	Skilled Female	Skilled Male	Unskilled Female	Unskilled Male	Capital	ARG	BRA	ROW	Total
Agriculture and agroindustries	0.6	0.8	0.9	1.2	1.0	-9	284	587	862
Exporting manufactures	0.5	0.6	1.0	0.7	1.2	10	54	377	441
Import substitution manufactures	0.8	1.0	0.8	1.1	1.0	-383	-322	-1,232	-1,938
Tradable services	1.5	1.4	0.8	0.5	1.1	435	-24	-162	249
Non tradable services	2.6	1.4	2.3	1.3	0.6	-	-	-	-
Oil and gas	1.0	1.0	0.6	0.8	1.1	-29	-8	-57	-94
Total	1.0	1.0	1.0	1.0	1.0	23	-16	-487	-480

Source: SAM

Labor demand increases more for women for both skill levels. In the case of skilled labor in model 1, this means a higher increase in wages for women (table 11). The gender wage gap thus falls. For unskilled workers, unemployment falls more among women. This, added to the fact that the relationship between unemployment and wages is stronger for women, leads to a higher increase in female wages. Additionally, employment increases more for women than for men. Therefore, all three gender gaps fall.

Table 11: Impact of trade openness on unemployment, employment and wages - percentage change

Skill	Gender	Exogenous labor supply	Endogenous labor supply	Endogenous labor supply and home production
		Unemployment		
Unskilled	Female	-4.30	-4.35	-4.37
Unskilled	Male	-4.13	-5.22	-5.48
		Employment		
Total	Female	0.18	0.28	0.25
Unskilled	Female	0.34	0.32	0.27
Skilled	Female	0.00	0.24	0.23
Total	Male	0.21	0.17	0.20
Unskilled	Male	0.33	0.19	0.24
Skilled	Male	0.00	0.14	0.14
		Wages		
Unskilled	Female	0.66	0.67	0.67
Skilled	Female	1.01	0.83	0.84
Unskilled	Male	0.42	0.54	0.57
Skilled	Male	0.94	0.86	0.88

Model 1 does not allow for a supply response to the increase in labor demand. When we introduce endogenous labor supply in models 2 and 3, the increase in wages positively affects the labor supply while the consequent rise in household income has the opposite effect. In the case of skilled workers the first effect predominates for both sexes, resulting in an increase in labor supply. The final effect on relative employment and wages depends on

the shape and shifts of the labor supply and demand curves for each sex. In this case, employment increases more for women and wages increase more for men. Thus, the employment gap declines, but the gender wage gap increases, contrary to model 1.

In the case of unskilled labor, labor supply declines. This is because the effect of the increase in household income outstrips the effect of the rise in wages. Men reduce labor supply more, so unemployment falls more among this group of workers. Contrary to model 1, the gender unemployment gap increases. If the wage curve for both sexes were identical, the gender wage gap would also increase. As the elasticity of wages to unemployment is greater for women, it would be possible to avoid this effect. Indeed, as in model 1, the final effect is that the gender wage gap falls.

Model 3 distinguishes between leisure and domestic work. Table 12 shows the change in time use by worker category. Skilled workers increase labor market supply and reduce time spent in domestic work and leisure. The increase in the labor market supply is notably higher for women. As was already mentioned, this reduces the employment gap. In contrast, the reduction in leisure and domestic work is less for women, with the result that the gender domestic work gap increases whereas the gender leisure gap declines.

Unskilled workers behave differently. Both men and women reduce their labor market supply, and, as already explained, the gender market work gap declines. Unskilled workers increase leisure and domestic work, with a larger effect for men. Thus, unlike skilled workers, the gender domestic work gap falls and the gender leisure gap increases.

Assuming that households are composed of men and women of the same skill-level (Piani), trade openness generates an intra-household reallocation of time. In the case of "unskilled households", equity improves in terms of gender time distribution between the labor market and domestic work. This result is not observed for "skilled households".

Table 12: Impact of trade openness on time distribution for each labor category - percentage change. Model 3

	Labor supply	Leisure time	Time spent in domestic work
Skilled female workers	0.23	-0.13	-0.10
Skilled male workers	0.14	-0.16	-0.12
Unskilled female workers	-0.08	0.02	0.01
Unskilled male workers	-0.19	0.13	0.09

4.2.2. Backwards induction experiments

The backwards induction experiments may be useful to test which of the stylized facts about the Uruguayan economy and labor market from 1994 to 2000 can be explained by increasing trade openness to the region and the world. Under this scenario, we simulate an increase in tariffs applied to imports from the three partners, with highest tariffs for imports from the ROW, as already shown in table 7.

Table 13 shows that an increase in protection has effects on macroeconomic variables that are opposite to the trade openness scenario. Tariffs increase more for imports from the ROW, and most of the fall in imports is from this region.

Table 13: Impact of trade protection on macroeconomic variables - percentage change.

	Exogenous labor supply	Endogenous labor supply	Endogenous labor supply and home production
		Tariff structure in 1994	
Absorption	-0.48	-0.41	-0.59
Household consumption	-0.55	-0.49	-0.51
Investment	-0.57	-0.32	-1.66
Real GDP	-0.70	-0.62	-0.81
Exports	-13.12	-13.09	-13.43
Imports	-10.55	-10.52	-10.80
Consumer price index	0.11	0.12	0.10

The impact on labor market demand is also opposite to the trade openness scenario: labor demand decreases for all categories of workers (see table 14). Unemployment rises and wages go down. Labor supply increases in the models where it is assumed to be endogenous because the fall in wages reduces the household's income. The positive effect on labor supply prevails over the negative impact of wages, and wages consequently fall more than in the fixed labor supply model.

