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MODELLING THE EFFECTS OF TRADE ON WOMEN, AT WORK AND AT HOME: COMPARATIVE PERSPECTIVES

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ABSTRACT. The effects of trade on women vary by socio-economic characteristics, sector and country. This paper assesses how well such effects can be captured by a gendered social accounting matrix (SAM) and computable general equilibrium (CGE) model. The model is applied comparatively to Bangladesh and Zambia to highlight how differences in resource endowments, labour market characteristics and socio-cultural norms shape the way in which trade expansion affects gender inequalities. The paper also compares simulation results to other approaches in the gender-and-economics literature, discusses strengths and limitations of the CGE methodology, and provides suggestions for further research.

JEL Classification: D58; J16; J22.
Keywords: Bangladesh; Zambia; Gender; Trade; CGE Models.

RÉSUMÉ. Les répercussions d'une libéralisation commerciale pour les femmes varient selon leurs caractéristiques socio-économiques, leurs secteurs d'emploi et les pays. Dans cet article, il s'agit d'évaluer si de tels effets sont bien saisis au moyen d'une matrice de comptabilité sociale (MCS) et d'un modèle d'équilibre général calculable (MEGC) traitant séparément les femmes et les hommes. Le modèle est appliqué au Bangladesh et à la Zambie pour montrer comment les différences dans les dotations factorielles, les caractéristiques du marché du travail et les normes socio-culturelles déterminent l'influence d'une libéralisation commerciale sur les inégalités entre les sexes. L'article compare également les résultats des simulations à ceux d'autres approches de la littérature économique sur les inégalités hommes-femmes, discute les apports et les limites des analyses en équilibre général et propose des pistes pour de futures recherches.

Classification *JEL* : D58 ; J16 ; J22.
Mots-clefs : Bangladesh ; Zambie ; inégalités hommes-femmes ; commerce ; modèles EGC.

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The differential effects of trade expansion on women and men in developing countries are mixed, differing by socio-economic characteristics, sector and geographical region. A gender-aware approach to trade expansion would measure, first, the impact on women's current material status, given existing tasks and responsibilities under the gender division of labour – what in the literature has been termed "practical gender needs" (Moser, 1989; Molyneux, 1985). It should also aim to assess whether trade policies contribute to more egalitarian gender relations, by reducing the basis of women's economic disadvantage and by modifying the gender division of labour in the labour market and/or in the household – thus addressing "strategic gender needs". For example, a short-term increase in female market employment might address a practical gender need by providing women with new earning opportunities. The extent to which strategic gender needs would also be met would depend on the level and quality of that employment and on whether the jobs would widen women's options.

Understanding how both practical and strategic gender interests are affected by greater exposure to trade would thus entail giving consideration to both short and long term changes in the labour market, in the household and in a range of other institutions – and to interactions among them. One would need to examine direct and indirect employment, price and income effects, and also variations in access to resources. It would be important to assess not only whether women increase their income relative to men but also whether they gain greater control over it, what effect earnings have on women's own perceptions and on their social relations within the household and in the broader community. This would require taking into account not only objective but also subjective aspects of well-being. Possible shifts in government spending and taxes resulting from trade liberalisation, as well as changes in risk and vulnerability of households, should also be given attention, as these are likely to have gender-differentiated outcomes (for example when a reduction in tariff revenue affects the public provision of infrastructure and social services that are more frequently used by women).

A variety of tools can be used to examine these dimensions – from econometrics to modelling to qualitative methods. Few studies of the differential effects of trade liberalisation on women and men employ general equilibrium models. Yet such models could be useful for gender analysis. They allow for linkages among actors and sectors and trace indirect effects under clear behavioural assumptions. Fontana and Wood (2000), for example, distinguish female from male labour and include household work and leisure as sectors, in addition to standard market activities. This paper develops their work empirically and methodologically. It applies the Fontana and Wood approach to Bangladesh and Zambia. These two countries have different resource endowments, with abundant labour in Bangladesh and abundant natural resources in Zambia. Gender relations in each are shaped by different labour market institutions, systems of property rights and socio-cultural norms, making comparison interesting. The paper also discusses the modelling approach in relation to other methods in the gender-and-economics literature, to identify strengths and limitations. Thus the analysis in

this paper involves three different levels of comparison: between social accounting matrices (SAMs), between model simulations and between methods.

Section 1 describes how a SAM can be made gender-aware. It illustrates this with data sets from Zambia and Bangladesh that are then used for CGE model simulations analysed in section 2. Section 3 analyses simulation results in the context of other non-modelling approaches and suggests improvements for future work.

Comparison of SAMs

SAMs as tools for gender analysis

By describing all transactions between sectors and institutions in the economy (at one point in time), social accounting matrices are a useful way of representing a wide range of socio-economic characteristics important for the design of policies. When appropriately disaggregated, SAMs can contribute significantly to understanding the gender effects of economic reforms, by providing better insights into the different roles of women and men in the generation and distribution of income and the interactions between households and the market economy.

The development of satellite time-use modules, which keep a record of how much time people spend on various tasks and impute a monetary value to non-market time, spent either on household activities or on leisure, is of particular relevance to gender analysis.

As early as 1987 Pyatt recommended extension of SAM accounts by imputing value to time which is not explicitly marketed for financial remuneration: "… since the economic activities of women are disproportionately concentrated on unremunerated activities, the present proposals would go a long way towards redressing the current practice of grossly discounting their contribution" (1987: 1).

To make these household services visible, beyond being important in itself, allows consideration of more constraints and interactions than with a standard accounting framework, particularly interactions between behaviour inside and outside the household which are crucial to understanding issues such as the response of female labour force participation to reform of economic policies. An accurate assessment of the gendered impact of economic policy changes also requires explicit consideration of time spent on leisure. This is because there are sharp differences in the extent of personal time between women and men and because changes in the market can alter the amount of time spent on rest and recreation, thus affecting welfare in ways that are overlooked in standard economic analysis. If two households have the same money income but in one its members have more personal time for leisure and relaxation, then there is an evident difference in their living standards, which should be taken into account in policy formulation.

Evaluations of this kind, however, are data-demanding and often methodologically difficult, which helps to explain why only a few countries to date provide SAM satellite accounts regu-

larly. Most of the (few) available SAMs with gender features limit these to disaggregation of some sort of conventional accounts. For example, Nyanzi (2000) in a SAM for Uganda distinguishes household types not only by location and income level but also by the gender of the household's head. This allows him to assess the gender implications of changes in both direct and indirect taxation.

Fontana and Wood (2000) take the gender disaggregation of SAMs further. They not only distinguish factors, sectors and households by gender, but also add estimates of social reproduction (or household work) and leisure to the standard accounting framework. This approach is used to extend two existing SAMs of Bangladesh and Zambia, which are compared in the following section.

Bangladesh and Zambia

Sub-Saharan Africa and South Asia are markedly different in their export structure, with Africa's exports heavily concentrated on primary products and South Asia's exports consisting mainly of labour-intensive manufactures. These differences largely reflect differences in the two regions' combination of human and natural resources relative to other regions: abundant natural resources and a low level of education in Africa and few natural resources and a low level of education relative to the supply of labour in South Asia (Wood and Mayer, 2001; Mayer and Wood, 2001). Zambia and Bangladesh are no exception to these patterns. In Zambia the main export is copper while in Bangladesh the main export is ready-made garments (RMG). The Bangladeshi labour force is on average less educated than the Zambian one but the ratio of person-years of schooling to the country's land area is 40 times larger in Bangladesh than in Zambia[3].

Whether women benefit from a country's greater exposure to trade depends on which factors of production experience a rise in demand, and what are the prevailing gender norms regulating ownership of the factors that stand to gain. Women are more likely to benefit from increases in labour intensive production because women's rights over their own labour are less alienable than their rights over land and natural resources. Property rights in land are usually more favourable to women in Sub-Saharan Africa than in South Asia but are less relevant to the gender distribution of gains from trade in the latter region (Joekes, 1999).

Traditionally, women's participation in market activities in Bangladesh has been very low and confined to a narrow range of casual jobs on the margins of the labour market. However, since the establishment of the garment factories in the 1980s, considerable changes in female labour force participation have taken place. These are documented in a rich literature (Kabeer, 2000; Sobhan and Khundker, 2001; Zohir, 1998). Women's contribution to agricul-

3. In 1990 the ratio, (with land area measured in square km, and years of schooling by average adult years of schooling multiplied by the number of adults), was 1,100 for Bangladesh and 27 for Zambia: Wood and Mayer (2001) and Mayer and Wood (2001).

ture is significant but still little studied, as women in this sector work mostly as unpaid family labour on activities carried out within the homestead.

Women in Zambia mostly work in the agricultural sectors. There is a strong dualism in men's and women's rights and responsibilities in Zambian agriculture. Non-staple food crops are women's sole responsibility but most crops are grown with both male and female labour. Zambia has a high proportion of female-headed households, who face particular constraints as producers and are over-represented among poor small farmers. In urban areas, women are heavily concentrated in informal sector occupations.

The gendered social accounting matrices for Bangladesh and Zambia described in this section both refer to a similar time period, 1994 for Bangladesh and 1995 for Zambia. They were constructed by integrating existing data sets with additional information on the gender structure of the economy, both in the labour market and at the household level[4]. The innovative feature of these two SAMs is the addition of social reproduction and leisure activities. Social reproduction includes services provided within households for own-consumption, which the standard System of National Accounts (SNA) defines as "economic" but not "productive" (United Nations, 1993), such as care of children, cooking and cleaning. Leisure covers activities which the SNA defines as "non-economic" (because they cannot be delegated to a third person) but excludes the minimum time needed for sleeping, eating, personal hygiene, and medical treatment (assumed to be 10 hours for both men and women)[5]. Fontana (2001) and Fontana (2002) provide details on how the value added in the social reproduction and leisure sectors was estimated.

TABLE 1 compares the export structure and the employment distribution of the female labour force in the two SAMs. It shows that exports are quite concentrated in both countries and that the proportion of the female labour force employed by the export sectors is higher in Bangladesh than in Zambia. Manufactures constitute about 92 per cent of total exports in Bangladesh and account for about 11 per cent of female market employment. In Zambia, copper constitutes about 78 per cent of exports but employs less than one per cent of the female labour force. In both Bangladesh and Zambia more than 60 per cent of women work in agriculture, a sector with few exports (and probably, in both countries, with few prospects of becoming a leading export sector). Women work also in services (30 per cent of the female labour force is in services in Zambia and 20 per cent in Bangladesh) but are mostly concentrated in sectors which are non-traded (trade and transport in Zambia and domestic services in Bangladesh).

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4. As explained in both this section and the introduction, Bangladesh and Zambia were chosen for comparison as they have different factor endowments and socio-economic features, thus illustrating well the issues addressed in this study. Data availability was another important factor influencing the choice of countries.
5. Some studies, such as Zaman (1995) on Bangladesh, suggest that time spent eating and sleeping might also vary by gender. In these SAMs, however, for simplicity, differences in time spent on personal care by men and women are all captured by differences in leisure time.

Table 1 - Export composition and gender structure of the labour force in Bangladesh and Zambia

%

	Bangladesh		Zambia	
	Total exports	Female market employment	Total exports	Female market employment
Primary products*	8.1	68.9	81.2	64.4
of which copper	0.0	0.0	78.4	0.3
Manufactures	91.9	11.2	8.6	6.3
of which garments	60.8	6.4	n.a.	n.a.
Services	0.0	19.9	10.2	29.3
Total	100.0	100.0	100.0	100.0

* SITC definition (includes processed primary).

