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GENDER IN ECONOMY-WIDE MODELLING

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Introduction

Diane Elson's seminal analysis of male bias in macroeconomic stabilization and structural adjustment policies has significantly contributed to our understanding of economies as gendered structures and economic change as a gendered process (Elson 1991; Elson 1993; Elson 1995). Elson's conceptualization stresses the importance of unpaid care work for the functioning of the market economy and its essential contribution to the maintenance and wellbeing of the labour force. Understanding the interdependence between reproductive and productive activities, and the gender division of labour within these, constitutes the starting point for any feminist economic analysis.[1] Economic policies that do not take the non-market sphere into account are likely to increase women's disadvantage (since it is women who carry the bulk of reproductive work) and to undermine the development of human capabilities in the long term.

Formal modelling has a role to play in fostering the formulation of economic policies that promote gender equality. Some feminist economists have reservations about the application of mathematics to economic analysis but others recognize the usefulness of models for diagnosing a country's macroeconomic problems from a gender perspective (i.e. Çağatay *et al.* 1995). Models can help in identifying key interactions and data gaps. By definition, a model is always partial and its value lies in concentrating attention on what the modeller takes to be the most significant aspects of an economic process. The contribution of a feminist model is therefore to make visible a different set of constraints and interactions than those recognized by conventional macro-models and to expose the main biases of the gendered economy. Developing alternative feminist macro-models could prove especially effective in generating gender awareness among those professional economists who communicate in technical terms. It should be seen as just one component of a wider strategy to influence the implementation of equitable and just policies.

Motivated by these considerations, Elson and other feminist economists called for the 'engendering of macroeconomic modelling' in a 1995 special issue of *World Development* (Çağatay *et al*. 1995). Many responses followed this invitation and they now constitute a significant body of work (some of it published in various issues of *World Development* and *Feminist Economics*). These newly developed models include a variety of approaches and theoretical perspectives, ranging from neoclassical to structuralist frameworks, from aggregated macro-models to multi sectoral micro-based models, and from stylized models to models drawing on detailed empirical data.

It is important to examine *how* these models have incorporated gender relations, and to ask whether existing approaches could contribute to a feminist transformation of the economy. Which model features can help to best expose key differences in power, wealth and access to economic resources (along sex, class and other dimensions)? What does the modeller's choice of behavioural equations reveal about her/his views on the role of unpaid carework for economic processes? How can we further encourage the construction of alternative macroeconomic models and their use in policymaking?

This chapter attempts to answer these questions with reference to a particular class of models: gender-aware Computable General Equilibrium (CGE) models. A CGE model is a system of equations that simulates the working of an entire economy and is based on the socioeconomic structure of a Social Accounting Matrix (SAM). The SAM is a way to organize data in such a way as to capture all transactions between a variety of economic actors and institutions over a year. Most of the equations in the model are microeconomic, specifying exactly how the quantities supplied and demanded in each market respond to price changes, but there are also a few macroeconomic equations to make everything add up (so that, for example, saving equals investment).

CGE models can include a high level of disaggregation and allow specific sectors, and the linkages among them, to be analysed simultaneously. For the purpose of feminist economic analysis, this provides an opportunity for representing the reproductive sector, and the gendered nature of its interdependencies with the productive sectors, by simply extending the conventional SAM accounting framework to include time spent on unpaid carework outside the market alongside market activities. The boundaries of what constitutes an economic system can thus be broadened; both the market and the non-market spheres become visible components. It follows that trade-offs between paid employment, market production, various forms of care provision, and other dimensions of wellbeing can be highlighted.

Another advantage of CGE models over other macro-models is that they are 'applied'; their construction requires assembling a wide variety of detailed empirical data at the macro, meso and micro levels. CGE models can therefore significantly contribute towards the project of building a comprehensive picture of the gendered structure of an economy. They can expose gaps in sex-disaggregated data as well as provide an opportunity to make existing sex-disaggregated data 'speak'. CGE models are mostly used to simulate the distributional impact of trade and

fiscal policies, hence, when appropriately designed, they would offer good insights into key gender aspects of macroeconomic adjustment.

Three different schools of CGE modelling are usually found in the literature: the neoclassical school, the neoclassical–structuralist school, and the structuralist school. Neoclassical models embody the belief that prices send correct signals to producers, workers, and consumers, and are the best mechanism to ensure the optimum allocation of resources in all markets. Factors of production are assumed to be fully employed and therefore adjustment to an external shock takes place simply through reallocation of labour between sectors, without substantial changes in overall real output. Neither the government deficit, nor the money supply, nor the aggregate price level have any impact on the full employment state of the economy. This description is not representative of actual economies and so other model variants have been constructed with the objective of achieving greater verisimilitude and practical relevance. The so called neoclassical–structuralist tradition (of which Sherman Robinson and other colleagues related to the International Food Policy Research Institute are among the most influential exponents) mostly keeps the theoretical structure of the neoclassical framework but specifies limited substitution elasticities in production and consumption, restrictions to labour mobility, and other similar features. These modifications are intended to reflect the fact that factors of production may respond to price signals inadequately and/or may be unable to shift quickly, if at all, between sectors (Dervis *et al.* 1982). In contrast to neoclassical models, structuralist models (Lance Taylor at the New School for Social Research is one of the leading authors within this modelling school) pay particular attention to the interaction between income distribution and quantity adjustments rather than to the role of price adjustments in restoring equilibrium after an economic shock (Taylor 1990). Capacity utilization is assumed to be variable and therefore employment and output in these models tend to change in response to demand (up to the maximum productive capacity of the economy). Prices are believed to be distorted by monopoly or other influences and hence can give wrong signals. To reflect this, wage setting, for example, is often modelled as a bargaining process in which employers have power over employees. In sum, structuralist models have many attractive features that better reflect the constraints and biases that often characterize the way economies in the real world work, but they too make many stylized assumptions.