In model 3, employment among skilled workers increases because the increase in labor supply outstrips the fall in labor demand. Employment increases more for women, while the fall in wages is also higher. The skilled gender wage gap consequently increases and the gender employment gap falls. Table 15 shows that time spent in leisure and domestic work falls both for women and men. The fall is higher for men in both cases, with the end result being an increase in gender domestic work gap and a decline in leisure gap.

In the case of unskilled labor, unemployment increases more than in model 1 for both men and women because of the increase in the labor supply, leading to a larger decline in wages. The fall in employment and the increase in unemployment are larger for men. These two gender gaps decline but the gender wage gap increases. Men and women similarly

reduce their time spent in leisure and domestic work, thus maintaining an unchanged gender leisure gap and slightly increasing the gender domestic work gap.

Table 14: Impact of trade protection on unemployment, employment and wages in a return to the 1994 tariff structure - percentage change

Skill	Gender	Exogenous labor supply	Endogenous labor supply	Endogenous labor supply and home production
		Unemployment		
Unskilled	Female	2.82	3.15	3.23
Unskilled	Male	4.42	4.46	4.86
		Employment		
Total	Female	-0.12	0.11	0.14
Unskilled	Female	-0.23	-0.11	-0.05
Skilled	Female	0.00	0.35	0.35
Total	Male	-0.22	-0.05	-0.09
Unskilled	Male	-0.35	-0.26	-0.32
Skilled	Male	0.00	0.29	0.28
		Wages		
Unskilled	Female	-0.42	-0.46	-0.48
Skilled	Female	-0.09	-0.30	-0.31
Unskilled	Male	-0.43	-0.44	-0.47
Skilled	Male	-0.02	-0.17	-0.20

Table 15: Change in the use of time for each labor category - 1994 tariff structure

	Labor supply	Leisure time	Time spent in domestic work
Skilled female workers	0.35	-0.19	-0.17
Skilled male workers	0.28	-0.31	-0.26
Unskilled female workers	0.19	-0.04	-0.05
Unskilled male workers	0.07	-0.04	-0.06

When we simulate an additional increase in protection due to an introduction of reference prices for textiles and garments, the macroeconomic impact is very similar to the results presented in table 13, but deeper. Table 16 presents the effect on the labor market. It should be noted that the introduction of reference prices, to protect female employment in textiles and garments, reduce the negative impact that higher tariffs have on unskilled female employment. However, unskilled female unemployment increases more, their wages fall more, and labor conditions for the rest of workers deteriorate. In terms of the gender gap, the only difference compared to the previous scenario is that the gender wage gap for unskilled workers declines in model 3. This happens because the protected are export-oriented: even when protection does reduce import competition, the negative impact on exports is even higher when the policy is implemented.

Table 16: Impact of trade protection on unemployment, employment and wages - percentage change. 1994 tariff structure plus reference prices in textiles and garments

Skill	Gender	Exogenous labor supply	Endogenous labor supply	Endogenous labor supply and home production
		Unemployment		
Unskilled	Female	2.83	3.31	3.37
Unskilled	Male	4.76	4.79	5.20
		Employment		
Total	Female	-0.12	0.11	0.15
Unskilled	Female	-0.23	-0.09	-0.02
Skilled	Female		0.34	0.34
Total	Male	-0.24	-0.07	-0.12
Unskilled	Male	-0.12	-0.29	-0.35
Skilled	Male		0.28	0.26
		Wages		
Unskilled	Female	-0.42	-0.49	-0.50
Skilled	Female	-0.13	-0.34	-0.35
Unskilled	Male	-0.46	-0.47	-0.51
Skilled	Male	-0.08	-0.22	-0.25

5. Sensitivity analysis

The results may be sensitive to changes in some of the parameters adopted in the study. In order to test the results' sensitivity, we run three different sensitivity analyses. We also include a new scenario that simulates a break of the MERCOSUR agreement through an increase in tariffs applied to imports from MERCOSUR countries.

5.1. Changes in elasticity of substitution by gender in the production function

In the model, the elasticity of substitution among men and women in the production function is the same for all products, with a value of 1.1. However, the substitution between men and women is presumably more imperfect in some sectors, such as in the construction sector where only 6% of workers are women. Therefore, we run a sensitivity analysis allowing the elasticity of substitution between men and women in the production function to vary among sectors. Even though there is no estimation of this elasticity, we assume that sectors with initially high intensity use of either male or female labor (over 80%) have imperfect substitution of labor by gender, and so the elasticity was set at 0.1. Other sectors present a medium intensity (between 70 and 80%), so the elasticity was set at 0.3. Finally, sectors that hire both male and female labor maintain the elasticity value of 1.1. Table 17 shows the values adopted for each sector.

Table 17: Elasticity of substitution among workers by gender

Elasticity of substitution		
Low	Medium	High
Agriculture, Husbandry, Forestry, Other primary, Wood and paper, Ceramics, Construction, Refinery, Import activities	Meat processing, Dairy products, Rice, Tanning, Non tradable activities, Gas, Trade and transport	Chemicals, Export activities, Hotels and restaurants, Health, Other services, Informal activities

Table 18 shows the impact of trade openness in model 3 (endogenous labor supply and home production) on employment and wages when the elasticity of substitution by gender varies among sectors. We can see that there are no significant differences with the results presented in the previous section. Although female employment increases more and male employment increases less, the differences are very slight. The main conclusions about the effects of trade openness on gender gaps remain the same.