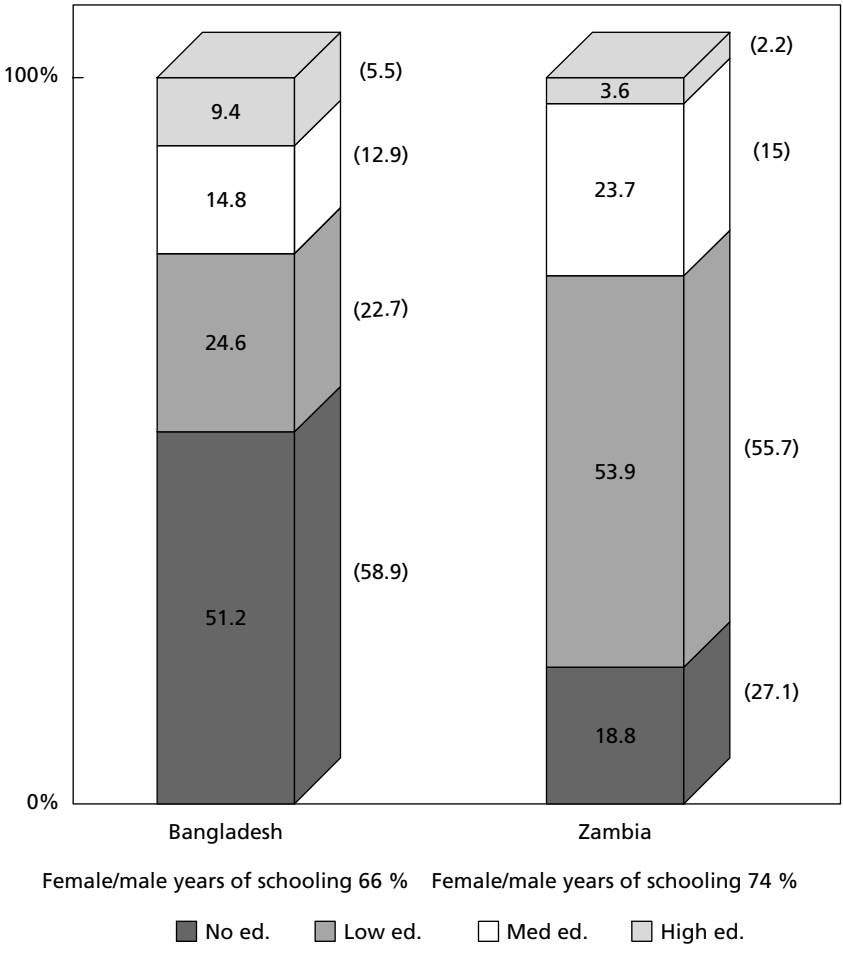
Source: 1994 Bangladesh and 1995 Zambia gendered SAMs (Fontana, 2003).

Bangladesh is far more populous than Zambia, with an adult population of about 63 million compared with 3 million in Zambia. This big difference in the size of the two countries is reflected in their different degree of openness. The share of exports and imports in GDP is higher in Zambia (77 per cent) than in Bangladesh (20 per cent). Hence one would expect the impact of changes in trade policies on the domestic labour market to be smaller in Bangladesh than in Zambia.

On average the adult population is better educated in Zambia than in Bangladesh, as illustrated in FIGURE 1. The level of education of women is lower than that of the total population in both countries. In Bangladesh the educational distribution of the adult population is more unequal not only across educational categories but also (though to a lesser extent) across genders: average years of schooling for women are about 66 per cent of average years for men in Bangladesh, and 74 per cent in Zambia.

Gender inequality is larger in Bangladesh than in Zambia also as far as wages are concerned. This is described in TABLE 2. Women with no education, for example, earn less than 50 per cent of what men of the same group earn in Bangladesh compared with 65 per cent in Zambia. The gender wage gap narrows with tertiary education in both Bangladesh and Zambia, to 70 per cent and 95 per cent respectively. This information should however be taken with caution as reliable data on wages are not available. Wage estimates from various labour force surveys had to be adjusted in both SAMs to correct for discrepancies between value added data and employment data. Other data (for example WISTAT data, United Nations, 1995) however seem also to indicate that gender wage inequalities are wider in Bangladesh than in Zambia. The smaller gap in earnings between female and male workers with university education can be explained by the fact that most highly educated women in both countries are employed by the public sector, where gender disparities in wages are less marked than in other sectors.

Figure 1 - Educational composition of the labour force*



* Figures in brackets are for the female labour force only.

Source: 1994 Bangladesh and 1995 Zambia gendered SAMs (Fontana, 2003).

As shown in TABLE 3, on average, the adult population of both Bangladesh and Zambia spend about 38 per cent of time on leisure and 62 per cent working. There are however differences between the two countries in how the work is distributed between the market and the household, with people in Bangladesh spending 28 per cent of the time on market work compared with 43 per cent in Zambia, and 34 per cent on social reproduction compared with 19 per cent in Zambia. These different patterns mainly reflect women's lower market partici-

Table 2 - Female/male wage gap by educational level

	No education	Low education	Med. education	High education
Bangladesh				
Average female hourly wages as percentage of male wages	48	54	45	70
Market employment (million hours per year)				
Female	133	47	22	11
Male	302	184	113	84
Zambia				
Average female hourly wages as percentage of male wages	65	59	95	95
Market employment (million hours per year)				
Female	906	2471	232	36
Male	557	2365	814	106

Source: 1994 Bangladesh and 1995 Zambia gendered SAMs (Fontana, 2003).

Table 3 - Allocation of time between market and non-market activities

%

Bangladesh	Total	Female	Male
Market	27.8	13.3	42.0
Social reproduction	34.4	53.2	16.1
Leisure	37.8	33.6	41.9
Total	100.0	100.0	100.0
Zambia	**Total**	**Female**	**Male**
Market	43.4	44.9	42.0
Social reproduction	18.5	32.9	5.7
Leisure	38.1	22.2	52.3
Total	100.0	100.0	100.0

Source: 1994 Bangladesh and 1995 Zambia gendered SAMs (Fontana, 2003).

pation in Bangladesh, which results in more time overall being devoted to household work. Men spend the same share of time on market work in the two countries (42 per cent) but enjoy more leisure in Zambia (52 per cent of total time compared with 42 per cent in Bangladesh). A possible interpretation is that, because of rigid socio-cultural norms that encourage women to stay within the homestead, in Bangladesh men are more likely to get involved in household tasks such as food shopping, or anything else that involves "being seen". Fafchamps and Quisumbing (1999) find this type of specialisation in rural Pakistan, where men dominate in "outside" housekeeping tasks such as firewood collection or visiting the market.

It is not certain whether the time allocation surveys for the two countries adopt the same definition of household work[6]. These different patterns, however, are consistent with other evidence on time allocation in South Asia and Sub-Saharan Africa. Studies reviewed in Ilahi (2000) show that in Africa women spend longer hours in both agricultural and non-agricultural activities than do men, while in Asia (and Latin America) the picture is one of a more marked gender division of labour, with men concentrating on income-generating work and women on housework.

The skill and gender composition of both market and non-market sectors varies between Bangladesh and Zambia (data are reported in TABLE A1.1 and A1.2, see APPENDIX 1). Of the two non-market sectors, social reproduction is somewhat more female intensive in Zambia (female time is 84 per cent of total labour time) than in Bangladesh (76 per cent of total). Moreover, while in Zambia social reproduction is more female intensive than any market sector, in Bangladesh there is one market sector, garments, which is more female intensive than social reproduction (83 per cent of total time is female). The garment sector is also the most export oriented sector (88 per cent of its output is exported, as indicated in TABLE A1.3) and one of the most labour-intensive sectors (labour accounts for 77 per cent of total value added).

Leisure is more male intensive in Zambia (only 27 per cent of total leisure time is female) than in Bangladesh (female share is 44 per cent). Indeed, in Bangladesh leisure is more female intensive than most market sectors (with the exception of livestock and horticulture and, of course, garments). Conversely, in Zambia, most market sectors (except for mining, capital-intensive manufacturing, infrastructure and forestry) are more female intensive than leisure. The most female-intensive sectors in Zambia are the agricultural sectors, especially food and livestock (in which 70 per cent of total time is female) and horticulture and groundnuts (60 per cent). These sectors are the least skill-intensive sectors in the market economy in Zambia (although on average they are more skill-intensive than similar sectors in Bangladesh, reflecting the higher average educational level of the workforce in Zambia). Other relatively female-intensive sectors in Zambia are trade and transport, with female time being 51 per cent of total time. The same sectors in Bangladesh are very male intensive (less than 5 per cent of total time is female). Mining, which is by far the most open sector in Zambia (more than 93 per cent of its output is exported), is highly male intensive, with a female share in total time of only 7 per cent. Mining is also the most capital-intensive sector (capital contributes 86 per cent of total value added).

6. Estimating the allocation of women's and men's time between market and non-market activities was not easy, as data on time-use, in both Bangladesh and Zambia, are sparse and cover neither all tasks nor all geographical areas (no time-use study was available for the urban areas, for example). Subsistence agriculture is included in market work.

Comparison of simulations

The previous section has highlighted several differences between Zambia and Bangladesh. Although the two countries have similar production structures (particularly the shares of both agriculture and manufacturing in GDP, as shown in TABLE A1.3), they differ in the sectoral composition of their foreign trade. The degree of their integration into world markets varies – with Zambia being more open than Bangladesh – and so does the female intensity of their traded sectors – with export sectors employing more women in Bangladesh than in Zambia. The mixture of human and natural resources is significantly different, and so are their patterns of distribution. It is to be expected therefore that same trade policies or shocks would have different gendered outcomes in the two countries.

A computable general equilibrium model applied to the Bangladesh and Zambia SAMs is used in this section to analyse the effects of trade liberalisation, simulated as abolition of all tariffs. Both Bangladesh and Zambia have, on average, moderate levels of protection, partly as a result of liberalisation programmes implemented in both countries since the late 1980s. As shown in TABLE 4, the average tariff rate, measured by the ratio of total tariff revenue to total imports, is about 18 per cent in Bangladesh and about 13 per cent in Zambia. The same table also shows that tariffs constitute approximately 30 per cent of total government revenue in both countries. However, as shown in TABLE A1.3, the degree of tariff dispersion is higher in Bangladesh, ranging from 2 per cent in commercial crops (mainly jute, sugar and tea) to more than 61 per cent for food processing (due to high protection in the edible oil sector). In Zambia the tariff ranges from almost zero in commercial crops (cotton, sugar, tobacco and coffee) to 21 per cent in horticulture and groundnuts.

Table 4 - Tariffs and openness

%

	Bangladesh	Zambia
Average tariff rate	18.4	13.4
Tariffs as share of government revenue	30.7	30.0
Imports as share of GDP m.p.	12.1	41.0
Exports as share of GDP m.p.	7.5	36.1

Source: 1994 Bangladesh and 1995 Zambia SAMs (Fontana, 2003).

In a second stage, the simulation of tariff abolition is re-run with alternative parameter values to test the sensitivity of the results to different degrees of responsiveness of gendered aspects of the division of labour to economic change.

The first part of this section provides a brief description of the model. The following sub-sections describe the main experiment and analyses alternative specifications.

The model

The model follows the approach developed by Dervis, de Melo and Robinson (1982). A standard version of the model is documented in Lofgren et al. (2001)[7], while the principles underlying its gendered application are discussed in Fontana and Wood (2000). Their basic framework is neoclassical, but some institutional rigidities and frictions are also included. For example sectors are characterised by imperfect substitution both on the demand side and on the supply side. It is also possible to model market imperfections restricting labour mobility (through a parameter which allow the marginal revenue product of a factor in a particular sector to deviate from the average return to that factor across the economy). The model is designed in such a way as to allow its users to easily choose between alternative features[8]. The discussion here is limited to a brief description of closures and exogenously specified elasticity parameters.

The macro closures and the factor market closures, as well as the elasticities for factor substitution and foreign trade, are set the same for both Bangladesh and Zambia. This might not be "realistic" but ensures that experiment outcomes are driven exclusively by differences in the initial socio-economic structure of the two countries (including their tariff system), rather than by differences in behavioural parameters.

It could be argued that behavioural parameters, by describing the ease with which systems adjust to change, are indeed an important component of a country's socio-economic structure. The aim of this paper is however to isolate the effects deriving from differences in sectoral composition of production and trade, and in factor distribution. Two earlier papers (Fontana, 2001 and Fontana, 2002) analysed experiments in which production, trade and consumption elasticities vary between Bangladesh and Zambia. Sensitivity analysis shows that initial shares are most important and that changes in elasticity values do not affect significantly simulation results.

The production function in the model is a three-level constant elasticity of substitution (CES) function. The substitution elasticity values for each level are listed in TABLE 5. At the lowest level, for each educational category, female labour and male labour of the same skill are aggregated into composite labour. To reflect the rigidity of gender roles, particularly within the household, female/male substitution is limited by setting the value of the elasticities to –0.5 in the market sectors and –0.25 in social reproduction and leisure.

The production function has an intermediate level which aggregates the four educational types of composite labour, with a substitution elasticity of –0.5, into one larger labour bun-

7. Features of the IFPRI standard model such as: a specification that permits any activity to produce multiple commodities; household consumption of non-marketed commodities; and treatment of transaction costs for marketed commodities; have the potential to be used for an improved gender analysis but have not been fully exploited in the current work, due to lack of data.

8. A list of equations is provided on request by the author and is also made available on the website of the quarterly (www.cepii.fr/francgraph/publications/ecointern).

dle. This larger labour bundle is the "output" of the reproduction and leisure sectors. In the market sectors, however, the production function has an upper level which combines composite labour with capital and land to produce net output (which is then combined in fixed proportions with intermediate inputs to make gross output). The value of the substitution elasticity at the upper level varies by sector, ranging from –0.5 in agriculture to –0.8 in manufacturing and services.