It is interesting to note that the CGE models that have incorporated gender features since 2000 (from now on CGGE: computable gender general equilibrium models) belong mostly to the neoclassical-structuralist tradition. One group of these newly developed CGGE models simply differentiates existing standard variables by sex and does not incorporate unpaid household labour. This omission appears surprising given that the design of this type of model would make it technically easy to include the unpaid sector in its interaction with market sectors. As noted earlier, the detailed treatment of multi-sectoral interdependencies is one of the distinctive features of the general equilibrium modelling approach, which would therefore lend

itself very well to the task of representing feedback effects between market and non-market spheres. Another group of CGGE models does include non-market sectors alongside market sectors. The most recent variants in this latter group, however, do not build on earlier representations of the unpaid sector. Instead they add complex dynamic and micro-simulation features, but these are designed without any gender analytical lens. This constitutes yet another puzzle which cannot simply be explained either by a lack of awareness or by the absence of empirical evidence. The remainder of this chapter focuses on these issues.

The chapter is organized as follows. The second section reviews in detail some of the CGGE models constructed in the last decade distinguishing between those which only disaggregate a few variables by sex and those which, in addition, make non-market activities visible. It asks whether the simulations related to these modelling exercises contribute any useful insight for a feminist agenda. The third section provides a few suggestions as to how some of the current limitations in CGGE modelling may be addressed, focusing in particular on the need for a more explicit and comprehensive treatment of feedback effects between market and non-market dimensions. The fourth section concludes.[2]

Existing computable gender general equilibrium (CGGE) models

This section distinguishes existing CGGE in two broad groups: those which only disaggregate labour factors of production by sex (for example, Arndt and Tarp (2000) for Mozambique; Thurlow (2006) for South Africa; Arndt *et al.* 2006 and Arndt *et al.* 2011 both again for Mozambique) and those which, in addition to providing some sex disaggregation of standard variables, integrate non-market activities into the broad CGE framework, making them visible alongside market activities (for example Fontana and Wood 2000; Fontana 2001; Fontana 2002; Cockburn *et al.* 2007; Siddiqui 2009; Filipski *et al.* 2011). A few examples of both the 'gender-disaggregation' (GD) modelling approach and the 'two-systems' (2S) modelling approach are analysed in some detail in the next two subsections. Since they exclude the unpaid household economy, studies in the first group cannot fully capture the gender effects of economic policy reforms. Models in the second category constitute an encouraging first attempt, but there is room for improvement. In particular, their representation of feedback effects between unpaid activities and the market economy need to be better articulated.

The 'gender disaggregation' school

The 'gender disaggregation' (GD) method involves disaggregating existing standard variables on the assumption that women and men follow different patterns in the labour markets, exhibit different consumption and savings behaviour and so on. In existing CGGE models, gender disaggregation is usually limited to labour factors, sectors of production and heads of households. This is the simplest approach,

but the least useful unless combined with other model behavioural specifications reflecting some plausible explanation as to the underlying causes of gender-based inequalities. Modellers' preference for this method may partly depend on data availability, but may also be a manifestation of their male biased view of the economy.[3] In GD-type simulation analyses, gender categories tend to be used simply to classify results with exclusive attention to the market sphere and the rules of behaviour of various agents remain largely governed by neoclassical principles. This offers little understanding of how gender relations influence the organization of both production and reproduction in a given economy.

This section focuses on the family of models constructed for the economy of Mozambique by Channing Arndt and other colleagues (Arndt and Tarp 2000; Arndt *et al.* 2006; and Arndt *et al.* 2011) taken as one of the most notable examples of the GD school. The first version of the model (Arndt and Tarp 2000) is the most original one – including not only sex-disaggregation of agricultural labour factors but also an endogenous risk variable used to explain the observed unequal gender patterns. Later versions of the Mozambican model contain a weaker representation of the gendered structure of the economy, which includes more sex-disaggregation of variables but fewer attempts at modelling key ways in which gender differences shape economic processes.

In the 2000 Mozambique model (or AT00) (Arndt and Tarp 2000), labour inputs are accounted for separately for women and men. This feature is limited to the eight agricultural sectors represented in the database, while labour employed in the non-agricultural sector is one undifferentiated category. There are two types of representative households, rural and urban, with no further differentiation of socio-economic characteristics. The gender disaggregation of the agricultural sectors singles cassava production out as the most female-intensive activity. Eighty per cent of labour inputs into this sector are from women, traditional export crops and livestock are male intensive sectors, while other food crops have high female shares (but not as high as for cassava).[4] Cassava is non-traded and produced mainly for home consumption. The authors interpret the high concentration of female farmers in cassava production as the result of women having primary responsibility for feeding their families but also limited access to fertile land and other productive inputs. They cannot therefore take risks in their agricultural diversification strategies and so opt for cassava for its properties as a 'famine reserve crop' (cassava is highly nutritious, drought and disease resistant, and can be stored easily).