Table 18: Impact of trade openness on unemployment, employment and wages

Skill	Gender	Elasticity equal in all sectors	Elasticity different in some sectors
		Unemployment	
Unskilled	Female	-4.37	-4.40
Unskilled	Male	-5.48	-5.46
		Employment	
Total	Female	0.25	0.26
Unskilled	Female	0.27	0.29
Skilled	Female	0.23	0.22
Total	Male	0.20	0.20
Unskilled	Male	0.24	0.23
Skilled	Male	0.14	0.14
		Wages	
Unskilled	Female	0.67	0.68
Skilled	Female	0.84	0.84
Unskilled	Male	0.57	0.56
Skilled	Male	0.88	0.88

5.2. Changes in the elasticity of substitution in the home production function

Substitution between men and women in domestic work may also be assumed as imperfect. In the model, this imperfection is reflected in the domestic good production function, which is a CES with an elasticity of substitution set at 0.7. In this section we run a sensitivity analysis, changing this parameter to a lower value (0.2) and a higher value (1.2). This elasticity may change the impact on time allocations by gender. Table 19 presents the impact of trade openness on time allocations by gender with the three values of the elasticity adopted.

Table 19: Impact of trade openness on time allocation of workers, with different elasticity of substitution values in the domestic production function

	Labor supply	Leisure time	Time spent in domestic work
Elasticity = 0.2			
Skilled female workers	0.21	-0.15	-0.05
Skilled male workers	0.13	-0.17	-0.06
Unskilled female workers	-0.07	0.02	0.01
Unskilled male workers	-0.18	0.13	0.03
Elasticity = 0.7			
Skilled female workers	0.23	-0.13	-0.10
Skilled male workers	0.14	-0.16	-0.12
Unskilled female workers	-0.08	0.02	0.01
Unskilled male workers	-0.19	0.13	0.09
Elasticity = 1.2			
Skilled female workers	0.24	-0.12	-0.14
Skilled male workers	0.15	-0.16	-0.18
Unskilled female workers	-0.08	0.02	0.02
Unskilled male workers	-0.19	0.12	0.15

Trade openness increases both demand for skilled labor and wages, so skilled workers are tempted to increase labor supply. When substitution between genders in domestic goods production is more imperfect, skilled workers increase labor supply less, reduce leisure time more and reduce domestic work less. Higher substitutability of workers by gender in the home production function leads to an increase in time spent by unskilled men in household activities. Despite this, the general conclusions about the effects of tariff reductions on gender gaps remain the same.

5.3. Maximum time available for work, domestic work and leisure

In the model we assume that the maximum time available for work, domestic work and leisure is 14 hours per day for both genders. The remaining hours of the day are supposed to be the minimum necessary for sleeping, eating, etc. We might assume, however, that women have fewer hours to freely distribute between different activities because of the rigidity of some tasks at home, such as childcare, eldercare, etc. In order to assess the impact of this gender rigidity at home, we assume that women have fewer hours per day to work in the labor market or at home, or to spend in leisure activities, so the maximum time available for women is set at 10 hours.

The changes in time allocation are, as expected, particularly important among women. When skilled women face a restriction on the maximum available number of hours to spend in the three activities, increased time spent in the labor market is less pronounced. Leisure time spent doing domestic work fall more because the original amount of hours in

the base year is lower. On the other hand, unskilled female workers reduce labor supply less, while they increase time spent in leisure and in domestic activities more.

Table 20: Impact of trade openness on workers' time allocation, with different availability of hours per day for women and men

	Labor supply	Leisure time	Time spent in domestic work
MAXHS= 10 (WOMEN)			
Skilled female workers	0.17	-0.18	-0.13
Skilled male workers	0.14	-0.16	-0.12
Unskilled female workers	-0.06	0.03	0.02
Unskilled male workers	-0.19	0.13	0.09
MAXHS= 14			
Skilled female workers	0.23	-0.13	-0.10
Skilled male workers	0.14	-0.16	-0.12
Unskilled female workers	-0.08	0.02	0.01
Unskilled male workers	-0.19	0.13	0.09

5.4. Break of MERCOSUR agreement

The trade openness scenario only simulates liberalization with the ROW, because tariffs on MERCOSUR imports are already zero. This means that we cannot simulate the gender-differentiated effects of liberalization with MERCOSUR partners on employment, wages and time allocation. This section presents the results of a new backwards experiment that simulates an increase in tariffs charged to MERCOSUR partners, using the tariff structure that was initially applied to imports from the rest of the world. The effects of trade openness with MERCOSUR partners should be interpreted as equal and opposite to these results.

Table 21 presents the impact on trade for each partner. We can expect that trade liberalization with MERCOSUR partners leads to a high increase in trade with the region, reducing imports from the ROW.

Table 21: Impact on trade flows from an increase in protection from MERCOSUR imports

Scenario	Trade Flow	Argentina	Brazil	Rest of the world
Increased protection to MERCOSUR	Exports	-8.0	-7.7	-6.5
	Imports	-28.3	-35.8	16.3
Increased protection to Argentina	Exports	-4.0	-4.0	-3.2
	Imports	-32.7	8.0	7.6
Increased protection to Brazil	Exports	-3.6	-3.4	-2.9
	Imports	6.6	-40.6	7.1

Table 22 presents the impact of this simulation on the labor market in model 3. Trade openness with MERCOSUR partners has a similar impact to trade openness with the rest of

the world. Labor demand increases, especially for female and skilled workers. However, the magnitude of the impact is smaller than the results presented in table 11.

Table 22: Impact of trade protection from MERCOSUR on unemployment, employment and wages - percentage change.