The treatment of foreign trade in the model is such that buyers in each sector divide their expenditure between imports and domestically produced goods in shares which vary in response to changes in the ratio of domestic to import prices. Likewise, producers in each sector divide their output between the home and the export markets in shares which vary with the ratio of domestic prices to export prices. These CES import Armington functions and export CET functions partially insulate domestic prices from world prices, unlike more standard trade models in which the domestic prices of traded goods are strictly determined by world prices. As shown in TABLE 6, the elasticity of substitution in both these functions is set at –2.0 in agriculture, –1.5 in manufacturing and –0.8 in services[9].

The values of elasticities of substitution between factors of production, income and price elasticities of household consumption, and trade elasticities – parameters that must be set independently of the data in the SAM – are based in the Bangladesh and Zambia models on "educated guesses". Econometric estimates for gender-related elasticities were not available.

Table 5 - Values of substitution elasticities in the CES production function

	Market			Non-market
Lower level (Labour by gender for each educational group)	0.5			0.25
Intermediate level (Labour by education)	0.5			0.5
	Ag	Mfg	Sv	
Upper level (Labour and non-labour factors)	0.5	0.8	0.8	–

Note: Ag: Agriculture; Mfg: Manufacturing; Sv: Services.

Table 6 - Values of trade elasticities

	CET*	Armington
Agriculture	2.0	2.0
Manufacturing	1.5	1.5
Services	0.8	0.8

* Constant elasticity of transformation.

9. Elasticity values of –0.8 are considered "medium low", –1.5 "medium high" and –3.0 "very high" (Sadoulet and de Janvry, 1995).

The approach was thus to set both the elasticity of substitution between female and male labour and the price elasticity of demand for social reproduction much lower than it is usual in CGE models so as to reflect the rigidity of gender roles in both the market and the household.

As for the macro closures, the balance of trade is fixed and the level of exports and imports adjust through changes in the real exchange rate. Government consumption in each sector is fixed in real terms, as is the demand for investment goods. The savings-investment balance is achieved through adjusting the household propensity to save. The government account balance is achieved through adjusting direct tax rates. It is assumed that loss of revenue from imports is fully recovered by introducing higher direct taxes. In the simulations described in this paper the government increases the income tax rate by a uniform number of percentage points for all income recipients, hence spreading the burden uniformly across households and enterprises. Alternative government account closure rules would be possible. For example, assuming increases in indirect taxes (as often recommended to developing countries by the international financial institutions), or flexible government consumption, would lead to important differences in the distributional effects of trade liberalisation, in terms of both income and gender[10].

A closure combining fixed foreign savings, fixed real investment and fixed real government consumption seemed to be preferable given the short-term static nature of the model. A closure with flexible foreign savings or flexible investment would lead in this context to misleading results. For example, decreases in investment would raise household welfare, but would not allow consideration of welfare losses in later periods likely to result from a smaller capital stock.

As for the factor market, the assumption is that the supply of capital and land in each sector is fixed, but labour is mobile, so that supply to each sector responds freely to demand, within limits set by the fixed total supplies of female and male labour. Alternative rules in the labour market that are relevant to gender analysis could be also modelled. For instance, wage determination mechanisms that reflect bargaining between workers and employers (Taylor, 1989) – with differences in power between male and female workers – or various kinds of rationing. The implications of alternative closures for simulation results will be examined in future work.

The simulation results described in the following pages are analysed with particular attention to: (i) changes in the allocation of female labour between employment in the market economy (and among its different sectors), social reproduction and leisure and (ii) the female wage rate, both absolute and relative to male wages. While the labour categories are identical in the two countries, the classification of production sectors and household types differs between them. To make comparison of results easier, changes are reported for aggregated categories.

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10. Some sensitivity analysis on the fiscal closure was carried out in an earlier paper (Fontana, 2002).

Abolition of tariffs

When all tariffs are removed, the total volume of imports increases by 3.5 per cent in Zambia and by 14.7 per cent in Bangladesh. Imports increase the most in manufacturing, but also in female-intensive agriculture in Zambia, and in manufacturing other than garments in Bangladesh, as these were previously the most protected sectors. In both cases the trade balance is restored by a depreciation of the exchange rate, which is greater in Zambia (7.6 per cent) than in Bangladesh (0.6 per cent), due to greater openness in the former country. The result has also partly to do with the supply elasticity of the export sectors, which is greater in Bangladesh than in Zambia because of the much larger share of labour value added in garments as compared with mining. Since the assumption in the model is that labour is a mobile factor while the supply of capital and land in each sector is fixed, a sector that uses large inputs of labour relative to land and capital is able to increase more easily its output in response to price changes[11].

As a result of the exchange rate depreciation, exports rise in both countries, mainly in garments in Bangladesh, and in mining and in male-intensive agriculture in Zambia. These changes in exports and imports cause domestic market output to increase in both countries by about 0.5 per cent. The results by sector are presented in TABLE 7. The sectors which expand the most are manufacturing in Bangladesh and mining in Zambia (i.e. the export sectors). Within the Bangladesh manufacturing sector, it is garments that rise while food, beverages and tobacco, and other manufacturing decline. Manufacturing in Zambia is unchanged, because of offsetting changes in the capital-intensive sector, which declines, and in the labour-intensive sector, which slightly increases. Agriculture (mainly grains) declines marginally in Bangladesh while it increases in Zambia, due to higher production of male-intensive commercial crops and maize, while output in both female-intensive sectors – food staples and horticulture – falls.

Table 7 - Effects of tariff abolition on output

percentage changes from the base

	Bangladesh	Zambia
Market, of which:	0.5	0.6
Agriculture	–0.2	0.4
Mining	–	1.8
Manufacturing	3.2	0.1
Services	0.2	0.4
Social reproduction	–0.2	–0.3
Leisure	–0.3	–0.7

Source: Model simulations.

11. The sectoral price elasticity of supply is given by $\varepsilon_i = \sigma_i * \theta_{iL}/\theta_{iK}$, where σ_i is the elasticity of substitution in production between factors and θ_{iL} and θ_{iK} are the factor shares for labour and capital or, more generally, for the mobile factor (L) and the fixed factor (K) (Dervis *et al.*, 1982: 264).

The corollary of higher market production is an output fall in social reproduction and leisure. The effect of tariff elimination is to reduce the average price of traded relative to non-traded goods and services. Hence, in both countries, market sectors expand and non-market sectors, being non-traded, contract. The decline is higher in leisure than in social reproduction, since the consumption of leisure is more responsive to price changes than that of household work. Leisure, a male-intensive activity, declines in Zambia more than in Bangladesh, because its opportunity cost increases more in the former country than in the latter, reflecting a larger rise in male wages. The increase in total output (both market and non-market) is 0.2 per cent in Bangladesh and negligible in Zambia[12].

Because of the different gender composition of the expanding and contracting sectors in the two countries, the increase in female market labour force participation in the experiment is larger in Bangladesh than in Zambia and so is the rise in female wages. Effects across educational groups also vary between the two countries.

Employment in the garment sector in Bangladesh rises by about 37 per cent for both women and men, but the absolute increase is higher for women than for men, because of their much larger initial share. Reflecting the educational composition of the garment sector's female labour force, the increase in market employment is largest for women with primary and secondary education (about three per cent), and less significant for the highly skilled (two per cent). Market participation of uneducated female workers rises only by one per cent, as the increase in their garment employment is partly offset by a decline in their time inputs in grain production. A shift in employment from agriculture to the manufacturing sector could have potentially significant positive effects, even when net increases in participation are slight, as this sector generally offer better working conditions than agriculture. Time spent in social reproduction by women with primary and secondary education declines on average by about 0.4 per cent, while their leisure time declines more. A similar pattern, although smaller in magnitude, can be observed for female workers with both higher education and no education. Because the abolition of tariffs causes a significant expansion of the most female-intensive sector in the Bangladesh economy, the economy-wide demand for female labour rises more than the demand for male labour, and hence the wage rate of women increases both absolutely and relative to men. The rise is largest for women with primary and secondary education. Their wage increases by about three per cent in absolute terms, and by two per cent and one per cent respectively relative to that of men with similar skills. These results are described in TABLE 8.

12. Under the assumption of full employment of all factors, changes in total output from simulations can only be slight. A small increase in output could be the result of reallocation of resources from less productive sectors to more productive ones. A wage distortion term called WFDIST is included in the model to capture possible wage differences across activities for the same labour category. WFDIST measures the extent to which the sectoral marginal revenue product of the factor deviates from the average return across the economy. Manufacturing is more productive than the average (WFDIST > 1) in Bangladesh and so is mining in Zambia, but agriculture is less productive than the average (WFDIST < 1) in both countries

Table 8 - Effects of tariff abolition on employment and wages, Bangladesh

percentage changes from base

	Female					Total male
	No education	Primary education	Secondary education	Post education	Total	
Employment						
All market sectors, of which:	**1.4**	**3.1**	**3.4**	**2.2**	**2.1**	**0.3**
Grains	–1.7	–2.0	–1.9	–1.7	–1.8	–1.4
Commercial crops	1.7	0.0	1.5	1.7	1.6	2.0
Livestock and horticulture	0.2	–0.1	0.0	0.2	0.1	0.5
Fishing	0.6	0.3	0.3	0.6	0.5	0.8
Food processing	–2.8	–3.1	–3.0	–2.8	–2.9	–2.6
Garments	36.8	36.4	36.5	36.8	36.6	37.1
Other textiles	10.5	10.2	10.2	10.5	10.4	10.7
Other manufacturing	–13.0	–13.3	–13.2	–13.0	–13.1	–12.9
Infrastructure	0.2	–0.1	–	0.2	0.2	0.4
Trade	0.5	0.2	0.2	0.5	0.4	0.7
Transport	0.7	0.4	–	0.7	0.6	0.9
Public services	0.2	–0.1	–0.1	0.2	0.1	0.3
Financial services	–	–0.1	0.0	0.2	0.1	0.3
Domestic services	0.0	–0.4	–0.3	–0.1	–0.1	0.1
All social reproduction	**–0.2**	**–0.4**	**–0.4**	**–0.2**	**–0.3**	**–0.1**
All leisure	**–0.3**	**–0.5**	**–0.5**	**–0.4**	**–0.4**	**–0.3**
Hourly wages						
Absolute	1.8	2.9	2.5	1.7		
Relative to males*	0.9	1.8	1.4	0.5		

* This is the difference between the absolute percentage change for females and the absolute percentage change for males. A positive value indicates that the female/male wage gap has narrowed.

Source: Model simulations.

Because the elimination of tariffs on traded market goods raises the average demand for market goods relative to non-market goods, female market employment rises in Zambia too, and so does the female wage rate, but by a smaller proportion than in Bangladesh. An important difference, however, is that in Zambia the gender wage gap widens, instead of narrowing as in Bangladesh. This is because mining and commercial crops, the sectors that expand the most as a result of tariff elimination in Zambia, are male intensive.

The increase in market labour force participation in Zambia is small on average (about one per cent) for all educational groups. Employment rises the most (1.1 per cent) for female workers with no education, because of expansion of commercial crops, and for women with secondary education, whose largest sectoral increase is in mining. While for this latter group the rise in market participation is entirely at the expense of their leisure, with only a negligible change in time spent on household work, for the former the decline in non-market time is by 0.5 in social reproduction and by more than one per cent in leisure. Although social reproduction and leisure decline on average, there are differences between some (rich) households, where non-market time rises, and other (poor) households, where it falls. Women of the same skill experience either a decline or a rise in their time inputs on house-

hold work and leisure, depending on the type of household they belong to[13]. It is because in Zambia women with higher education are concentrated in rich households, while women with less education mainly belong to poor ones, that the decline in female non-market time is larger for the latter than for the former.

The impact on wages too differs between these two groups of female workers, with gains being smaller for the higher educated. Women with secondary education are in fact the ones for whom wages increase the least in absolute terms (0.4 per cent) and decline the most (1.1 per cent) relative to men. This is because the sectors that expand in the experiment on average use uneducated female labour more intensively than secondary educated labour. As for other categories of female workers, employment rises by 0.4 per cent for women with primary education, while their wages increase by 0.8 per cent in absolute terms but fall by 0.5 per cent relative to men. Employment of women with tertiary education increases by 0.6 per cent and their wages by 1.0 per cent. The results are reported in TABLE 9.

Changes in the functional distribution of income favour female labour over male labour and labour over land and capital in Bangladesh, while in Zambia non-labour factors gain more than labour factors, and capital gains more than land.