This is modelled by adding to the equations for cassava production an endogenous variable representing a risk premium, which is set greater than one in the base case. This premium results in more factors (largely female labour inputs) being allocated to production than profit maximization would require, and thus in returns to female labour in the cassava sector being lower. The model is used to simulate the 'gender effects' of increased productivity (assumed to come from across-the-board new technological adoption) and of reduced marketing costs in agriculture. The reporting of experiment results refers mostly to aggregated variables such as

agricultural output, GDP, agricultural terms of trade and overall household welfare. Only factor returns are analysed separately for women and men.

The findings from the simulation are that, when applied to all agricultural crops including cassava, technological innovation increases overall production and reduces risk, and hence induces reallocation of female labour away from cassava. Female participation in market-oriented crops rises and so does the female wage. The reduction of marketing costs causes agricultural male labour to gain more than female labour because male farmers tend to produce goods with relatively higher marketed shares.

The most recent variant of the Mozambique model (ABT11) (Arndt *et al.* 2011) is based on an updated and more disaggregated dataset than AT00.[5] It includes 56 productive sectors (26 of which are agricultural and food processing activities) which employ six labour types differentiated by both gender and three types of skill (proxied by education levels). The only labour-use table provided in Arndt *et al.* (2011) reports labour shares by sex and skill for four broad sectors calculated from primary micro-survey data: food crops, cash crops, livestock and non-farm activities. It is not clear whether the same labour shares have been applied to all subsectors within a particular broad sector (assuming for example that the share of 47 per cent for males and 53 per cent for females is the same across all kinds of food crops such as cassava, other roots, beans and so on) or whether more detailed data on labour intensities of specific subsectors are available.

The model not only extends the number of sectors and labour types relative to AT00, it also disaggregates representative households by location, per capita expenditure quintiles and sex of the self-reported household head. However, no difference in behaviour associated with these sex disaggregated categories is modelled. The initial gendered distribution of factors and household characteristics (the fact that, for example, females are clustered in fewer sectors as workers, or rely on different sources of income as heads of households than corresponding males), combined with a neoclassical framework governing behaviour in various markets, is what essentially drives the results.

Simulations in ABT11 set out to explore how poverty reduction and gender effects from introduction of bio-fuels (i.e. cultivation of new jatropha crops) in Mozambican agriculture may vary depending on the female intensity of new crop production and other complementary policy measures. These include interventions to promote higher levels of female education and technological improvements to increase food crop yields. Gender effects are captured by changes in: (a) female factor income relative to male factor income and (b) income poverty of female-headed households relative to male-headed ones.

Alternative scenarios in which jatropha is produced using different female labour intensities are simulated. Predictably, results show that the intensity at which women are employed in bio-fuels production affects the extent to which traditionally female intensive crops are displaced. Evidently, annual food production declines more rapidly and cereals prices increase faster when women become 80 per cent of the labour force in the new sector, than with lower female shares. Female workers'

wages rise significantly and so does nominal income accruing to female-headed households. A commensurate reduction in poverty levels does not follow though, because the resulting food price increases reduce real incomes of poor households who are net buyers of food, an interesting result.

Two extra experiments are run to make the point that complementary policies aimed at promoting female education as well as technological innovation in food production could enhance the benefits of growing bio-fuel crops on a large scale. An increase in the educational attainment of female workers is assumed to translate automatically in an increase in their productivity and wages. As a consequence all households experience higher income levels than in the 'basic scenario' and benefits appear to be more equally distributed across households than in the scenario without education promotion. Because of improved education levels, however, more women migrate to non-farm activities, further undermining food production. When higher female education is coupled with increases in food crop yields (through some unspecified change in production technologies), this results in sufficient food production for all. In sum, a 'happy ending' but probably not a realistic one, for reasons that will be elaborated in a later section.

The authors identify a micro-simulation module and a dynamic feature as the two 'main innovations' of ABT11, but design them without any gender analytical lens. The separate module that links representative household groups in the CGE model to consumption and income micro-survey data for individual households is used to calculate ex-post per capita consumption and standard poverty measures from simulated changes in commodity prices and household expenditure. Per capita values appear to be obtained as simple averages of household level quantities, thereby excluding the possibility that resources within families might be unequally distributed (because of gender, age or status). Some sort of dynamic dimension is added by linking a series of static models between periods. However, population and labour supply, as well as factor productivity, are all updated exogenously from one year to another, assuming their rate of growth to be independent from any of the gendered variables in the model.

GD models: what contribution to the feminist project?

Both the AT00 and the ABT11 models usefully highlight some important gender biases in the Mozambican economy, most notably the high concentration of female labour in a few agricultural (mainly subsistence) activities and associated lower female productivity as well as earnings. Simulation exercises focus usefully on emerging policy issues (such as technological innovation and expansion of bio-fuel production) and are of relevance to the rural sector, where the majority of Mozambican women live and work. AT00 provides a more aggregated picture than ABT11 but makes it more relevant from a feminist perspective by at least attempting to explain underlying causes of gender-specific labour allocation patterns in terms of different household responsibilities, and related attitudes towards risk, between

women and men (hence adding a 'distortion' to the neoclassical framework). AT00 also describes higher marketing costs for crops managed by women (presumably due to more restricted access to infrastructure, possible difficulties in dealing with traders, high costs of holding inventories, etc.) but fails to explore the gender specific policy implications of this pattern.