Skill-level	Gender	Increased protection to MERCOSUR	Increased protection to Argentina	Increased protection to Brazil
		Unemployment		
Unskilled	Female	2.04	1.07	0.90
Unskilled	Male	2.21	1.23	0.95
		Employment		
Total	Female	-0.17	-0.08	-0.08
Unskilled	Female	-0.18	-0.09	-0.08
Skilled	Female	-0.15	-0.07	-0.07
Total	Male	-0.06	-0.04	-0.03
Unskilled	Male	-0.05	-0.04	-0.02
Skilled	Male	-0.08	-0.03	-0.04
		Wages		
Unskilled	Female	-0.30	-0.16	-0.13
Skilled	Female	-0.40	-0.20	-0.18
Unskilled	Male	-0.22	-0.12	-0.09
Skilled	Male	-0.22	-0.11	-0.10

6. Concluding remarks

In the 1990s the Uruguayan economy deepened trade openness. At the same time there was a reallocation of employment towards the services sector, an increase in the wage gap by skill-level, and an increase in unemployment. Female participation in the labor market grew and the gender wage gap decreased.

In this paper we analyzed the gender-differentiated impacts of trade openness in Uruguay using a gender-aware CGE model. Two main simulations were implemented. The first was complete trade liberalization, eliminating tariffs with the rest of the world. The second was a backward experiment that sets tariff to the 1994 level.

The abolition of tariffs improves the situation of women in terms of employment and wages. The gender employment gap declines for all types of workers. The gender wage gap is reduced among unskilled workers, but in the case of skilled workers the result depends on the specifications of the model. When we introduce endogenous labor supply, the wage gap increases.

The effects of an abolition of tariffs on time allocation are different according to skill-level too. Skilled workers reduce leisure time and domestic work, and increase time spent in the labor market. The increase in the total work burden is higher for women whereas the gender leisure gap falls. The effect is the opposite for unskilled workers, who reduce labor supply, which can be explained by the increase in household income. Meanwhile, domestic

work and leisure time increase. As the decline in the gender gap increases the relative opportunity cost of female non-participation in labor market, we may expect a decrease in traditional specialization (i.e. women in domestic work and men in labor market). Indeed, we find reduced gender gaps in the labor market and in time spent doing domestic work. However, the increase in leisure is higher for men.

The backwards simulation that sets the tariff structure to the 1994 level has opposite effects on macroeconomic variables compared to the total tariff abolition scenario. In the labor market, demand for all types of workers decreases, wages go down, unemployment increases and the gender wage gap increases for both skill levels. These results are consistent with some of the stylized facts observed in the 1990s in Uruguay. Trade openness with the region and the world increased relative demand for female labor, which could explain the observed decrease in the gender wage gap. However, the results of the simulation show a decrease in unemployment, while in fact it grew. This inconsistency reflects one limitation of our model, which does not consider changes in technology. The 1990s saw a strong increase in productivity in Uruguay, which was partly due to technological change that reduced demand for unskilled labor.

Our results point out that the gender-differentiated impact of a tariff reduction or an increase in protection depends on the magnitude and direction of the changes in trade flows. Factor content of trade varies among partners. Net exports to Argentina are skilled and female intensive while net exports to Brazil and the ROW are more intensive in unskilled male labor. Similar conclusions were found in Terra et al (2006) when analyzing the differentiated impact according to skill-level.

The paper also shows that it is important to introduce endogenous labor supply in the model because the calibrated elasticities of supply for Uruguay lead to non negligible changes in labor market participation. The results obtained with a fixed labor supply are different, showing that modelization of labor supply is key.

Unlike other gender-aware models, our model considers differing behavior in the public and private sectors in terms of gender discrimination. This fact is very important in a Uruguayan model, because public employment is a relevant share of total employment, and there is evidence that there is no discrimination in the public sector.

It is also important to use appropriate data. First, the SAM should distinguish the gender-specific activities. In fact, our results should be treated carefully because the sectoral aggregation of our SAM does not allow separate consideration of sectors with greater segregation by gender, especially garments, textiles, domestic service and education. Second, it is necessary to have good quality surveys about time use. Although the

Uruguayan survey has some limitations (such as its coverage), the collected information is consistent with the evidence from other countries.

We simulated a specific policy to protect unskilled women: the introduction of reference prices in unskilled female intensive sectors. The policy improves the relative situation of unskilled women, but it worsens the situation of all other workers in the labor market. We conclude that this type of indirect policy is not the best way to improve the conditions of poorer women in the labor market. A policy that more directly tackles the problem, such as direct subsidies, would be a better option.

We also run a sensitivity analysis that assumes that women have fewer hours to distribute among different activities. This assumption tries to reflect the rigidity of the burden of domestic tasks for women. Under this assumption, we find that women face restrictions to changing their labor market participation. Policies that supply childcare and eldercare services would reduce the related burden and provide women more flexibility to assign time in order to maximize their utility.

References

Aguirre, R. and K. Batthyány. 2005. “Trabajo no remunerado y uso del tiempo. Encuesta en Montevideo y área metropolitana 2003”. UNIFEM, UdelaR, Montevideo.

Amarante, V. 2001. “Diferencias salariales entre trabajadores del sector público y privado”. Serie Documentos de Investigación, DT 2/01, Instituto de Economía, Facultad de Ciencias Económicas y de Administración, UdelaR.

Amarante, V. and A. Espino. 2001. “La evolución de la segregación laboral por sexo en Uruguay. 1986-1999”. Documento de Trabajo 3/01, Instituto de Economía, Facultad de Ciencias Económicas y de Administración, UdelaR.