Table 9 - Effects of tariff abolition on employment and wages, Zambia

percentage changes from base

	Female					Total male
	No education	Primary education	Secondary education	Post education	Total	
Employment						
All market sectors, of which	**1.1**	**0.4**	**1.1**	**0.6**	**0.7**	**1.1**
Groundnuts & horticulture	0.0	0.1	–	–	0.1	–0.2
Commercial crops	6.7	0.0	–	–	6.7	6.4
Food & livestock	–0.4	–0.3	–	–	–0.3	–0.6
Fishing & forestry	0.6	0.8	1.0	0.7	0.8	0.5
Maize	2.3	2.4	–	–	2.4	2.1
Infrastructure	5.7	5.8	6.0	5.7	5.9	5.5
Mining	13.8	14.0	14.2	13.9	14.1	13.7
Labour-intensive manufacturing	0.8	0.9	1.1	0.8	0.8	0.5
Capital-intensive manufacturing	–1.8	–1.7	–1.5	–1.8	–1.6	–2.0
Market services	0.9	1.0	1.2	0.9	1.1	0.7
Trade & Transport	0.5	0.6	0.8	0.6	0.6	0.3
Public services	0.1	0.2	0.4	0.1	0.3	–0.1
All social reproduction	**–0.5**	**–0.4**	**0.0**	**–0.1**	**–0.4**	**–0.4**
All leisure	**–1.1**	**–0.9**	**–0.4**	**–0.2**	**–0.8**	**–0.8**
Hourly wages						
Absolute	1.0	0.8	0.4	1.0		
Relative to males	–0.8	–0.5	–1.1	–0.3		

Source: Model simulations.

13. Differences among households are not discussed in this paper. Earlier papers analysed these differences for other simulations.

To conclude, the gender impact of tariff abolition appears overall to be more positive in Bangladesh than in Zambia (FIGURE 2). In Bangladesh women gain in terms of higher market employment and wages. Importantly, it is not only their absolute wages that increase, but also their wages relative to men. In Zambia, absolute income gains are smaller than in Bangladesh while the gender wage gap widens. Thus, in Bangladesh, outcomes are favourable not only because a "practical" gender interest (an increase in the total female wage bill) is satisfied, but also because an opportunity arises for a "strategic" gender interest to be met (through redressing the gender imbalance in economy-wide wages). In both Bangladesh and Zambia higher female market employment means that women spend less time on caring for families and leisure activities. In Bangladesh, the narrowing of the gender wage gap, and thus the increase in the opportunity cost of female workers' time relative to that of male workers, encourages some substitution of male for female labour in social reproduction, potentially leading to a more equitable allocation of tasks within the household[14].

Alternative gender related elasticities

In this section, two variants (V1 and V2) of the main experiment are described. The first experiment increases the price elasticity of social reproduction as a proxy for greater responsiveness of the consumption, or output, of social reproduction to changes in its relative price (and hence more flexibility in the allocation of women's time). The second simulation increases the elasticity of substitution in production between male and female workers in both the market and the household to explore the effects of greater responsiveness of the mixture of female and male workers to changes in their relative wages[15].

Higher price elasticity of demand for social reproduction

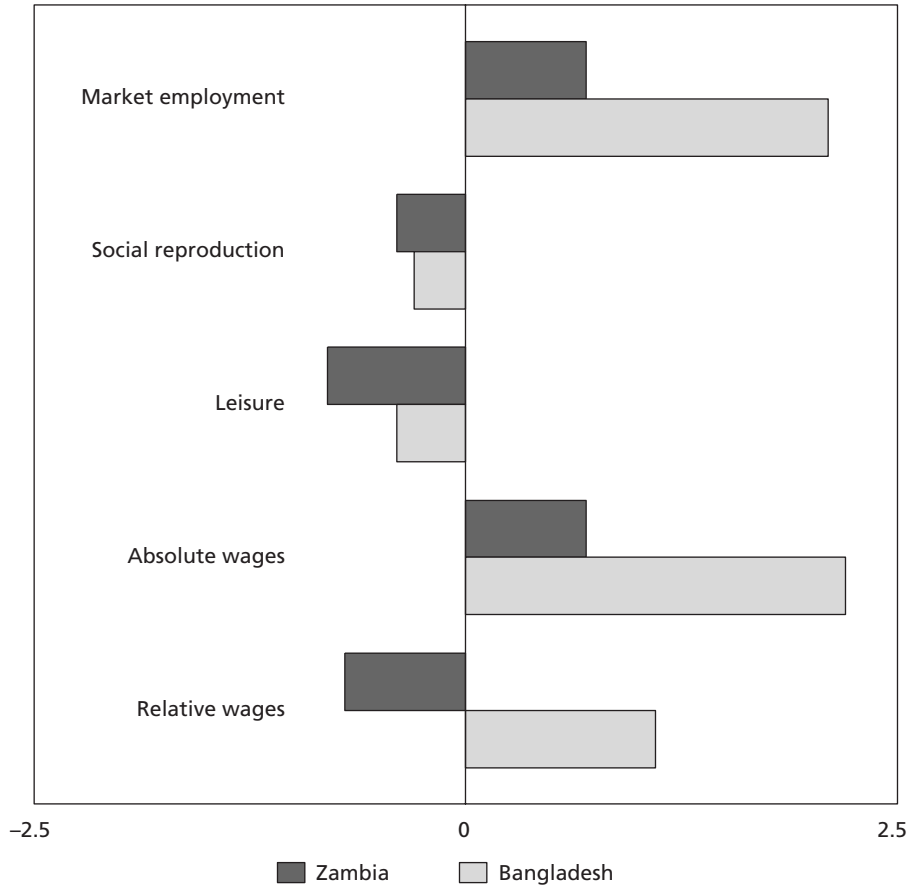
In this version of the main experiment (V1) the price elasticity of demand for social reproduction is set close to –1.0, compared to –0.3 in the main experiment in Zambia and –0.5 in Bangladesh[16]. The main effect of higher responsiveness of consumption of social reproduction services to changes in their relative price is that women's non-market time declines more

14. This happens because the model assumes that the world works in a "Beckerian" way. According to Becker (1965), an increase in the market value of women's time would bring about a reallocation in the division of labour with women increasing their time into market-oriented activities while men reallocated some of their time into domestic non-paid tasks. In reality, the intra-household division of labour might not be very responsive to economic incentives because of strong social and cultural norms. Estimates of the relative role of economic incentives and social customs in determining the allocation of household work show that both are important (Fafchamps and Quisumbing, 1999, on rural Pakistan). A way of representing this in the current model is to vary the elasticity of substitution between male and female labour in non-market activities or the price elasticity of demand for social reproduction.

15. A longer version of this paper analyses other simulations such as across-the-board tariffs and higher import prices of grains.

16. The relationship between different parameters and elasticity values in the Linear Expenditure System (LES), is quite rigid. Changing the price elasticity value for one commodity involves changing all other price and income elasticities for each household type, to satisfy Engel's law (sum of marginal budget shares must be equal to one). The new value of the price elasticity for social reproduction in both countries was chosen so as to keep adjustments to other parameters within a reasonable range.

Figure 2 - Effects on percentage changes in female employment and wages (average across all educational groups)



Source: Model simulations.

in social reproduction and less in leisure, compared with the main experiment. The higher elasticity of demand for household work permits a larger outflow of female labour from social reproduction both in Bangladesh and in Zambia, but the way in which women's time released from the household is reallocated to other activities varies between the two countries, depending on the female intensity of their other sectors, both in the market and the non-market sphere. As shown in TABLE 10, in Zambia the main effect is to make the increase in female market participation larger, especially for women with no education and with primary education, who work mainly in agriculture. Their involvement in crop production is

higher than in the main experiment and, as a result, output in this sector rises more. On average, however, gains in female wages are smaller than in the main experiment, and the gender wage gap widens more. In Bangladesh, the main effect is to allow the outflows from leisure to be smaller. The increase in market participation is smaller too, especially for semi-skilled women (with primary and secondary education), who constitute the majority of workers in the garment sector. For these workers, gains in absolute wages are about the same as in the main experiment but the gender wage gap narrows less. Because of the smaller increase in manufacturing, market output rises slightly less than in the main experiment, social reproduction declines more and leisure falls less.

Since women appear to be more "time-poor" in Zambia than in Bangladesh (leisure constitutes 22 per cent of women's time in Zambia and 34 per cent in Bangladesh), one would have hoped to see a more significant effect (i.e. a much smaller decline of) on women's leisure in Zambia, from simulating a higher elasticity of demand for their household work. This however could have not been expected given the model structure. Because in Zambia commercial crops and maize, the production of which increases as a result of tariff abolition, are more female intensive than leisure, most of the female time released from social reproduction is spent on working more in agriculture. Conversely in Bangladesh, because leisure is more female intensive than most market sectors, the time freed up from household work mainly attenuates the decline in leisure.

Table 10 - Effects of tariff abolition on female market participation and wages, with different elasticity values

percentage changes from the base

	No education			Primary education			Secondary education			Post education		
Bangladesh	Main	V1	V2	Main	V1	V2	Main	V1	V2	Main	V1	V2
Market employment	**1.4**	1.2	1.4	**3.1**	2.8	3.0	**3.4**	3.2	3.4	**2.2**	2.4	2.3
Social reproduction	**–0.2**	–0.3	–0.1	**–0.4**	–0.5	–0.4	**–0.4**	–0.5	–0.3	**–0.2**	–0.5	–0.2
Leisure	**–0.3**	–0.1	–0.4	**–0.5**	–0.2	–0.6	**–0.5**	–0.3	–0.5	**–0.4**	–0.1	–0.4
Wages												
Absolute	**1.8**	1.9	1.5	**2.9**	2.9	2.4	**2.5**	2.4	2.1	**1.7**	1.3	1.6
Relative to males	**0.9**	0.9	0.5	**1.8**	1.7	1.0	**1.4**	1.1	0.8	**0.5**	–0.1	0.3
Zambia												
Market employment	**1.1**	1.3	1.2	**0.4**	0.6	0.4	**1.1**	1.1	1.2	**0.6**	0.5	0.6
Social reproduction	**–0.5**	–0.8	–0.6	**–0.4**	–0.6	–0.4	**0.0**	–0.1	–0.1	**–0.1**	–0.1	–0.1
Leisure	**–1.1**	–1.0	–1.1	**–0.9**	–0.8	–0.8	**–0.4**	–0.4	–0.4	**–0.2**	–0.2	–0.2
Wages												
Absolute	**1.0**	0.8	1.3	**0.8**	0.6	1.0	**0.4**	0.3	0.9	**1.0**	1.1	1.1
Relative to males	**–0.8**	–1.1	–0.2	**–0.5**	–0.8	–0.1	**–1.1**	–1.2	–0.3	**–0.3**	–0.3	–0.1

Source: Model simulations.

Higher elasticity of substitution in production

In this variant of the experiment (V2), the elasticity of substitution between male and female workers, for each skill category, is increased from –0.5 to –2.5 in all market sectors and from –0.25 to –1.25 in all non-market sectors. As described in TABLE 10, in Zambia there are no significant differences in sectoral output changes compared with the main simulation. The higher substitution elasticity causes a marginally higher rise in total market participation for women with no education and women with secondary education, while the effect on market participation for women with primary and tertiary education is unchanged. Women with no education and secondary education experience also a larger decline in social reproduction time while the decline in leisure is the same as in the previous experiment. In Bangladesh, too, differences from the main experiment, in terms of both output changes and female market force participation, are slight. Changes in market participation for women with no education and secondary education are the same as in the main simulation. Market employment increases marginally less for women with primary education (while their leisure time declines more) and more for women with higher education.

Even though these changes are slight, it is possible to note some dissimilarity between Bangladesh and Zambia, particularly as regards patterns across educational categories. In Bangladesh, the higher elasticity of substitution affects female workers with primary and tertiary education, but hardly alters the impact on women with no education and secondary education. Conversely, in Zambia, it is these two latter categories which are most affected, while the effects on female workers with primary and tertiary education are unchanged compared with the main simulation. These differences can be explained by the different wage patterns by level of education in the two countries.

To sum up, the variants of the main experiment show that higher price responsiveness of social reproduction and higher elasticity of substitution in production between male and female labour matter for the overall impact of tariff abolition. These elasticities are determined by a variety of social and cultural factors. The effects of changing them can be positive or negative for gender equality, depending on the gender composition of the non-market sectors relative to market sectors, and on the extent and nature of the gender wage gap.