ABT11 distinguishes representative households by sex of the head, a new disaggregation relative to AT00. This is justified by evidence that female-headed households are about 20 per cent of total Mozambican households and tend to be poorer than male-headed households. Unfortunately this is not followed by any attempt to describe behavioural differences between family structures. It could have been plausible to assume a higher propensity to work for lower wages among women heads of households than among women in male-dominated ones, as proposed by Braunstein (2000) for example. The distinction between male-headed and female-headed households appears to be often used throughout the analysis as a proxy for gender differences broadly. Feminists have long stressed the limitations of using female headship as a category of gender analysis (i.e. Budlender 2003 and Chant 2004) and rather encourage a focus on analysing income, consumption and time use patterns at the individual level. This latter is a more meaningful way to capture inequalities in the varied experience of women of different age and status living in different household settings. In some instances, distinguishing household types by the presence of young children or availability of basic infrastructure (such as electricity and piped water) could be a more helpful approach for exposing gender relevant dimensions than differentiating by headship.

Other key gender biases in various markets likely to affect the effectiveness of the interventions being simulated are not considered in either AT00 or ABT11, making the policy recommendations resulting from the experiments of limited relevance for a feminist agenda. For example, simulations in both models assumes, unrealistically, that more efficient agricultural production methods can easily be adopted by both female and male farmers, on any crop, and that female labour can freely move to other sectors once 'released' from the subsistence sector. This ignores the well documented fact that female farmers in Mozambique, and indeed many other agriculture-based countries, can only use less mechanized production technologies than male farmers and cannot easily engage in commercialized crops, primarily due to time-consuming family responsibilities (including food processing), limited financial resources and restricted access to extension services (Mozambique Ministry of Agriculture 2007 and FAO 2011). Technological change in itself is unlikely to provide a wider range of income-generating opportunities to women unless constraints to female farmers adopting new production techniques are removed. An alternative set of experiments exploring the range and significance of such constraints would be more useful for the design and implementation of gender-equitable agricultural policies than the simulations proposed in AT00 and ABT11.

The simulations in ABT11 are useful in pointing out potentially significant trade-offs between bio-fuel production and food production. The impact of these trade-offs, however, is likely to be underestimated because housework is

ignored. The exclusion of the non-market sphere not only leads to the omission of important information about women's activities and wellbeing, but also affects simulation results with regard to standard market variables. For instance, family responsibilities are likely to constrain female producers' capacity to respond to new incentives and hence a smaller increase in output than that predicted by ABT11 would result. Arndt and Tarp acknowledge that omitting unpaid reproductive activities is one key limitation of their approach and point to this as a 'critical topic for future research and data generation work (Arndt and Tarp 2000: 1312). Ten years on, the authors still focus exclusively on the productive sectors and state they have chosen 'to elect for a more parsimonious model, though consideration of social reproduction is an important topic for future research' (Arndt *et al.* 2011: 1651). This must mean that they do not consider social reproduction to be relevant for understanding the issues they set out to study after all. One of the strengths of models is that they are partial representations of reality, but partiality is not benign.

It has been observed in the section "The 'gender disaggregation' school" above that, in both AT00 and ABT11, a number of shares, ratios and parameters about market variables (both sex-disaggregated and not sex-disaggregated ones) are set arbitrarily because of a lack of reliable data. It is of course reasonable to make plausible assumptions when information is missing. The point is reiterated here to stress that the authors appear somewhat selective when they use the absence of accurate data as a justification for not considering unpaid work.

The lack of any gender feature in the new dynamic component of the ABT11 model is a real missed opportunity. Feedback effects between non-market and market sectors could have been modelled, for example, by linking the provision of care in the base case with the productivity of the labour force in subsequent periods. This aspect will be further elaborated in the third section of this chapter.

The 'two-systems' (2S) school

Other existing CGGE models have included some representation of unpaid reproductive activities in addition to sex-disaggregation of factors and households. In other words, this category of models conceptualizes the world in terms of two sectors or systems (2S), one of which comprises the market economy and one which comprises the unpaid care economy. The first CGGE model of this kind was constructed by Fontana and Wood (Fontana and Wood 2000; Fontana 2001, 2002, 2007) to analyse the gender effects of trade policies in Bangladesh and Zambia. Later studies apply the same approach to other countries such as Nepal (Fofana *et al.* 2005), South Africa (Cockburn *et al.* 2007), Uruguay (Terra *et al.* 2008 and Pakistan (Siddiqui 2009), with only little variation in model characteristics or simulation design relative to Fontana and Wood.[6] The model for the Dominican Republic constructed by Filipski *et al.* (2011) could be regarded as the most recent example of the 2S approach but its analysis of the non-market sphere is watered down relative to previous efforts and its gender focus appears weak.

Like the GD models, the Bangladesh and Zambia models have several market sectors, differentiate workers by gender as well as other characteristics such as education and distinguish a number of representative households. The most important addition relative to the GD models is that both unpaid household work and leisure activities are integrated into the representation of the economy. Employment is measured in hours and time spent on household work and leisure is valued at a specified wage (usually the average market wage) separately for different groups of men and women.

A housework 'sector' and a leisure (or non-work) 'sector' are estimated for each household type. These two non-market sectors are constructed to behave, in some respects, like market sectors but to differ from market sectors in important ways. In particular, the demand for (and so the supply of) unpaid housework (also called social reproduction, or care) is less responsive to changes in its price than is the case for market goods because these services are essential. The greater rigidity of the gender division of labour in reproduction than in market sectors is captured by setting a lower elasticity of substitution between female and male labour. Members of each type of household are assumed to 'produce' particular kinds of care, which is not traded among households but consumed by the members of that household group only. It is assumed care in the household is produced with labour time only and provided overwhelmingly by women (reflecting available evidence from existing time-use studies). It is 'consumed' (enjoyed) by the family as a whole, without a clear distinction over whether some family members are likely to benefit more than others from it.