Armington, P.S. 1969. “A theory of demand for products distinguished by place of production”. IMF Staff Papers, vol. 16, pp. 159-176.

Blanchflower, D. and A. Oswald. 1994. *The wage curve*. Cambridge and London. MIT Press.

Bucheli, M. 2002. “Una aproximación al efecto del trabajador añadido”. LC/MVD/R.195, Oficina de CEPAL de Montevideo.

Bucheli, M. and G. Sanromán. 2005. “Salarios femeninos en Uruguay: ¿existe un techo de cristal?” Revista de Economía 12:2 Segunda Epoca, Banco Central del Uruguay.

Bucheli, M. and C. Casacuberta. 2005. “Incidencia y duración del desempleo, 1991-2002”, in *Uruguay: Empleo y protección social. De la crisis al crecimiento*, ISBN 92-2-317102-2. Organización Internacional del Trabajo, Santiago de Chile.

Bucheli, M. and C. González. 2007. “An Estimation of the Wage Curve for Uruguay”. Documento No. 11/07, Departamento de Economía, Facultad de Ciencias Sociales, Universidad de la República, Uruguay.

Çagatay, N. 2001. “Trade, Gender and Poverty”. Background paper, United Nations Development Programme, Trade and Sustainable Human Development Project.

Casacuberta, C. and M. Vaillant. Nov 2004. “Trade and wages in Uruguay in the 1990’s”. Revista de Economía, Banco Central del Uruguay, 11:2, Segunda Época.

De Soria X.; F. Rivas and M. Taboada 2001. “Oferta laboral de las mujeres”. Documento No. 18/01, Departamento de Economía, Facultad de Ciencias Sociales, Universidad de la República, Uruguay.

Diez de Medina, R. 1992. “El sesgo de selección en la actividad de jóvenes y mujeres”. Documento No. 12/92, Departamento de Economía, Facultad de Ciencias Sociales, Universidad de la República, Uruguay.

Fofana, I.; J. Cockburn and B. Décaluwé. 2003. “Modeling male and female work in a computable general equilibrium mode applied to Nepal”. PEP Network training material, Université Laval.

Fofana, I.; J. Cockburn; B. Décaluwé; R. Mabugu and M. Chitiga. 2005. “Does Trade Liberalization Leave Women Behind in South Africa? A Gender CGE Analysis”. Presented in the 4th PEP Research Network General Meeting, Colombo, Sri Lanka, June.

Fontana, M. 2001. "Modelling the effects of trade on women: a closer look at Bangladesh". IDS Working Paper No 139.

Fontana, M. Oct 2003. “The gender effects of trade liberalization in developing countries: a review of the literature”. Discussion Papers in Economics DP 101, University of Sussex.

Fontana, M. and A Wood. 2000. “Modeling the effects of trade on women at work and at home”. World Development. 28:7, pp. 1173-1190.

Harris, R. Dec 1984. “Applied General Equilibrium Analysis of Small Open Economies with Scale Economies and Imperfect Competition”. *American Economic Review*. 74:5, pp.1016-1032.

Laens, S. and I. Terra. 1999. “Effects of the completion of MERCOSUR on Uruguayan labor market. A simulation exercise using a CGE model”. Documento de Trabajo 21/99, Departamento de Economía, Facultad de Ciencias Sociales, UdelaR.

Laens, S and I Terra. Nov 2000. “Efectos del perfeccionamiento del MERCOSUR sobre el mercado de trabajo de Uruguay: un ejercicio de simulación usando un modelo CGE”, Revista de Economía, Banco Central del Uruguay, 7:2, segunda época.

Piani, G. 2003. “¿Quién se casa con quién? Homogamia educativa en las parejas de Montevideo y Zona Metropolitana”. Documento de Trabajo 13/03, Departamento de Economía, Facultad de Ciencias Sociales, UdelaR.

Rivas, F. and M. Rossi. 2000. “Discriminación salarial en el Uruguay 1991-1997”. Documento de Trabajo Nº 7/00, Departamento de Economía, Facultad de Ciencias Sociales, UdelaR.

Rivas, F. and M. Rossi. 2002. “Evolución de las diferencias salariales entre el sector público y el sector privado en Uruguay”. Documento de Trabajo Nº 2/02, Departamento de Economía, Facultad de Ciencias Sociales, UdelaR.

Siddiqui, R. 2007. “Modelling Gender Dimensions of the Impact of Economic Reforms in Pakistan”. MPIA Working Paper 2007-13, PEP.

Terra, I.; G. Bittencourt; R. Domingo; C. Estrades; G. Katz; A. Ons and H. Pastori. 2005. “Estudios de competitividad sectoriales. Industria manufactura”. Documento de Trabajo Nº 23/05, Departamento de Economía, Facultad de Ciencias Sociales, UdelaR.

Terra, I.; M. Bucheli; S. Laens and C. Estrades. 2006. “The Effects of Increasing Openness and Integration to the MERCOSUR on the Uruguayan Labor Market: A CGE Modelling Analysis”. MPIA Working Paper 2006-06, PEP.

Annex 1: The estimation of the distribution of time

Information about the time devoted to home production is available in a unique time use survey *EUS* (*Encuesta sobre Uso del Tiempo y Trabajo No Remunerado*) carried out by the Department of Sociology of the FCS-UdelaR. The survey was collected over four months in 2003 in the city of Montevideo and its metropolitan area. This region includes 59% of Uruguay's urban population, urban dwellers in turn being 92% of the total population.

The observation unit is the household and the sample size is 1200 households. The respondent was the person responsible for household tasks: 84% of the respondents are women and 16% are men. Aguirre & Batthyány present more information about the characteristics of the survey and analyze the main results.