Comparison of methods

Many different methods can be used to analyse the gender effects of economic reforms: qualitative methods, econometric methods and modelling methods. Each of these methods includes in turn a variety of approaches. For example, some econometric studies use time-series analysis while others are based on panel data analysis. Single-country static general equilibrium models, such as those used in this paper, are only one of many types of models. Modelling can be at the household level, country level or global level, could focus on specific sectors (partial equilibrium) or on the whole economy (general equilibrium) and be either dynamic or static.

Each approach has strengths and weaknesses. No single method or discipline can provide all the answers and often a combination of tools is the best solution. This combination can take various forms. In some cases it might be preferable to use different methods simultaneously but separately, while in others (for example when qualitative information from anthropological and sociological studies is used to specify some model behaviour) a full integration of approaches can be more effective[17]. Validating model results with studies from other methods can also strengthen their influence on policy (Devarajan and Robinson, 2002).

This section compares the model results described in the previous sections with other work in the gender and trade literature. It is divided in three main parts. The first part highlights results that are the same as with other methods. The second part discusses ways in which the modelling approach contributed to a better understanding of the impact (its "strenghts"). The third part examines aspects that the Bangladesh and Zambia models did not cover (their "limitations"). Some of these limitations are specific to the models used in this paper, while others are characteristic of CGE modelling in general. The third part also suggests how CGE models could be improved, so as to reduce their shortcomings relative to what we would like to know about the gender impact of trade.

Results in common with other methods

The simulation findings that trade liberalisation raises female employment and wages in a labour-abundant country like Bangladesh but is not as beneficial for women in a natural resource-abundant country like Zambia are consistent with other evidence. Several studies show that the growth of export-oriented manufacturing, especially in South and South-east Asia, has created many jobs for women, at wages which are higher than they could have earned in the alternative forms of work open to them. Very little research exists on the impact of trade on women in mineral-rich countries like Zambia. The limited research on Sub-Saharan Africa shows that the impact of expanding exports in agriculture is generally less favourable to women (Fontana, 2003).

The SAMs and CGE models in this paper expose reasons for the differences in impact. They clearly show where women are located in the economy, and highlight the mechanisms through which changes in the domestic prices of imports and exports affect a country's output structure and hence its factor demand (and wages). Thus in Bangladesh, where the main export is female intensive (and low skill intensive), women benefit from trade liberalisation. Conversely in Zambia, where the main export is a mineral resource that is highly capital and male intensive in production, women are disadvantaged by greater exposure to trade.

An important point made in feminist economics research (most notably by Elson, 1991) is that increases in female market employment might be at the expense of the time women devote to caring for their families, or, more likely, of their leisure. Macro-economic analysis that omits

17. For a useful discussion on how/when to integrate qualitative and quantitative methods in development research see Kanbur (2002) and Kanbur (2001).

explicit consideration of household work and assumes that women's unpaid labour is infinitely elastic paints a seriously incomplete picture of the impact of changes in policies on the welfare of women and of their dependents. By incorporating social reproduction and leisure sectors, the model used in this paper addresses these concerns and operationalises them numerically.

The responsiveness of gendered aspects of the division of labour to changes in economic incentives – for example, how much the amount of time women spend on household activities falls in response to improvements in their market wage or employment opportunities – varies depending on a wide range of social and cultural norms. For instance, in an analysis of foreign direct investment in Indonesia, Braunstein (2000) discusses how family structures and institutional contexts influence female labour supply: women heads of households may be prepared to work for much lower wages than women in patriarchal households. Some of these interesting dimensions can be implicitly captured by the value of key parameters in the model: for instance, the elasticity of substitution between male and female labour in market and non-market production, and the price elasticity of demand for social reproduction. Depending on the values assigned to these key parameters, the magnitudes of the effects of the experiments in this paper have been shown to vary, which is important to consider when designing policies.

Results not attainable by other methods

The gendered CGE models of Bangladesh and Zambia provide an integrated framework for the analysis of the effects of trade on women which allows consideration of more constraints and interactions than it is possible using other methods.

Most existing research on the gender impact of trade liberalisation looks at specific firms or sectors in isolation, or only at one aspect of well-being, and hence does not provide sufficient analysis of linkages among different dimensions. Partial equilibrium analysis assumes that repercussions from one market to another will be slight and neglects the indirect effects that change in one sector may have on prices, output and employment in other sectors (both market and non-market). Such approaches cannot produce an accurate measurement of net outcomes – it would not be possible to know whether, for example, the number of female jobs that are destroyed in sectors producing import-substitutes would be greater than the number of female jobs created in female-intensive exporting sectors.

Moreover, the use of a partial sectoral method to assess the impact of a trade shock in a non-female-intensive sector, would likely lead to conclude that the shock did not have any gender implications, even though the indirect effects on women were substantial. Most studies of the manufacturing sector in Bangladesh and elsewhere explore effects at the household level (for example Hewett and Amin, 2000 and Zohir, 1998), but do not consider linkages with the rest of the market economy. Some of the Africa agricultural studies (for instance Kennedy, 1994, on Kenya; Kumar, 1994, on Zambia; Katz, 1995, on Guatemala) do however go beyond a single-sector approach, since they examine the effects of commercialisation of certain crops on the food production sector, on other non-farm activities, and on consumption as well as income – important steps towards a general equilibrium analysis.

One of the most important advantages of CGE modelling over other existing methods commonly used is its ability to include a wide range of macroeconomic, sectoral and social impacts and to provide economy-wide quantification of these effects. It is important to know whether effects of a specific policy measure are big or small and what are the main causal chains. By providing a simulation laboratory for controlled experiments, CGE models improve our understanding of the many ramifications induced by a shock and highlight the strength of various forces at work. This can lead at times to exposing a particular mechanism that had not been apparent before.

By contrast with the sectoral studies, more conventional CGE models permit analysis of both direct and indirect effects of trade policies. However, by excluding the household and leisure sectors, they disregard important broader welfare implications and are likely to yield inaccurate results about the impact of such reforms on standard market variables. Within the CGE modelling methods class, gendered models get closer than non-gendered models to results obtained by other methods. An example of this is provided in Fontana and Wood (2000), by comparing results of the same experiment with the stylised model run with and without the non-market sectors. Exclusion of social reproduction and leisure from the model not only omits important information about women's activities and well-being, but also makes the supply of labour to the market economy less flexible.

Model limitations and suggestions for further research

The Bangladesh and Zambia CGE models shed no light on whether gains in female employment from greater trade openness would be sustained over time. Recent studies based on time-series analysis (e.g. Kusago and Tzannatos, 1998) point to a decline in women's share in the manufacturing labour force of several middle-income countries (such as Mexico, Malaysia and South Korea). Female workers do not seem able to maintain their position within the industrial workforce as the composition of exports moves towards more technologically sophisticated goods. Changes over time in gender patterns of production have been observed also in some African agriculture – these too, often, to women's disadvantage. Evidence seems to suggest that, as the prospects for market sales of a crop rises, more men tend to move into its production, e.g. groundnuts in Zambia (Wold, 1997). On a more positive note, case studies of Bangladesh (Kabeer, 2000; Zohir, 1998) suggest that increasing female employment has the potential to change families' attitudes towards considering daughters as assets instead of liabilities. This could lead to more girls being sent to school and hence to a better educated female labour force in the future. These long-term changes are likely to affect strategic gender interests in important ways and are better captured by methods others than CGE modelling.

Time-series analysis indicates dynamic processes of the gender patterns of work. This brings attention to deviations from expected trends, some of which could not be anticipated by a model. For a better understanding of the nature of, and reasons for, these "surprises", qualitative approaches are particularly valuable. Even though qualitative methods might have the disadvantage that their findings cannot be generalised (if random samples are not used), they add

nuances to the analysis that could not be captured by any of the quantitative methods. Through analysis of in-depth interviews of female garment workers and of their family members, Kabeer (2000), for example, points to the diversity of social, cultural and economic factors that have affected women's decisions and their employers' behaviour in Bangladesh since the mid-1980s.

The model used in this analysis is a single period static model and assumes labour endowments and production technology to be fixed[18]. In principle however CGE models can be made dynamic. For instance, the potential positive long-term effect of trade expansion on female education in Bangladesh could be captured by considering in the model a sequence of equilibria whereby in each period the skill level of the female labour force is updated, and the extent of this change is a function of increases in female-intensive production, or a similar such hypothesis. Changes in the productivity of the labour force over time could also be made function of the level of social reproduction provided in each period. This would offer an opportunity to link explicitly the productivity of the labour force to the provision of care.

Still on household activities, the social reproduction sector could be broken up into several subsectors such as childcare, preparing meals and DIY activities. Some of these activities could be modelled as producing joint outputs. This would allow a better understanding of gender roles within the household and would help identify which aspects of women's reproductive labour are likely to be most affected when their time inputs to market activities increase. Time allocation studies of developed countries show that women usually perform the household tasks which are most time inflexible and energy-intensive (Bonke *et al*., 2002; Floro and Miles, 1999) – often carrying out more than one activity at the same time. Information on children's labour by gender, to monitor whether girls and boys are kept out of school to undertake household tasks that their employed mothers no longer have time to complete (for example, Katz, 1995), could also be incorporated in the model. Some indicators could be constructed to link the provision of care to outcomes – using for instance educational levels of the workforce or health statistics.

The Bangladesh and Zambia models were not able to establish conclusively whether rises in female employment and earnings translate into welfare gains for women. This is because the CGE approach used in this paper does not take into account the nature of production relations and the unequal distribution of power and resources between different people.

An intricate web of institutions and norms mediates individuals' access to resources and its translation into impact, which in-depth qualitative research is better able to explain. Several anthropological and sociological studies suggest that, in general, women are more likely to exercise control over the proceeds of their labour when it is carried out in forms of production which are independent of male household members and in social relationships outside the familial sphere (Beneria and Roldan, 1987). Kabeer (2000) provides an interesting example of this in her study of the effects of the clothing industry on two different groups of Bangladeshi women, one working in factories in Dhaka and one involved in home-based

18. Changes in production methods or labour endowments could of course be simulated as part of an experiment.

work in East London. While in Bangladesh the regularity of the wages from the factory jobs, and the location of the work outside the control of male relatives, has increased women's influence on household decisions, and permitted them to escape from situations of oppression, in London, the organisation of work around home-based piecework has meant that the empowering effects have been weak. The CGE model, in its current formulation, would record in both cases an increase in female income, without detecting any difference in outcomes arising from differences in women's ability to control resources.

A more fully developed model of the household based on bargaining behaviour could redress some of these limitations. Game-theoretic approaches – which introduce the idea of preference heterogeneity, bargaining power divergences and individual resource control – are increasingly used to model household decision-making (for example Smith and Chavas, 1999; Warner and Campbell, 2000). Collective household models have the advantage that they allow consideration of unequal intra-household resource allocation. However they take the rest of the economy as given and thus neglect feedback effects.

Ideally, if data on consumption expenditures and assets were available for each household member, some intra-household allocation aspects could be explored within a CGE framework. This could be done by simply assigning different weights to individual utility functions of women and men. These weights could be chosen so as to reflect differences in asset ownership between spouses (which studies have shown is an important determinant of bargaining power). It might be desirable to take intra-household analysis a step further, by nesting a fully developed household model within a CGE model. This would allow consideration of more interactions between macro and micro dimensions than other approaches, but would have the disadvantage of high computational complexity. Another option could be to keep a simpler CGE structure, but to develop an independent module outside the model to be used for post-simulations calculations. This might easier to implement, but should be used only when feedback effects are known to be small.

A shortcoming of CGE models more generally is to disregard the process required to move from the initial to the final equilibrium state, thus ignoring adjustment costs. For example, women who lose their jobs in import substituting industries might not be able to take advantage of newly created opportunities elsewhere in the economy in the short run, or not at all, if adequate training and assistance is not provided or there are severe constraints to their physical mobility. Some studies of displaced workers (for example Beneria, 1998) provide information by gender on the circumstances of their lay-offs, availability of re-training, length of their unemployment spells, quality of any new employment available to them, and other impacts at the family level. The value of these studies is to highlight important short-term effects neglected by the modelling approach.

Finally, CGE models cannot say anything about women's and men's perceptions and feelings. Subjective happiness is a concept that covers many more aspects of human welfare than the standard concept of utility based on revealed preferences (for a review see Frey and Stutzer,

2002). "…Oddly, while economists generally think that people are the best judges of their own welfare, they resist asking people directly how they feel" (Ravallion, 2001 cited in Kanbur, 2002). Research needs to incorporate the possibility that, in some cases, women might not enjoy their higher income if they face increased social tensions as a result of taking paid work. In other cases, women might derive important psychological benefits from paid work that more than compensate for the loss of leisure time and any social censure. Even as regards taking care of children and the elderly in the household, perceptions across individual women might vary from feeling happy to feeling overburdened. Satyajit Ray, in the 1960s Bengali movie "Mahanagar" (The big city), beautifully illustrates the complexity facing women in these choices. Addressing these problems require information which is not found in conventional economic analysis but on which there is a growing literature in other disciplines (for example Chen, 1997; Mohamed and Rajan, 2003).