Other country applications differ from the Fontana and Wood approach with regard to minor details such as computational procedures[7] or a different disaggregation of sectors, factors and households, but with no substantial change to the general principles governing the functioning of the unpaid household reproductive sector in relation to the productive sectors. Choices over data grouping and model variables tend to reflect each author's judgement over the dimensions that best capture key distortions in the distribution of resources in the economy concerned. For example in the South Africa model, labour factors are differentiated by age as well as gender, and households are grouped by ethnicity as well as location (Cockburn *et al*. 2007); in the Pakistan model, household types are differentiated by employment status and gender of the household head as well as location (Siddiqui 2009). Siddiqui's (2009) valuable addition is a distinct module to calculate econometrically the impact of simulated changes on individual consumption, literacy and infant mortality, separately for women and men, alongside time-related and income-related indicators.

All these country models are used to examine only the effects of trade reforms. Trade simulations mostly take the form of tariff reduction, or tariff abolition, coupled with exchange rate depreciation (to keep the trade balance fixed) and endogenous adjustments in domestic tax revenues (to hold government revenue constant). Other trade related simulations involve price changes of key exports or imports (such as grains in Bangladesh and copper in Zambia).

The great level of detail in the disaggregation of factors, sectors and households permits an understanding of how trade impacts on female workers vary, depending on whether or not they have education, live in rural or urban areas and belong to low-income or high-income households, among other characteristics. Importantly, the integration of unpaid household work and leisure allows emphasis on a wider range of trade-offs than in conventional trade models. Most experiments point to the fact that the gender effects of trade are neither entirely positive nor entirely negative and can have contradictory results for the wellbeing of different groups of women and men. For example, the expansion of garment exports in Bangladesh is shown to increase both market participation and wages of women with primary and secondary education, but also to cause a decline in their time for both care and leisure. Although time for unpaid care and leisure declines on aggregate, differences between rich and poor households are also exposed. Women of the same educational level must increase their total workload (market work combined with housework) to compensate for lower family income in poor households but can enjoy a moderate rise in non-work time in rich households.

2S models: what contribution to the feminist project?

All the models within the 2S approach contribute to the project of building a picture of the gender structure of an economy in ways which are more comprehensive than models within the GD school, potentially offering greater support to a feminist policy agenda. This is because 2S models extend the conventional representation of the economic system to include unpaid activities and thus uncover deeply unequal gender patterns in household work that underpin other inequalities in the market sphere. By organizing information on time patterns by a range of socio-economic characteristics at both the household and the individual level, the social accounting matrices underlying these models expose differences in unpaid care burdens between different groups of women and men. This could usefully inform the design of targeted policies to reduce and redistribute unpaid work and also point to areas where more regular collection of time use data is needed.

The simulation runs show how important it is to include housework (as well as non-work) in the model framework as this allows improved analysis by endogenizing labour market supply – which is treated as fixed in most models – and by including dimensions other than those resulting from economic gains. This approach offers a welcome alternative to those macroeconomic models that paint an incomplete picture of the impact of changes in policies on wellbeing by assuming women's unpaid labour to be infinitely elastic.

The reporting of changes in both income-related and time-related indicators for women and men across socio-economic characteristics and family structures can be especially illuminating. This way of presenting results could be valuable for making policymakers more aware that 'women' and 'men' in any given country do not constitute homogenous categories – a fact which is still overlooked in some policy circles.

In existing 2S models, the general rules governing how various economic agents and markets respond to trade reforms mostly follow neoclassical principles. This leaves little scope for an adequate representation of gender-based unequal power in either firms or households which is likely to affect prices, wages and allocation of resources. For instance, strong export performance in a female-intensive sector is not necessarily accompanied by a reduction in the gender wage gap, or improvement in women's working conditions (van Steveren *et al.* 2007). In the family of models developed by Fontana, there is at least an attempt to capture different degrees of gender bias among employers and/or household members. This is obtained by assigning different values to key parameters and undertaking sensitivity analysis. Simulations that are run with alternative gender-related parameter values show that a less rigid gender division in the paid labour market could mitigate the negative impact on women of a decline in a female-intensive sector, for example. They also show that more gender egalitarian relations within households result in a higher female labour supply response and greater market output following an increase in female wages. These insights can be useful for the design of policies, but a more explicit model representation of power would be desirable.

One of the main limitations of the early models within the 2S CGGE school is the absence of a mechanism for representing the complete range of feedback effects between the market and the non-market sphere. These models treat unpaid housework just as a 'final consumption good' that enters directly the utility function of the household, and merely affects current wellbeing (for the household in aggregate, and in ways which are only vaguely specified), thus neglecting longer term impacts, for both individuals and the economy as a whole. Housework constrains female labour supply to market sectors but is not linked explicitly to the productivity of either the current or future labour force. Making this link would be a necessary next step towards fully capturing and quantifying the broader spectrum of interactions between macroeconomic policies and the development of human capabilities. It is disappointing that the most recent models claiming to be rooted in the 2S approach, for example those of Filipsky *et al.* (2011) and Cockburn *et al.* (2009), do not contribute to address these shortcomings but rather offer variants in which the gender focus is diluted.