The survey inquires about several personal characteristics of household members, such as the relationship with the respondent, sex and age. A set of questions collects information about the characteristics of labor market participation for all household members: hours of work, commuting time, occupation, etc. The most important feature of the survey is that it seeks to identify and quantify the main types of labor that people over 14 years old engage in. The questionnaire offers a list of tasks and the respondent has to record the time spent doing each task in the week prior to the interview. Additionally, she has to report the distribution among household members for the total time spent in each task. Notice that this second question is asked only when the respondent actually does the task.

In order to estimate time spent in domestic work, we consider the following tasks: buying food and home furnishings; taking care of pets and plants; organizing and distributing household tasks; several tasks related to child care (feeding children, taking them to school, playing with them, helping them with their homework, bathing them, putting them to sleep); and taking care of elders (such as giving them their medicines or keeping them company). Some tasks are not included in our analysis due to their low frequency: buying and mending clothes, repairing the house or home furnishings, and running household errands.

The time spent doing each task is collected in a table. The tasks appear in the rows and the columns distinguish the members of the household. As just one column is used for the children of the respondent, it is not possible to know the sex of every person. Specifically, there is a problem when the respondent has at least two children of different sexes. In these cases we assign the average for each child older than 14 years old. As there is only one column to report information about the mother and mother-in-law of the respondent, we proceed analogously. The same happens with the father and father-in-law.

Another disadvantage of the data is that the survey does not inquire about the time distribution for the tasks that the respondent does not do. Thus, each task that is the

responsibility of another member of the household is not considered. As 84% of the respondents are women, we expect to observe missing information about time allocation for tasks that are traditionally considered “male tasks”. This appears to be the case for “repairing the house or home furnishings” which consequently has been dropped from the instrumental definition of domestic work.

The calibration of the CGE model requires disaggregating domestic work between categories that take into account sex, education and household income. As the *EUS* does not inquire about the last two variables, we assigned the information about domestic work in the *EUS* survey to the Household Survey *(ECH*) microdata collected in 2001 by *INE*. The *ECH* survey is also used to calibrate other CGE model variables according to a procedure which first fits a model based on the individual *EUS* data to explain the time spent doing domestic work, then applies the estimated coefficients to microdata from the ECH.

In order to estimate the coefficients we use a Generalized Lineal Model. The dependent variable is the amount of time spent on domestic work by the individual. The independent variables are chosen between the set of potential determinants that are collected both in the *EUS* and the *ECH*.

The explanatory variables are: i) a dummy variable that takes a value of 1 when the individual works in the labor market, ii) the amount of hours spent in the labor market in the week prior to the interview, iii) age and its square, iv) a dummy variable that takes value if there is a woman (other than the individual) older than 13 years old, v) a deprivation indicator, vi) size of the household and vii) number of household members less than 14 years old. The deprivation indicator stems from a deprivation index that weights the lack of some conditions that reflects a lack of status. The plausible conditions to be considered are chosen from a set of goods whose possession is specified in both *EUS* and *ECH*: water-heater, heater, fridge, color television, paid television service, washing machine, dishwasher, microwave oven, personal computer, internet access, personal car and a telephone. The weights reflect that the higher the percentage of people who possess the good, the higher the feeling of privation, and thus, the higher the privation index.

We fit a model for men and a model for women. The results appear in Table A1.

Table A1: Results of the GLM estimation. Dependent variable: time spent in domestic work.

	Women	Men
Worker (value 1 if worker)	-13.057**	3.534
	(4.143)	(3.378)
Hours spent in labor market	-0.011	-0.180*
	(0.096)	(0.053)
Age	3.083*	1.543*
	(0.272)	(0.251)
Age squared	-0.032*	-0.017*
	0.003	(0.003)
Another woman (a)	-19.484*	-45.508*
	(2.710)	(9.680)
Privation index	10.051**	1.030
	(4.080)	(3.082)
Household size	-4.359*	-4.971*
	(0.839)	(0.445)
Number of member less than 14 years old	2.381**	0.820
	(1.049)	(0.974)
Constant	-1.908	47.731*
	(5.913)	(11.285)

(a) Takes value 1 if there is a woman (other than the individual) older than 13 years old
*99%; **95%

Annex 2: Core model and calibration of parameters

The CGE model is based on Terra et al (2006). Its structure is quite conventional in terms of the analysis of trade-related issues but we work with alternative specifications regarding the labor market in order to take into account gender issues. Specifically, we use three different versions of the model: first, we disaggregate male and female labor demand (model 1), second, we consider male and female labor supply as endogenous (model 2) and third, we incorporate domestic work into the model (model 3).

The main features of the CGE model (model 0) are:

- It is a multi-sector model, including two special cases. In one of them we assume that employment and wages are fixed: this part of the model gathers all activities in which institutional arrangements and/or trade unions deter workers' dismissal or wage reductions (mainly in public services and the financial sector). The other case is an informal sector that produces one type of good, only for domestic final consumption.
- We assume that Uruguay has three trading partners (Argentina, Brazil and the rest of the world). The Uruguayan economy is explicitly modeled, while in the case of the other trading partners only import supply and export demand are endogenous.
- Perfect competition is assumed in all sectors. However, goods are not homogenous, as they are differentiated by geographic origin.
- We assume that there are ten representative households which represent different income levels (by deciles of the income distribution).
- The government collects tariffs and taxes. Government revenue is used to buy goods and services and to make transfers to households. We assume that the government has fixed consumption of goods and services (in physical units) and that transfers to households are updated according to changes in the average wage. Government savings is obtained as a residual.
- On the production side, the study uses a nested production function. At the top level, firms combine intermediate inputs with value added according to a Cobb-Douglas function. Value added is obtained with a constant elasticity of substitution (CES) function that combines capital and composite labor. Then, composite labor is obtained by combining skilled and unskilled labor with a CES. In the informal sector, thevalue added is only composed by unskilled labor.
- Goods are imperfect substitutes in consumption (Armington). The small country assumption is made for imports, so the country faces a perfectly elastic supply curve in the external markets. However, it is assumed that the country faces a downward

sloping demand curve for exports (quasi-small open economy)[6]. Export demand is a function of relative prices and real income of the trade partners, which are considered as exogenous.