Conclusions

The CGE model used in this paper provides useful insights into the gendered economic outcomes of trade policies that could not have emerged using other approaches. It is applied comparatively to Bangladesh and Zambia. Simulation results highlight how differences in resource endowments, labour market institutions and socio-cultural norms shape the way in which trade expansion affects gender inequalities, resulting in more favourable effects in Bangladesh than in Zambia.

The paper also suggests that some of the gender effects are better analysed with other methods. In particular, the SAM/CGE approach appears to be more effective in answering questions regarding practical gender needs than in shedding light on how strategic gender needs are affected by economic reforms. No single approach can provide all the insights and information and, hence, the main recommendation of this paper is that a combination of methods be applied.

Methodological tools other than CGE models are useful not only for exploring those dimensions of the gender impact of trade – such as subjective well being or sector-specific changes – that by their very nature require more in depth and more qualitative analyses than what the modelling can offer. Other methods can also be valuable in informing modelling choices. A constant "dialogue" between methodologies should be encouraged in which insights from one approach are used to enrich, or challenge, findings from another approach. The extent to which different perspectives will be used and how they will be combined will depend, each time, on the particular focus of the analysis and specific country contexts.

M. F.[19]

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Appendix 1

Table A1.1 - Educational and gender structure of SAM sectors, Bangladesh

	Shares of sectoral employment *% of female labour*				Females *% of total labour*
	No education	Low education	Med. education	High education	
Grains	59	26	12	4	17
Commercial crops	57	28	11	4	3
Livestock & horticulture	61	25	11	3	47
Fishing	36	17	28	19	29
Food processing	48	26	18	9	30
Garments	43	34	17	7	83
Other textiles	31	35	20	14	12
Other manufacturing	37	31	20	12	16
Infrastructure	48	27	12	13	5
Trade	30	29	24	18	5
Transport	56	26	11	7	1
Public services	5	8	17	70	20
Financial services	3	9	13	75	6
Domestic services	48	25	17	9	43
All market sectors	49	26	15	11	24
All social reproduction	55	23	14	8	76
All leisure	50	25	15	10	44
ALL	51	25	15	9	49

Source: 1994 Bangladesh SAM.

Table A1.2 - Educational and gender structure of the SAM sectors, Zambia

	Shares of sectoral employment *% of female labour*				Females *% of total labour*
	No education	Low education	Med. education	High education	
Maize	7	88	5	0	54
Commercial crops	6	94	0	0	41
Horticulture and groundnuts	19	54	24	4	60
Food and livestock	60	40	0	0	70
Fishing and forestry	12	78	10	0	7
Mining	10	45	41	4	7
Labour-intensive mfg	7	31	57	5	43
Capital-intensive mfg	43	49	7	1	4
Construction and utilities	20	80	0	0	3
Trade and transport	18	46	33	4	51
Public services	35	49	15	1	29
Market services	6	36	52	6	32
All market sectors	7	22	53	18	49
All social reproduction	20	65	14	2	84
All leisure	25	55	18	3	27
ALL	19	54	24	4	47

Source: 1995 Zambia SAM.

Table A1.3 - Sectoral structure of Bangladesh and Zambia

	Net output	Labour	Export intensity*	Import penetration*	Tariff revenue
	% of GDP	*% of tot VA*			*% of imports*
Bangladesh					
Grains	8.8	54.8	–	2.3	12.5
Commercial crops	3.6	33.2	0.1	6.6	2.0
Livestock and horticulture	6.9	44.5	0.2	1.9	8.5
Fishing	2.8	6.3	10.0	–	–
Food processing	4.5	13.1	1.4	1.8	61.4
Garments	1.5	84.9	87.5	8.2	4.1
Other textiles	2.7	72.2	18.5	28.3	11.8
Other manufacturing	3.9	42.2	1.9	45.8	20.8
Infrastructure	12.2	17.5	–	–	–
Trade	16.7	76.6	–	–	–
Transport	14.5	35.4	–	–	–
Public services	12.2	32.2	–	–	–
Financial services	5.5	20.4	–	–	–
Domestic services	3.9	92.7	–	–	–
All market sectors	100.0	43.6	11.4	19.6	18.4
All social reproduction	36.6	100.0	–	–	–
All leisure	52.6	100.0	–	–	–
Total	189.2				–
Zambia					
Maize	4.3	69.5	4.3	15.0	3.1
Commercial crops	1.4	55.6	15.6	16.9	0.4
Horticulture and groundnuts	5.6	90.6	2.9	2.7	21.0
Food and livestock	6.7	80.7	1.9	4.7	18.6
Fishing and forestry	4.8	55.7	–	0.2	15.9
Mining	17.3	13.9	93.3	23.3	20.3
Labour-intensive manufacturing	9.6	51.7	4.0	13.0	11.8
Capital-intensive manufacturing	3.1	35.2	9.1	65.0	14.1
Construction and utilities	6.4	17.7	10.1	0.2	19.5
Trade and transport	20.6	57.9	–	7.7	13.4
Public services	7.3	77.1	–	–	–
Market services	13.0	52.8	8.6	25.2	13.4
All market	100.0	50.9	16.5	20.3	13.4
All social reproduction	20.8	100.0			
All leisure	67.8	100.0			
Total	188.6				

* Export intensity is measured as the share of exports in gross output and import penetration is measured as the share of imports in domestic use.

Source: 1994 Bangladesh and 1995 Zambia SAMs (Fontana, 2003).

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Modelling the effects of trade on women, at work and at home: comparative perspectives
Marzia FONTANA

Appendix : Mathematical Summary Statement for the CGE Model
(see footnote 8 in the paper)

Table A.4. Mathematical Summary Statement for the CGE Model

SETS

Symbol	Explanation	Symbol	Explanation
$a \in A$	activities	$c \in CMN (\subset C)$	commodities not in *CM*
$a \in ACES (\subset A)$	activities with a CES function at the top of the technology nest	$c \in CT (\subset C)$	transaction service commodities
$a \in ALEO (\subset A)$	activities with a Leontief function at the top of the technology nest	$c \in CX (\subset C)$	commodities with domestic production
$c \in C$	commodities	$f \in F$	factors
		$f \in FDIS (\subset F)$	disaggregated factors
		$f \in FAGG (\subset F)$	aggregated factors
$c \in CD (\subset C)$	commodities with domestic sales of domestic output	$i \in INS$	institutions (domestic and rest of world)
$c \in CDN (\subset C)$	commodities not in *CD*	$i \in INSD (\subset INS)$	domestic institutions
$c \in CE (\subset C)$	exported commodities	$i \in INSDNG (\subset INSD)$	domestic non-government institutions
$c \in CEN (\subset C)$	commodities not in *CE*	$h \in H (\subset INSDNG)$	households
$c \in CM (\subset C)$	imported commodities		

PARAMETERS

$cwts_c$	weight of commodity c in the CPI	$\overline{qg}_c$	base-year quantity of government demand
$dwts_c$	weight of commodity c in the producer price index	$\overline{qinv}_c$	base-year quantity of private investment demand
ica_{ca}	quantity of c as intermediate input per unit of activity a	$shif_{if}$	share for domestic institution i in income of factor f
$icd_{cc'}$	quantity of commodity c as trade input per unit of c' produced and sold domestically	$shii_{ii'}$	share of net income of i' to i (i' ∈ INSDNG'; i ∈ INSDNG)
$ice_{cc'}$	quantity of commodity c as trade input per exported unit of c'	ta_a	tax rate for activity a
$icm_{cc'}$	quantity of commodity c as trade input per imported unit of c'	te_c	export tax rate
$inta_a$	quantity of aggregate intermediate input per activity unit	tf_f	direct tax rate for factor f

iva_a	quantity of aggregate intermediate input per activity unit	$\overline{tins_i}$	exogenous direct tax rate for domestic institution i
$\overline{mps_i}$	base savings rate for domestic institution i	$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$mps01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates	tm_c	import tariff rate
pwe_c	export price (foreign currency)	tq_c	rate of sales tax
pwm_c	import price (foreign currency)	$trnsfr_{i\,f}$	transfer from factor f to institution i
$qdst_c$	quantity of stock change	tva_a	rate of value-added tax for activity *a*

Greek Letters

a_a^a	efficiency parameter in the CES activity function	d_c^t	CET function share parameter
a_a^{va}	efficiency parameter in the CES value-added function	$d_{fagg,a}^{va}$	CES value-added function share parameter for aggregated factor *fagg* in activity *a*
$a_{fagg,a}^{va2}$	efficiency parameter in the CES lower level value-added function	$d_{fdi\$a}^{va2}$	CES lower level value-added function share parameter for disaggregated factor *f* in activity *a*
a_c^{ac}	shift parameter for domestic commodity aggregation function	g_{ch}^m	subsistence consumption of marketed commodity c for household h
a_c^q	Armington function shift parameter	g_{ach}^h	subsistence consumption of home commodity c from activity a for household h
a_c^t	CET function shift parameter	q_{ac}	yield of output c per unit of activity a
b_{ach}^h	marginal share of consumption spending on home commodity c from activity a for household h	r_a^a	CES production function exponent
b_{ch}^m	marginal share of consumption spending on marketed commodity c for household h	r_a^{va}	CES value-added function exponent
		$r_{fdi\$a}^{va2}$	CES lower level value-added function exponent
d_a^a	CES activity function share parameter	r_c^{ac}	domestic commodity aggregation function exponent
d_{ac}^{ac}	share parameter for domestic commodity aggregation function	r_c^q	Armington function exponent
d_c^q	Armington function share parameter	r_c^t	CET function exponent

EXOGENOUS VARIABLES

$\overline{CPI}$	consumer price index	$\overline{MPSADJ}$	savings rate scaling factor (= 0 for base)
$\overline{DTINS}$	change in domestic institution tax share (= 0 for base; exogenous variable)	$\overline{QFS}_f$	quantity supplied of factor
$\overline{FSAV}$	foreign savings (FCU)	$\overline{TINSADJ}$	direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{GADJ}$	government consumption adjustment factor	$\overline{WFDIST}_{fa}$	wage distortion factor for factor f in activity a
$\overline{IADJ}$	investment adjustment factor		

ENDOGENOUS VARIABLES

$DMPS$	change in domestic institution savings rates (= 0 for base; exogenous variable)
DPI	producer price index for domestically marketed output
EG	government expenditures
EH_h	consumption spending for household
EXR	exchange rate (LCU per unit of FCU)
$GOVSHR$	government consumption share in nominal absorption
$GSAV$	government savings
$INVSHR$	investment share in nominal absorption
MPS_i	marginal propensity to save for domestic non-government institution (exogenous variable)
PA_a	activity price (unit gross revenue)
PDD_c	demand price for commodity produced and sold domestically
PDS_c	supply price for commodity produced and sold domestically
PE_c	export price (domestic currency)
$PINTA_a$	aggregate intermediate input price for activity a
PM_c	import price (domestic currency)
PQ_c	composite commodity price
PVA_a	value-added price (factor income per unit of activity)
PX_c	aggregate producer price for commodity
$PXAC_{ac}$	producer price of commodity c for activity a
QA_a	quantity (level) of activity
QD_c	quantity sold domestically of domestic output
QE_c	quantity of exports
QF_{fa}	quantity demanded of factor f from activity a
QG_c	government consumption demand for commodity
QH_{ch}	quantity consumed of commodity c by household h
QHA_{ach}	quantity of household home consumption of commodity c from activity a for household h
$QINTA_a$	quantity of aggregate intermediate input
$QINT_{ca}$	quantity of commodity c as intermediate input to activity a
$QINV_c$	quantity of investment demand for commodity
QM_c	quantity of imports of commodity
QQ_c	quantity of goods supplied to domestic market (composite supply)
QT_c	quantity of commodity demanded as trade input
QVA_a	quantity of (aggregate) value-added
QX_c	aggregated quantity of domestic output of commodity
$QXAC_{ac}$	quantity of output of commodity c from activity a
$TABS$	total nominal absorption
$TINS_i$	direct tax rate for institution i (i $\in$ INSDNG)
$TRII_{ii'}$	transfers from institution i' to i (both in the set INSDNG)
WF_f	average price of factor
YF_f	income of factor f
YG	government revenue
YI_i	income of domestic non-government institution
YIF_{if}	income to domestic institution i from factor f

cont. Table A.4.