In their analysis of the effects of free trade agreements in rural Dominican Republic, Filipsky *et al.* (2011), state from the outset that their main aim is to explore possible impacts of CAFTA on both 'immigrants' and 'women', somewhat suggesting that these two groups are two homogenous categories and treating them as an 'add-on' rather than an integral part of the analysis. The 'engendering' of their model centres essentially around a set of disaggregations both in the labour market and among households, but these only partially contribute to making visible the key biases in the gendered structure of the Dominican economy. The authors, for example, do not pay sufficient attention to non-farm activities, in which Dominican and Haitian (immigrant) rural women appear to be engaged in large numbers, and focus almost entirely on agricultural crops, which in the Dominican Republic are all male-intensive sectors. They usefully distinguish many categories of labour,

including hired workers and unpaid workers, the latter defined as workers who cultivate their own land or work on family plots. However, it seems no further differentiation is made between farmers who have control over resources, on the one hand, and contributing family workers with no independent access to family assets, on the other – a crucial distinction from a gender perspective given that contributing family workers are the most vulnerable group and mostly women (as stressed for instance in ILO 2010 and FAO 2011).

The most valuable feature of the Dominican model is an explicit representation of the imperfect allocation of labour, between six categories (agricultural and non-agricultural work, paid work, and unpaid productive work – i.e. subsistence farming, housework, and leisure) for four separate groups: Dominican males, Dominican females, Haitian males, and Haitian females. For each of these groups and categories a specific wage (or shadow wage in the case of unpaid work) is determined by the interplay of supply and demand. Workers can 'switch' between the six categories but it is not clear from the narrative in the article whether these are discrete choices (i.e. a worker is for example either in housework or agricultural work, but cannot be simultaneously involved in both) or not. If the former, this would be not representative of actual circumstances (most people tend to be engaged in multiple activities at the same time, both in the market and the non-market sphere), and would constitute a drawback from a feminist perspective by not allowing measurement of overall time burdens.

The authors do not undertake any sensitivity analysis with alternative gender-related values and rather prefer to keep 'labour allocation elasticities between time uses equal for males and females, locals and immigrants, preferring to err on the side of caution' (Filipsky *et al.* 2011: 1863) and further explain that 'we could for example rigidify the female labour supply compared to the male one, but this would run the risk of making our gender-sensitive results be driven by ad-hoc gendered parameters' (Filipsky *et al.* 2011: fn. 15). This is a considerable limitation because it is precisely this type of gender-focused sensitivity analysis that could make a contribution to policy formulation; it would enable model users to see how simulation outcomes may differ depending on the degree of gender bias in various parts of the economy. In the reporting of the results, Filipsky *et al.* (2011) resort mostly to the distinction between female-headed and male-headed households as their main way to capture key gender differences in impacts, and do not discuss any possible implications of changes in the level of unpaid housework despite acknowledging this as the main area for further research.

Cockburn *et al.* (2009) of Laval University, who had indeed included reproduction activities in earlier models of Nepal and South Africa (as noted in previous paragraphs), drop entirely the non-market component in their new 'dynamic' multi-country modelling of Ghana, Senegal, Uganda and Honduras in favour of an approach that measures the gender impact of tariff changes only in terms of wage differentials between women and men, under rather stringent and gender-blind assumptions.

Towards a fuller integration of reproduction into CGE frameworks

CGGE models constitute a growing but still fairly young body of work. Strengthening the gender analytical lens of this modelling approach could take many possible avenues. The core features will vary depending on the specific country context and the key questions of interest, of course, but would ideally include both a better representation of power relationships between workers and employers at the firm level, and an explicit treatment of rules governing intra-household resource allocation (to incorporate both time and more tangible assets). Above all, economy-wide modelling needs further refinements in its treatment of the unpaid non-market sphere of reproduction and its interconnection with the market sphere of production. This section makes two proposals as to how this latter objective could be taken forward: (a) distinguishing between different types of unpaid care activities (as a way of enabling identification of specific interventions to reduce and redistribute these) and (b) linking the productivity of the labour force and skill formation to the provision of care (as a way of stressing the characteristic of labour as a produced means of production, and exposing the long-term costs of human resource depletion likely to be associated with economic strategies that do not recognize the value of unpaid household work to society).

Disaggregating unpaid work

Different unpaid household activities fulfil different objectives, are carried out using different technologies (inputs of time combined with some tools and infrastructure) and can be replaced with market services only to some extent (and only when household income level allows it). For example, looking after children has a strong relational component and involves close emotional interaction. Parents derive intrinsic satisfaction from much of the care they provide. Only after a certain level may they be opting for paying for a private childminder or seeking other forms of help from their community. Collecting water or cleaning a bathroom on the other hand, involve much drudgery, and time required for these activities can be significantly reduced simply by providing better physical infrastructure and/or appropriate household technology. As these examples illustrate, each component of unpaid care work would require public support through a different mix of policy measures and it is therefore useful if these differences are made explicit in an economy-wide model.

Importantly, there is a strong income as well as gender dimension to the distribution of unpaid work. For instance, one needs electricity, water, wheat and other food to cook a meal. However, people with low earnings and restricted access to basic infrastructure would have to use charcoal instead of a stove and grind their own flour instead of buying it refined. Achieving nutrition security, thus, is likely to require much more effort and own time inputs from the most vulnerable. The ratio of unpleasant and physically demanding unpaid work over more fulfilling unpaid

work is shown to be higher in poor households than in rich households across countries (for example Budlender 2010).