- Total demand for each sector is composed by domestic demand (intermediate and final) plus exports to each of the trading partners.
- The trade balance is fixed at the initial level. The equilibrium in the model is defined by simultaneous equilibrium in goods and factor markets and in the external sector.
- There are three factors of production: capital, skilled labor and unskilled labor (in further specifications of the model, the labor market is also segmented by gender). The supply of each factor is fixed and there is no international mobility. Skilled labor is employed only in the formal sector. Unskilled labor may be employed in the formal or the informal sector.
- Unemployment is fixed.
- The model was run using GAMS (General Algebraic Modeling System).

Equations

First we present all the equations for the basic model (model 0). Then we will specify the main characteristics of the three versions of the model:

Model 1: Disaggregated labor demand by gender

Model 2: Endogenous labor supply and leisure

Model 3: Endogenous labor supply and domestic work

Lower fonts indicate endogenous variables, capital fonts refer to exogenous variables and Greek letters indicate parameters. The subscripts *i, j* refer to sectors, the subscripts *z, t* refer to geographic zones, the subscripts *f* refer to representative households grouped according to income levels, the subscripts *k* refer to *f* plus government and the subscript *h* refers to factors of production as follows:

i, j = {1, 2, …, J}

z = {Uruguay (u), Argentina (a), Brazil (b), rest of the world (r)}

t = a, b, r

f = (f1, f2, f3, f4, f5, f6, f7, f8, f9, f10)

K = (f1, f2, f3, f4, f5, f6, f7, f8, f9, f10, g)

H = (SL, NSL, CAP)

---

[6] Following Cox's specification (1994).

Where *SL* refers to skill labor, *NSL* refers to unskilled labor and *CAP* refers to capital.

We can define a subset LAB of factors H:

LAB = (SL, NSL)

1. Demand structure

The demand functions are derived from a Cobb-Douglas utility function which is an increasing function of consumption of composite goods that combines different varieties of differentiated goods. In turn, the sub-utility functions follow an Armington specification in perfectly competitive sectors, with the goods differentiated by geographic origin.

Consumers maximize a Cobb-Douglas utility function subject to their budget constraint. As such, demand for each good is stated thus:

$$c_{if} = \mu_{if} . \frac{y_f (1 - td_f)(1 - msav_f)}{pf_i} \quad (1)$$

where c_{if} is the demand for a composite final good *i* (differentiated by geographic origin), y_f is the total income of a representative household *f* in Uruguay, td_f is the direct tax rate, $msav_f$ is the marginal propensity to save and pf_i is the composite price index. This index can be written as:

$$pf_i = \left(\sum_z \lambda_{zi}^{\phi_i} \left(p_{zi} \right)^{1-\phi_i} \right)^{1/(1-\phi_i)} \quad (2)$$

where λ_{zi} is the share parameter in the Armington function, Φ_i is the elasticity of substitution between goods of different origins and p_{zi} is the market price of good *i* from market *z.*

Investment demand of good *i* is a fixed share of total investment *I*:

$$c_{iinv} = \mu_{iinv} \frac{I}{pf_i} \quad (3)$$

Final demand of differentiated good *i* produced in country *z*, from institution *k* is:

$$d_{zik} = \lambda_{zi}^{\phi_i} . \left(\frac{p_{zi}}{pf_i} \right)^{-\phi_i} . c_{ik} \quad (4)$$

where d_{zik} is the final domestic demand from institution *k*.

The export demand for a representative domestic firm is a decreasing function of the export price:

$$e_{iz} = \frac{e_{0iz}.p_{iz}^{-\eta_i}.R_t}{ER.pd_{zi}^{-\eta_i}} \quad (5)$$

where e_{iz} is the demand for a variety of the differentiated good *i* in market *z*, p_{iz} is the export price from Uruguay, pd_{zi} is the domestic price index of good *i* in market *z*, R_t is the real income of the partner *t*, *ER* is the exchange rate and e_{oiz} is a parameter.

2. Production

Each sector combines primary factors and intermediate inputs following a Cobb-Douglas production function. The value added is a nested CES production function combining skilled labor, unskilled labor and capital.

3. Cost

Total variable cost is derived from a Cobb-Douglas production function with constant returns to scale. The variable unit cost is:

$$v_i = \omega_i \left(vc_i \left(1 + tind_i\right)\right)^{1-\sum_j \alpha_{ji}} . \prod_j vi_{ji}^{\alpha_{ji}} \quad (6)$$

where v_i is the variable unit cost, vc_i is the value added cost and vi_{ij} is the composite price of intermediate inputs. α_{ij} is the distribution parameter of the Cobb-Douglas production function, $tind_i$ is the value added tax rate and ω_i is a parameter.