EQUATIONS

#	Equation	Domain	Description
Price Block			
1	$PM_c = pwm_c \cdot (1+tm_c) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c}$ $\begin{bmatrix} import\ price \\ (LCU) \end{bmatrix} = \begin{bmatrix} import\ price \\ (FCU) \end{bmatrix} \cdot \begin{bmatrix} tariff \\ adjust- \\ ment \end{bmatrix} \cdot \begin{bmatrix} exchange\ rate \\ (LCU per \\ FCU) \end{bmatrix} + \begin{bmatrix} cost\ of\ trade \\ inputs\ per \\ import\ unit \end{bmatrix}$	$c \in CM$	Import Price
2	$PE_c = pwe_c \cdot (1-te_c) \cdot EXR - \sum_{c' \in CT} PQ_c \cdot ice_{c'c}$ $\begin{bmatrix} export \\ price \\ (LCU) \end{bmatrix} = \begin{bmatrix} export \\ price \\ (FCU) \end{bmatrix} \cdot \begin{bmatrix} tariff \\ adjust- \\ ment \end{bmatrix} \cdot \begin{bmatrix} exchange\ rate \\ (LCU\ per \\ FCU) \end{bmatrix} - \begin{bmatrix} cost\ of\ trade \\ inputs\ per \\ export\ unit \end{bmatrix}$	$c \in CE$	*Export Price*
3	$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c}$ $\begin{bmatrix} domestic \\ demand \\ price \end{bmatrix} = \begin{bmatrix} domestic \\ supply \\ price \end{bmatrix} + \begin{bmatrix} cost\ of\ trade \\ inputs\ per \\ unit\ of \\ domestic\ sales \end{bmatrix}$	$c \in CD$	Demand price of domestic non-traded goods
4	$PQ_c \cdot (1-tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c$ $\begin{bmatrix} absorption \\ (atdemand \\ pricesnetof \\ salestax) \end{bmatrix} = \begin{bmatrix} domestic\ demand\ price \\ times \\ domestic\ sales\ quantity \end{bmatrix} + \begin{bmatrix} import\ price \\ times \\ import\ quantity \end{bmatrix}$	$c \in (CD \cup CM)$	Absorption
5	$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c$ $\begin{bmatrix} producer\ price \\ times\ marketed \\ output\ quantity \end{bmatrix} = \begin{bmatrix} domestic\ supply\ price \\ times \\ domestic\ sales\ quantity \end{bmatrix} + \begin{bmatrix} export\ price \\ times \\ export\ quantity \end{bmatrix}$	$c \in CX$	Marketed Output Value
6	$PA_a = \sum_{c \in C} PXAC_{ac} \cdot q_{ac}$ $\begin{bmatrix} activity \\ price \end{bmatrix} = \begin{bmatrix} producer\ prices \\ times\ yields \end{bmatrix}$	$a \in A$	Activity Price
7	$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca}$ $\begin{bmatrix} aggregate \\ intermediate \\ input\ price \end{bmatrix} = \begin{bmatrix} intermediate\ input\ cost \\ per\ unit\ of\ aggregate \\ intermediate\ input \end{bmatrix}$	$a \in A$	Aggregate intermediate input price
8	$PA_a \cdot (1-ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a$ $\begin{bmatrix} activity\ price \\ (netof\ taxes) \\ timesactivitylevel \end{bmatrix} = \begin{bmatrix} value\text{-}added \\ pricetimes \\ quantity \end{bmatrix} + \begin{bmatrix} aggregate \\ intermediate \\ input\ pricetimes \\ quantity \end{bmatrix}$	$a \in A$	Activity revenue and costs

9	$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c$ $\left[CPI \right] = \left[\begin{array}{c} prices\ times \\ weights \end{array} \right]$		Consumer price index
10	$DPI = \sum_{c \in C} PDS_c \cdot dwts_c$ $\left[\begin{array}{c} Producer\ price\ index \\ for\ non\text{-}traded\ outputs \end{array} \right] = \left[\begin{array}{c} prices\ times \\ weights \end{array} \right]$		Producer price index for non-traded market output

Production and commodity block

11	$QA_a = a_a^a \cdot \left(d_a^a \cdot QVA_a^{-r_a^a} + (1 - d_a^a) \cdot QINTA_a^{-r_a^a} \right)^{\frac{1}{r_a^a}}$ $\left[\begin{array}{c} activity \\ level \end{array} \right] = CES \left[\begin{array}{c} quantity\ of\ aggregate value\text{-}added, \\ quantity aggregate intermediate input \end{array} \right]$	$a \in ACES$	CES technology: activity production function
12	$\frac{QVA_a}{QINTA_a} = \left(\frac{PINTA_a}{PVA_a} \cdot \frac{d_a^a}{1 - d_a^a} \right)^{\frac{1}{1 + r_a^a}}$ $\left[\begin{array}{c} value\text{-}added - \\ intermediate\text{-} \\ input\ quantity \\ ratio \end{array} \right] = f \left[\begin{array}{c} intermediate\text{-}input \\ - value\text{-}added \\ price ratio \end{array} \right]$	$a \in ACES$	CES technology: Value—Added—Intermediate—Input ratio
13	$QVA_a = iva_a \cdot QA_a$ $\left[\begin{array}{c} demand\ for \\ value\text{-}added \end{array} \right] = f \left[\begin{array}{c} activity \\ level \end{array} \right]$	$a \in ALEO$	Leontief technology: Demand for aggregate value-added
14	$QINTA_a = inta_a \cdot QA_a$ $\left[\begin{array}{c} demand\ for\ aggregate \\ intermediate\ input \end{array} \right] = f \left[\begin{array}{c} activity \\ level \end{array} \right]$	$a \in ALEO$	Leontief technology: Demand for aggregate intermediate input
15	$QVA_a = a_a^{va} \cdot \left(\sum_{fagg \in F} d_{fagga}^{va} \cdot QF_{fagga}^{-r_a^{va}} \right)^{-\frac{1}{r_a^{va}}}$ $\left[\begin{array}{c} quantity of\ aggregate \\ value\text{-}added \end{array} \right] = CES \left[\begin{array}{c} aggregated factor \\ inputs \end{array} \right]$	$a \in A$	Value-added and aggregated factor demands
16	$W_{fagg} \cdot \overline{WFDIST}_{fagga} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{fagg \in F'} d_{fagga}^{va} \cdot QF_{fagga}^{-r_a^{va}} \right)^{-1} \cdot d_{fagga}^{va}$ $\left[\begin{array}{c} marginal\ cost\ of \\ aggregated\ factor\ fagg\ in\ activity\ a \end{array} \right] = \left[\begin{array}{c} marginal\ revenue\ product \\ of\ aggregated\ factor\ fagg\ in\ activity\ a \end{array} \right]$	$a \in A$ $f \in F$	Aggregated factor demand

17	$$QF_{fagga} = a^{va2}_{fagga} \cdot \left(\sum_{fdis \in F} d^{va2}_{fdisa} \cdot QF_{fdisa}^{-r^{va2}_{fagga}} \right)^{-\frac{1}{r^{va}_{fagga}}}$$ $$\begin{bmatrix} quantity of\ aggregate \\ factor \end{bmatrix} = CES \begin{bmatrix} disaggregated\ factor \\ inputs \end{bmatrix}$$	$a \in A$	Lower level factor aggregation
18	$$W_{fdis} \cdot \overline{WFDIST}_{fdisa} = W_{fagg} \cdot \overline{WFDIST}_{fagga} \cdot QF_{fagga} \cdot \left(\sum_{f \in F'} d^{va2}_{fdisa} \cdot QF_{fdisa}^{-r^{va2}_{fagga}} \right)^{-1} \cdot d^{va2}_{fag}$$ $$\begin{bmatrix} marginal\ cost\ of \\ disaggregated\ factor\ fdis\ inactivity\ a \end{bmatrix} = \begin{bmatrix} marginal\ revenue\ product \\ of\ factor\ f\ in activity a \end{bmatrix}$$	$a \in A$ $f \in F$	Disaggregated factor demand
19	$$QINT_{c\,a} = ica_{c\,a} \cdot QINTA_a$$ $$\begin{bmatrix} intermediate\ demand \\ for\ commodity\ c \\ from\ activity\ a \end{bmatrix} = f \begin{bmatrix} aggregate\ intermediate \\ input\ quantity \\ for\ activity\ a \end{bmatrix}$$	$a \in A$ $c \in C$	Disaggregated intermediate input demand
20	$$QXAC_{a\,c} + \sum_{h \in H} QHA_{ach} = q_{a\,c} \cdot QA_a$$ $$\begin{bmatrix} marketed\ quantity \\ of\ commodity\ c \\ from\ activity\ a \end{bmatrix} + \begin{bmatrix} household\ home \\ consumption \\ of\ commodity\ c \\ from\ activity\ a \end{bmatrix} = \begin{bmatrix} production \\ of\ commodity\ c \\ from\ activity\ a \end{bmatrix}$$	$a \in A$ $c \in CX$	Commodity production and allocation
21	$$QX_c = a^{ac}_c \cdot \left(\sum_{a \in A} d^{ac}_{a\,c} \cdot QXAC_{a\,c}^{-r^{ac}_c} \right)^{-\frac{1}{r^{ac}_c - 1}}$$ $$\begin{bmatrix} aggregate \\ marketed \\ production\ of \\ commodity\ c \end{bmatrix} = CES \begin{bmatrix} activity\text{-}specific \\ marketed \\ production\ of \\ commodity\ c \end{bmatrix}$$	$c \in CX$	Output Aggregation Function
22	$$PXAC_{a\,c} = PX_c \cdot QX_c \left(\sum_{a \in A'} d^{ac}_{a\,c} \cdot QXAC_{a\,c}^{-r^{ac}_c} \right)^{-1} \cdot d^{ac}_{a\,c} \cdot QXAC_{a\,c}^{-r^{ac}_c - 1}$$ $$\begin{bmatrix} marginal\ cost\ of\ com- \\ modity\ c\ from\ activity\ a \end{bmatrix} = \begin{bmatrix} marginal\ revenue\ product\ of \\ commodity\ c\ from\ activity\ a \end{bmatrix}$$	$a \in A$ $c \in CX$	First-Order Condition for Output Aggregation Function
23	$$QX_c = a^t_c \cdot \left(d^t_c \cdot QE_c^{r^t_c} + (1 - d^t_c) \cdot QD_c^{r^t_c} \right)^{\frac{1}{r^t_c}}$$ $$\begin{bmatrix} aggregate\ marketed \\ domestic\ output \end{bmatrix} = CET \begin{bmatrix} export\ quantity, domestic \\ sales\ of\ domestic\ output \end{bmatrix}$$	$c \in (CE \cap CD)$	Output Transformation (CET) Function
24	$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1 - d^t_c}{d^t_c} \right)^{\frac{1}{r^t_c - 1}}$$ $$\begin{bmatrix} export\text{-}domestic \\ supply\ ratio \end{bmatrix} = f \begin{bmatrix} export\text{-}domestic \\ price\ ratio \end{bmatrix}$$	$c \in (CE \cap CD)$	Export-Domestic Supply Ratio

25	$QX_c = QD_c + QE_c$ $\left[\begin{array}{c}\text{aggregate}\\ \text{marketed}\\ \text{domestic output}\end{array}\right] = \left[\begin{array}{c}\text{domestic market}\\ \text{sales of domestic}\\ \text{output [for}\\ c \in (CD \cap CEN)]\end{array}\right] + \left[\begin{array}{c}\text{exports [for}\\ c \in (CE \cap CDN)]\end{array}\right]$	$c \in (CD \cap CEN) \cup (CE \cup CDN)$	Output Transformation for Non-Exported Commodities
26	$QQ_c = a_c^q \cdot \left(d_c^q \cdot QM_c^{-r_c^q} + (1-d_c^q) \cdot QD_c^{-r_c^q}\right)^{-\frac{1}{r_c^q}}$ $\left[\begin{array}{c}\text{composite}\\ \text{supply}\end{array}\right] = f\left[\begin{array}{c}\text{import quantity,domestic}\\ \text{use of domestic output}\end{array}\right]$	$c \in (CM \cap CD)$	Composite Supply (Armington) Function
27	$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{d_c^q}{1-d_c^q}\right)^{\frac{1}{1+r_c^q}}$ $\left[\begin{array}{c}\text{import-domestic}\\ \text{demand ratio}\end{array}\right] = f\left[\begin{array}{c}\text{domestic-import}\\ \text{price ratio}\end{array}\right]$	$c \in (CM \cap CD)$	Import-Domestic Demand Ratio
28	$QQ_c = QD_c + QM_c$ $\left[\begin{array}{c}\text{composite}\\ \text{supply}\end{array}\right] = \left[\begin{array}{c}\text{domestic use of}\\ \text{marketed domestic}\\ \text{output [for}\\ c \in (CD \cap CMN)]\end{array}\right] + \left[\begin{array}{c}\text{imports [for}\\ c \in (CM \cap CDN)]\end{array}\right]$	$c \in (CD \cap CMN) \cup (CM \cap CDN)$	Composite Supply for Non-Imported Outputs and Non-Produced Imports
29	$QT_c = \sum_{c' \in C'} \left(icm_{c\,c'} \cdot QM_{c'} + ice_{c\,c'} \cdot QE_{c'} + icd_{c\,c'} \cdot QD_{c'}\right)$ $\left[\begin{array}{c}\text{demand for}\\ \text{transactions}\\ \text{services}\end{array}\right] = \left[\begin{array}{c}\text{sum of demands}\\ \text{for imports, exports,}\\ \text{and domestic sales}\end{array}\right]$	$c \in CT$	Demand for Transactions Services