A number of related studies for high-income countries (most notably by Gronau and Hammermesh 2003 and Uriel, Ferri and Molto 2005) could constitute a useful starting point for building an analytical framework that distinguishes between unpaid activities fulfilling different functions and treats unpaid household time as the necessary input to transform market goods and services into wellbeing for household members. For example, in their recent study of Israel and the United States, Gronau and Hammermesh (2003) use household data on expenditures of time and goods to generate an exhaustive set of 'composite' commodities that households produce/consume using a combination of goods and time (such as 'eating', 'health', 'lodging', etc.), and calculate their time/goods intensity. Interestingly, they show that the time intensity of 'eating', 'health', and most other composite commodities varies with age and education. Uriel *et al.* (2005) apply a similar approach to Spain by modifying an existing social accounting matrix (SAM) to include non-SNA time alongside SNA commodities and by adding to it four activities that result from the transformation of SNA commodities: 'providing food', 'providing clothes', 'providing shelter', and 'providing care and education'.[8] The application of this approach to lower-income country contexts is now likely to have become more feasible thanks to the growing availability of high quality, nationally representative time-use data.

The attractive feature of this method is that it would allow emphasis on the varied circumstances of households and individuals within households by exposing both their care needs and the quantity as well as quality of the means available to satisfy these needs. The integration of such an approach within a CGE framework would allow precise quantification of the economy-wide distribution of the costs and benefits of unpaid work across different socio-economic groups and could point to macro-policies and infrastructural investment that may contribute to a fairer distribution. For example, experiments could be run to assess the impact on both time and income distribution of alternative infrastructural projects (i.e. roads vs. piped water) or alternative taxation structures.

'Dynamic' CGE models

A number of computable general equilibrium models with dynamic characteristics (i.e. describing some process of economic growth over the medium to long term rather than focusing on comparative static analysis) have been constructed in recent years for developing countries. These include: (a) a few models in the neoclassical tradition which claim to be gendered but are not so in a meaningful sense and (b) a few models in the structuralist tradition that could easily include gender dimensions but do neglect them.

Some of the so-called neoclassical 'recursive dynamic' CGE models have been briefly reviewed in earlier sections (Arndt *et al.* 2011 and Cockburn *et al.* 2009). These models introduce dynamics by iterating several steps with a few stock variables

updated between steps. In other words, the CGE model is built as a series of static CGE models that are linked between periods by behavioural equations for endogenous variables and by minimal updating procedures for exogenous variables.

Cockburn *et al.* (2009) treat only physical capital stock as endogenous variables and make no attempt to link changes over time in its accumulation to specific gender dimensions of the economic processes being simulated (for instance how capital accumulation may be affected by changes in the female intensity of paid employment, as suggested in Erturk and Çağatay (2000), and male/female differentials in saving rates). An even more problematic limitation in their model is that female and male labour supplies are constructed simply to increase at the exogenous population rate. Labour market participation rates and unemployment rates are fixed over time. It follows that the only gender impact of trade liberalization which is captured in the simulations comes from wage effects driven by the initial import and export composition of the economies concerned.

This chapter argues that this is a missed opportunity from the perspective of treating labour as a produced means of production; this 'dynamic' device could be used to endogenously update the productivity of the labour force by making it a function of the level of care provision in earlier periods. Different parameter values would be applied across workers of different skills and gender depending on the available evidence. This procedure evidently would require the modelling framework to contain an account of time spent on unpaid care work which Cockburn *et al.* (2009) unfortunately omit. Studies of the link between care and productivity can be more easily found for developed countries than for developing countries. However, an emerging literature that could provide empirical support for parameter calibration in the proposed simulation exercises already exists – for example analyses of the effects of nutrition practices during early childhood on economic productivity and hourly wages of adults (for Guatemala see Hoddinott *et al.* 2008). This could constitute a fruitful starting point.

Within the heterodox school, Gibson (2005) is the best example of a model that addresses explicitly the issues of human resources and their significance for economic development.[9] His framework usefully incorporates a household decision-making model for 'human capital accumulation' in which families face liquidity-constrained trade-offs between educating their members (thus enabling them to aspire to skilled jobs in the future) and current consumption needs. This modelling structure is used to demonstrate the role of human capital formation in the transition to a more globalized economy. It alerts to the risk that if households become too poor and as a result withdraw their children from school, the supply of skilled labour will be reduced, with serious consequences for a country's competitiveness in the export market. Simulations help to explore a number of policy measures that could avoid vicious circles of stagnation and poverty.

Human capital accumulation is governed by an equation similar to the one that usually describes physical capital accumulation and is assumed to vary by the socio-economic status of the household. It can be affected by public policies – for example an increase in public sector expenditure can encourage higher rates of

skill formation by lowering the costs of education – and includes an exogenously given rate of depreciation. It is a function not only of formal education but also other processes such as informal training and learning by doing on the job. This treatment of human capital accumulation has many attractions from the point of view of feminist analysis and would seem a natural fit for the task of representing feedback effects from the reproductive sphere to the market economy. The next few paragraphs suggest a few possible steps in this direction.

As a first step, simply distinguishing female human capital accumulation from male human capital accumulation would allow consideration of a number of gender biases observed empirically in the way families make decisions with regard to their children's education – for example the fact that in some contexts girls are the first to be withdrawn from school if a household is struggling financially. Related simulations could track down how these gender dynamics in turn affect a country's international competitiveness (and the extent of its domestic inequality) in ways that are different from when the process of human capital development is assumed not to be gender differentiated.