In turn, value added is a combination of labor and capital, specified as a CES. Thus, vc_i is:

$$vc_i = \left[\left(1-\delta_i\right)^{\sigma_i} . r_i^{(1-\sigma_i)} + \delta^{\sigma_i} . w_i^{(1-\sigma_i)}\right]^{1/(1-\sigma_i)} \quad (7)$$

where r_i and $w_{i,,}$ are the rental rate of capital and the average wage, δ is the distribution parameter of the CES function for value added, while σ_i is the elasticity of substitution between capital and labor.

As the model considers two types of labor, the average wage is a combination of skilled and unskilled wages. It is assumed that skilled labor and unskilled labor are combined following a CES function, so the average wage is:

$$w_i = \frac{1}{\varphi_i} . \left[\left(1-\xi_i\right)^{\theta_i} . \left(wu\right)^{1-\theta_i} + \xi_i^{\theta_i} . ws^{1-\theta_i}\right]^{1/(1-\theta_i)} \quad (8)$$

where w_i is the average wage, wu_i and ws_i are the unskilled and the skilled wages, respectively, ξ and φ are the distribution and scale parameters, and θ_i is the elasticity of substitution between skilled and unskilled labor.

The intermediate inputs are differentiated by geographic origin with an Armington formulation. The composite price of intermediate inputs is:

$$vi_{ji} = \left(\sum_{z} \gamma_{zji}^{\phi_j} . \left(p_{zj} \right)^{1-\phi_j} \right)^{1/(1-\phi_j)} \quad (9)$$

where p_{zj} is the price in the local market of input *j* used in sector *i* in each zone, γ_{zji} is the CES distribution parameter and ϕ_j is the elasticity of substitution between goods from different origins.

4. Input and factor demand by firm

Firms maximize their profits, so demand for intermediate inputs and value added (labor and capital) in each sector is obtained from their maximization program:

$$x_{zji} = \frac{\alpha_{ji} . v_i}{vi_{ji}} \left(\frac{p_{zj}}{\gamma_{zji} . vi_{ji}} \right)^{-\phi_j} \quad (10)$$

where x_{zji} is the demand for input *j* coming from country *z* and used by sector *i* for each firm in sector *i*. It is a decreasing function of the input price.

Valued added demand is a decreasing function of the value added cost and an increasing function of the unitary cost and output in each sector:

$$va_i = \alpha v_i q_i \frac{v_i}{vc_i \left(1 + tind_i \right)} \quad (11)$$

Factor demand is a decreasing function of the rate of return and is an increasing function of value added and its price:

$$fd_{hi} = \left(\frac{w_{hi}}{\delta_{hi} . vc_i} \right)^{-\sigma_i} . va_i \quad (12)$$

Finally, the labor demand equations are the following:

$$l_{lab,i} = \left(\frac{w_{lab} (1 + tfac_{lab})}{\xi_i . w_{l,i}} \right)^{-\theta_i} . fd_{li} \quad (13)$$

5. Domestic pricing

In the perfectly competitive sectors, the equilibrium price of output is equal to its variable unit cost (v_i):

$$p_{ui} = v_i \left(1 + tex_i \right) \quad \text{when i= competitive sectors} \quad (14)$$

where the lower case *"u"* refers to Uruguay, and *tex* is the excise tax paid by sector *i*. The firms charge the same price in domestic and foreign markets.

6. General Equilibrium

Public services fix prices, wages and employment whereas production level and capital demand is endogenous.

Household income is endogenous and is the sum of the returns to factors of production and transfers from the government:

$$y_f = \sum_i (l_i.w_i + k_i.r_i). + tr_f + \overline{wg}\,\overline{\lg} \qquad (15)$$

Government income is the sum of the receipts of tariff collection, indirect taxes and profits from public firms:

$$y_g = \sum_i (l_i.w_i + k_i.r_i).tind_i + \sum_i (\pi_i). + \sum_i \left(\sum_z \tau_{zi} d_{zi} n_{zi} p_{zi}. + n_{ui} \sum_z \sum_j \tau_{zj} x_{zji}.n_{zj}.p_{zj} \right) \qquad (16)$$

Government expenditure is the sum of household transfers, public wages and government consumption:

$$GE = \sum_f \overline{tr}_f + \sum \overline{d}_{zig} p_{zi} + \overline{wg}\,\overline{\lg} \qquad (17)$$

where *GE* is the government expenditure, *d* is the government consumption of good *i*, which is a fixed coefficient, *wg* is the public wage and *lg* is public employment, both fixed.

Government savings is the difference between government income and expenditure:

$$SG = y_G - GE \qquad (18)$$

It is assumed to be endogenous.

The equilibrium condition in the labor market is:

$$LS_{lab} = \sum_i l_{lab,i} \qquad (19)$$

where LS_i is the supply of labor, which is exogenous.

The equilibrium equation for capital is:

$$K_i = k_i \qquad (20)$$

where K_i is capital supply (exogenous).

When factors are assumed to be sector specific there is one equilibrium condition for each factor and sector, but when factors are assumed to be perfectly mobile there is only one equation for each factor.

The equilibrium conditions in the goods market require that supply equals demand in each sector:

$$q_i = d_{ui} + \sum_j x_{uij} + \sum_t e_{it} \qquad (21)$$

Finally, the external equilibrium is:

$$\sum_i \sum_t e_{it} . p_{ui} ER - \sum_i \sum_t d_{ti} p_{ZI} - \sum_i n_{ui} \sum_j \sum_t x_{tji} .. p_{tj} = B \qquad (22)$$

In all the simulations, *B* is fixed in terms of the numerary.

At equilibrium, investment is equal to total savings:

$$I = \sum_f \left(msav_f . y_{f.} \left(1 - td_f\right)\right) + SG - SCCB.ER$$