Institution block

28	$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{f\,a} \cdot QF_{f\,a}$ $\left[\begin{array}{c}\text{income of}\\ \text{factor } f\end{array}\right] = \left[\begin{array}{c}\text{sum of activity payments}\\ \text{(activity-specific wages}\\ \text{times employment levels)}\end{array}\right]$	$f \in F$	Factor Income
29	$YIF_{i\,f} = shif_{i\,f} \cdot \left[\left(1-tf_f\right) \cdot YF_f - trnsfr_{row\,f} \cdot EXR\right]$ $\left[\begin{array}{c}\text{income of}\\ \text{institution } i\\ \text{from factor } f\end{array}\right] = \left[\begin{array}{c}\text{share of income}\\ \text{of factor } f \text{ to}\\ \text{institution } i\end{array}\right] \cdot \left[\begin{array}{c}\text{income of factor } f\\ \text{(net of tax and}\\ \text{transfer to RoW)}\end{array}\right]$	$i \in INSD$ $f \in F$	Institutional factor incomes
30	$YI_i = \sum_{f \in F} YIF_{i\,f} + \sum_{i' \in INSDNG'} TRII_{i\,i'} + trnsfr_{igov} \cdot \overline{CPI} + trnsfr_{irow} \cdot EXR$ $\left[\begin{array}{c}\text{income of}\\ \text{institution } i\end{array}\right] = \left[\begin{array}{c}\text{factor}\\ \text{income}\end{array}\right] + \left[\begin{array}{c}\text{transfers}\\ \text{from other domestic}\\ \text{non-government}\\ \text{institutions}\end{array}\right] + \left[\begin{array}{c}\text{transfers}\\ \text{from}\\ \text{government}\end{array}\right] + \left[\begin{array}{c}\text{transfers}\\ \text{from}\\ \text{RoW}\end{array}\right]$	$i \in INSDNG$	Income of domestic, non-government institutions
31	$TRII_{i\,i'} = shii_{i\,i'} \cdot (1-MPS_{i'}) \cdot (1-TINS_{i'}) \cdot YI_{i'}$ $\left[\begin{array}{c}\text{transfer from}\\ \text{institution } i' \text{ to } i\end{array}\right] = \left[\begin{array}{c}\text{share of net income}\\ \text{of institution } i'\\ \text{transfered to } i\end{array}\right] \cdot \left[\begin{array}{c}\text{income of institution}\\ i', \text{ net of savings and}\\ \text{direct taxes}\end{array}\right]$	$i \in INSDNG$ $i' \in INSDNG'$	Intra-Institutional Transfers

32	$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right) \cdot (1 - MPS_h) \cdot (1\text{-}TINS_h) \cdot YI_h$$ $$\begin{bmatrix} \text{household income} \\ \text{disposable for} \\ \text{consumption} \end{bmatrix} = \begin{bmatrix} \text{household income, net of direct} \\ \text{taxes, savings, and transfers to} \\ \text{other non-government institutions} \end{bmatrix}$$	$h \in H$	Household Consumption Expenditure
33	$$QH_{ch} = g_{ch} + \frac{b^m_{ch} \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot g^m_{c'h} - \sum_{a \in A} \sum_{c' \in C} PXAC_{ac'} \cdot g^h_{ac'h} \right)}{PQ_c}$$ $$\begin{bmatrix} \text{quantity of} \\ \text{household demand} \\ \text{for commodity } c \end{bmatrix} = f \begin{bmatrix} \text{household} \\ \text{consumption} \\ \text{spending,} \\ \text{market price} \end{bmatrix}$$	$c \in C$ $h \in H$	Household Consumption Demand for Marketed commodities
34	$$QHA_{ach} = g^h_{ach} + \frac{b^h_{ach} \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot g^m_{c'h} - \sum_{a \in A} \sum_{c' \in C} PXAC_{ac'} \cdot g^h_{ac'h} \right)}{PXAC_{ac}}$$ $$\begin{bmatrix} \text{quantity of} \\ \text{household demand} \\ \text{for home commodity } c \\ \text{from activity } a \end{bmatrix} = f \begin{bmatrix} \text{household} \\ \text{disposable} \\ \text{income,} \\ \text{producer price} \end{bmatrix}$$	$a \in A$ $c \in C$ $h \in H$	Household Consumption Demand for Home Commodities
35	$$QINV_c = \overline{IADJ} \cdot \overline{qinv}_c$$ $$\begin{bmatrix} \text{fixed investment} \\ \text{demand for} \\ \text{commodity } c \end{bmatrix} = \begin{bmatrix} \text{adjustment factor} \\ \text{times} \\ \text{base-year fixed} \\ \text{investment} \end{bmatrix}$$	$c \in CINV$	Investment Demand
36	$$QG_c = \overline{GADJ} \cdot \overline{qg}_c$$ $$\begin{bmatrix} \text{government} \\ \text{consumption} \\ \text{demand for} \\ \text{commodity } c \end{bmatrix} = \begin{bmatrix} \text{adjustment factor} \\ \text{times} \\ \text{base-year government} \\ \text{consumption} \end{bmatrix}$$	$c \in C$	Government Consumption Demand
37	$$YG = \sum_{i \in INSDNG} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in CE} te_c \cdot pwe_c \cdot QE_c \cdot EXR + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YF_{govf} + trnsfr_{govrow} \cdot EXR$$ $$\begin{bmatrix} \text{government} \\ \text{revenue} \end{bmatrix} = \begin{bmatrix} \text{direct taxes} \\ \text{from} \\ \text{institutions} \end{bmatrix} + \begin{bmatrix} \text{direct taxes} \\ \text{from} \\ \text{factors} \end{bmatrix} + \begin{bmatrix} \text{value-} \\ \text{added} \\ \text{tax} \end{bmatrix} + \begin{bmatrix} \text{activity} \\ \text{tax} \end{bmatrix} + \begin{bmatrix} \text{import} \\ \text{tariffs} \end{bmatrix} + \begin{bmatrix} \text{export} \\ \text{taxes} \end{bmatrix} + \begin{bmatrix} \text{sales} \\ \text{tax} \end{bmatrix} + \begin{bmatrix} \text{factor} \\ \text{income} \end{bmatrix} + \begin{bmatrix} \text{transfers} \\ \text{from} \\ \text{RoW} \end{bmatrix}$$		Government Revenue
38	$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{igov} \cdot \overline{CPI}$$ $$\begin{bmatrix} \text{government} \\ \text{spending} \end{bmatrix} = \begin{bmatrix} \text{government} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{transfers to domestic} \\ \text{non-government} \\ \text{institutions} \end{bmatrix}$$		Government Expenditures

System Constraint Block

39	$$\sum_{a \in A} QF_{f\,a} = \overline{QFS}_f$$ $$\begin{bmatrix} demand\ for \\ factor\ f \end{bmatrix} = \begin{bmatrix} supply\ of \\ factor\ f \end{bmatrix}$$	$f \in F$	Factor market
40	$$QQ_c = \sum_{a \in A} QINT_{c\,a} + \sum_{h \in H} QH_{c\,h} + QG_c + QINV_c + qdst_c + QT_c$$ $$\begin{bmatrix} composite \\ supply \end{bmatrix} = \begin{bmatrix} intermediate \\ use \end{bmatrix} + \begin{bmatrix} household \\ consumption \end{bmatrix} + \begin{bmatrix} government \\ consumption \end{bmatrix} + \begin{bmatrix} fixed \\ investment \end{bmatrix} + \begin{bmatrix} stock \\ change \end{bmatrix} + \begin{bmatrix} trade \\ input\ use \end{bmatrix}$$	$c \in C$	Composite Commodity Markets
41	$$\sum_{c \in CM} pwm_c \cdot QM_c + \sum_{f \in F} trnsfr_{row\ f} = \sum_{c \in CE} pwe_c \cdot QE_c + \sum_{i \in INSD} trnsfr_{irow} + \overline{FSAV}$$ $$\begin{bmatrix} import \\ spending \end{bmatrix} + \begin{bmatrix} factor \\ transfers \\ to\ RoW \end{bmatrix} = \begin{bmatrix} export \\ revenue \end{bmatrix} + \begin{bmatrix} institutional \\ transfers \\ from\ RoW \end{bmatrix} + \begin{bmatrix} foreign \\ savings \end{bmatrix}$$		Current Account Balance for RoW (in Foreign Currency)
42	$$YG = EG + GSAV$$ $$\begin{bmatrix} government \\ revenue \end{bmatrix} = \begin{bmatrix} government \\ expenditures \end{bmatrix} + \begin{bmatrix} government \\ savings \end{bmatrix}$$		<u>*Government Balance*</u>
43	$$TINS_i = \overline{tins}_i \cdot \left(1 + \overline{TINSADJ} \cdot tins01_i\right) + \overline{DTINS} \cdot tins01_i$$ $$\begin{bmatrix} direct\ tax \\ rate\ for \\ institution\ i \end{bmatrix} = \begin{bmatrix} base\ rate\ adjusted \\ for\ scaling\ for \\ selected\ institutions \end{bmatrix} + \begin{bmatrix} point\ change \\ for\ selected \\ institutions \end{bmatrix}$$	$i \in INSDNG$	Direct institutional tax rates
44	$$MPS_i = \overline{mps}_i \cdot \left(1 + \overline{MPSADJ} \cdot mps01_i\right) + DMPS \cdot mps01_i$$ $$\begin{bmatrix} savings \\ rate\ for \\ institution\ i \end{bmatrix} = \begin{bmatrix} base\ rate\ adjusted \\ for\ scaling\ for \\ selected\ institutions \end{bmatrix} + \begin{bmatrix} point\ change \\ for\ selected \\ institutions \end{bmatrix}$$	$i \in INSDNG$	Institutional savings rates
45	$$\sum_{i \in INSDNG} MPS_i \cdot \left(1 - TINS_i\right) \cdot YI_i + GSAV + EXR \cdot \overline{FSAV} = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$$ $$\begin{bmatrix} non\text{-}govern\text{-} \\ ment\ savings \end{bmatrix} + \begin{bmatrix} government \\ savings \end{bmatrix} + \begin{bmatrix} foreign \\ savings \end{bmatrix} = \begin{bmatrix} fixed \\ investment \end{bmatrix} + \begin{bmatrix} stock \\ change \end{bmatrix}$$		Savings-Investment Balance

46	$$TABS = \sum_{h \in H} \sum_{c \in C} PQ_c \cdot QH_{ch} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{ac} \cdot QHA_{ach}$$ $$+ \sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$$ $$\begin{bmatrix} total \\ absorption \end{bmatrix} = \begin{bmatrix} household \\ market \\ consumption \end{bmatrix} + \begin{bmatrix} household \\ home \\ consumption \end{bmatrix}$$ $$+ \begin{bmatrix} government \\ consumption \end{bmatrix} + \begin{bmatrix} fixed \\ investment \end{bmatrix} + \begin{bmatrix} stock \\ change \end{bmatrix}$$		Total Absorption
47	$$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$$ $$\begin{bmatrix} investment- \\ absorption \\ ratio \end{bmatrix} \cdot \begin{bmatrix} total \\ absorption \end{bmatrix} = \begin{bmatrix} fixed \\ investment \end{bmatrix} + \begin{bmatrix} stock \\ change \end{bmatrix}$$		Ratio of Investment to Absorption
48	$$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c$$ $$\begin{bmatrix} government \\ consumption- \\ absorption \\ ratio \end{bmatrix} \cdot \begin{bmatrix} total \\ absorption \end{bmatrix} = \begin{bmatrix} government \\ consumption \end{bmatrix}$$		Ratio of Government Consumption to Absorption