In addition, the model could be extended by making the time that household members devote to caring for each other visible. This could then feed into the equation for human capital accumulation of both care 'providers' and care 'receivers': (a) as one of the key factors contributing to skill formation and (b) as a variable affecting its rate of depreciation. This treatment would constitute a significant improvement in the assessment of the impact of macro policies on sustainable and equitable development by including explicit consideration of their direct and indirect effects on care provision in an economy.[10]

The specifics of the gender variants of either of these proposed dynamic modelling approaches would need of course to be carefully spelt out. It is hoped that the suggestions offered in this section at least demonstrate that the task is analytically necessary, technically feasible and politically desirable. Even in the event that relationships between the variables concerned could not be estimated with accuracy, a range of scenarios with alternative parameter values could be simulated.

Conclusions

A number of computable general equilibrium models with gender features have been constructed in the last twelve years. These are mostly models in the neoclassical structural tradition and can be distinguished into two broad groups based on the extent of their gender analytical lens: (a) those models which simply disaggregate existing standard variables by sex – usually limited to labour factors, sectors of production, and heads of households (the 'GD approach'); and (b) those models which conceptualize the economic system in terms of two spheres – the market economy and the unpaid non-market sphere – in addition to differentiating variables by sex (the '2S approach').

Models within the 2S approach are likely to be more demanding in terms of data but are also more effective in that they expose the full range of gender biased distortions in an economy, hence potentially providing more valuable support for a feminist policy agenda. A growing body of feminist empirical studies as well as greater availability of high quality sex-disaggregated surveys in recent years would be expected to have offered rich material, and encouragement, for the further development of models and simulations within the 2S tradition. The analysis undertaken in this chapter suggests that, on the contrary, most recent CGGE models have a weaker gender focus than earlier efforts. The new exercises tend to centre on more disaggregations and new complex dynamic and micro-simulation components, but these are interpreted rather mechanically. Male and female categories are simply used to classify results with little attention to processes underpinning unequal gender patterns. What is most disappointing is that the treatment of the non-market sector in these models becomes watered down or is dropped altogether.

It may be useful to ask why, given the apparent attractions of the 2S over GD approach, there have been relatively few new 2S models developed and used since 2000 and why, they have not displaced the GD models. Since the answer is unlikely to be a lack of information, it must be to do with the worldview of the modellers who have taken up the lead in this field. These are mostly fairly mainstream economists who, it seems, continue to treat gender as an 'add-on' category rather than an integral part of their analysis.

Structuralist CGE modellers usually give more weight to distortions, inequalities and power relations underlying economic processes in the construction of their models than conventional economists. So far they have not sufficiently engaged with gender concerns in their analysis and it is hoped they will do so in the future. Their tools, conceptualizations and modelling techniques provide a more fertile ground for the development of a fully gendered CGE model.

Strengthening the gender analytical lens of CGGE modelling could take many possible avenues. This chapter suggested priority to be given to further refinements in the treatment of the unpaid non-market sphere of reproduction and its interconnection with the market sphere of production. This could involve both distinguishing between different types of unpaid care activities (to enable better identification of specific interventions to reduce and redistribute these) and linking, more explicitly, care provision to the productivity of current and future labour force (to stress the characteristics of labour as a produced means of production). This latter step would be crucial in providing an opportunity to explore a range of policy scenarios to avoid vicious circles of stagnation and human resource depletion.

Notes

1 Beneria and Sen (1981), Folbre (1994) and Himmelweit (2002), among others, have provided valuable contributions to these arguments.
2 The words 'reproduction', 'social reproduction', 'non-market work', 'unpaid work', 'housework', 'care' are used in this chapter interchangeably. Each of course can be used with a different political meaning as highlighted for example in Quick (2008).

3 CGGE modellers in the GD school have so far been only men.
4 Female shares in cassava as well as in other crops are not based on representative country data. The authors acknowledge they are using simply 'informed guesses' drawing on anecdotal evidence (including from African countries other than Mozambique) as well their own extensive field experience as economic advisers to the Mozambican government.
5 The article by Arndt *et al*. 2006 is an intermediate product that provides no additional insight relative to other versions.
6 Most of the more recent modelling exercises have all been undertaken as part of an initiative aimed at promoting gender awareness in CGE modelling coordinated by the University of Laval, Quebec, and sponsored by the IDRC Canada.
7 Fontana *et al*. 2005 use an explicit labour supply function calculating maximum time available for work or leisure by using arbitrarily set elasticities of labour supply separately for women and men, while Fontana and Wood 2000 assume household leisure is a composite of men's and women's leisure which enters the LES demand function together with other market and non-market goods.
8 The UN System of National Accounts (SNA) recognizes as productive work the following categories: employment for establishments; primary production activities not for establishments such as agriculture, animal husbandry, fishing, forestry, fetching of water, and collection of fuel wood; services for income and other production of goods not for establishments such as food processing, trade, business and other services. Water and fuel collection have been added only since 1993 but they are still often not included in measures of GDP in practice. Food preparation, household maintenance, management, and shopping for own household; care for children, the sick, the elderly, and disabled; community services and help to other households are still considered 'non-productive' activities, and hence are not recorded. Only some countries record these in separate 'satellite accounts'. It is these activities that most literature calls non-SNA work or extended-SNA work.
9 The model has other relevant features such as two distinct productive processes (formal and informal) for non-traded goods and varied capacity utilization across sectors.
10 The model developed by Braunstein *et al*. (2011) constitutes an important contribution in this direction but it is not applied to any specific country data.

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