Applied modelling of gender equitable macro-policies and care provision: the contribution of computable general equilibrium (CGE) models

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Abstract:
Since the late 1990s a number of computable general equilibrium (CGE) models have been developed to address the gender distributional effects of macroeconomic policies. The extent to which existing CGE models integrate gender as an analytical category varies as does the range of policy questions they explore. In this paper we ask in which way Social Accounting Matrices (SAMs) and CGEs can help to inform policies to promote gender equality and care provision, particularly in the context of middle-high income ageing economies. We first critically analyze the existing gender-aware CGE literature. We then review a number of other CGE models and related approaches, which are not explicitly concerned with gender differences but nonetheless have might be relevant for the policy questions that concern us. These features include: representations of labor market imperfections and wage determination mechanisms; an emphasis on the role of public investment for human capacities development; distributional concerns related not only to gender but also age, employment status, care needs and similar. We conclude with suggestions on how to further develop CGE model design.
1. Introduction

The importance of public investment and adequate care policies for gender equality has come to the forefront of the policy agenda in recent years. It is of significance that the Sustainable Development Goals framework for the first time explicitly recognizes the unequal distribution of unpaid domestic work and care as the main source of gender inequality (United Nations, 2015). And it is an achievement that Target 5.4., in particular, draws attention to the role that public policies can play in providing infrastructure and social services to both reduce and redistribute domestic work and care. Current policy debates acknowledge that ageing societies, growing populations and changing family structures, as well as women’s continued secondary status in paid employment, demand urgent action on the provision and organization of care, to ensure that the care needs of all segments of the population are met, and responsibility for care provision is fairly shared between individuals and institutions (Horstead & Bluestone, 2018; ILO, 2019; UN Women, 2019). Gender-aware policy tools to rigorously quantify the effects of alternative approaches to care provision are key to translate commitments on paper into effective interventions on the ground. Economy-wide models applied to fiscal policy analysis are one example of such tools and are reviewed in this paper.

It is important that the design of these models specifies the full range of gender distributional dynamics associated with alternative public spending priorities.

This paper refers to the ILO definition of care policies as “public policies that allocate resources to recognize, reduce and redistribute unpaid care in the form of money, services and time” (ILO, 2018). The ILO includes among these policies the direct provision of childcare and eldercare services (considered a part of social infrastructure in feminist literature, e.g. Seguino, 2019) as well as care-related social protection transfers and benefits given to workers with care responsibilities or people who need care. It is useful to note that modes of care provision as well as finance matter for gender equality. Both direct public care provision and grants and social transfers are needed in a country. However, the impact on quality (of both services and employment) is different if the government provides finance but the supply comes from the private sector rather than the public sector. The design of a gender-aware model should include representation of these differences, as will be further elaborated in later sections.

Women’s access to public social services and their bargaining position in the labor market are closely inter-related (Elson & Fontana, 2019; Pearson, 2014). To reduce gender inequality (as well as other forms of inequality), redistribution through the fiscal system needs to be accompanied by changes in the operation of the labor market, with the aim to increase employment returns for low-income women, in particular. To reflect these dynamics, a gender-aware model should allow for a representation of labor markets as characterized by segmentation and discrimination, alongside a representation of the unequal distribution of care work among different groups of women and men.

The emphasis on intersectionality is equally important. The most burdensome forms of care work, both paid and unpaid, tend to be performed by women and girls disadvantaged because of their social class, migration status and/or poverty. Moreover, a number of studies (reported in ILO, 2019) point to the fact that mothers of young children face an especially severe penalty, in terms of access to quality jobs, earnings and care burdens. Growing evidence also documents the vulnerability of older women who, in many countries, after retirement, need to continue to engage in (precarious) forms of paid work to avoid poverty, and at the same time
often become main carers for their grandchildren, some time their older husbands or even their own parents (Horstead & Bluestone, 2018; Samuels et al., 2018). These brief observations thus underscore the relevance of constructing a model that enables to assess the distributive implications of public investment and care policies through a lens that considers how gender intersects with other sources of disadvantage such as stages in the life cycle/age, social status, ethnicity, and a lack of income.

Care policies may also involve physical infrastructure which reduces women’s drudgery work, such as obtaining water and procuring energy. This kind of infrastructural investment is likely to be more relevant in low-income country contexts. In this paper, we focus on middle- and high-income countries and hence pay greater attention to social infrastructure than physical infrastructure. In general, however, we suggest that an important objective of applied policy modelling should involve exploring which forms of public investment and financing modalities to increase social (and physical) infrastructure can best support care provision that is accessible and affordable to all women and men and reduces inequality. In other words, what level and composition of public investment can best redress gender, income and other inequalities in a particular economy? Our focus wishes to be on distributional implications of policies, not on how gender inequalities may interact with GDP growth. We ask how Social Accounting Matrices (SAM)-based Computable General Equilibrium (CGE) models as specific modelling tool can help in answering these questions.

There is a long tradition in policy analysis of distributional issues that rely on Input-Output (I/O) Tables and Social Accounting Matrices (SAMs) as core databases (Adelman & Robinson, 1978; Leontief, 1986; Lofgren, Robinson, & El-Said, 2003; Round, 2003). Distinctive features of this approach are the emphasis on accounting for resource endowments, income and consumption by diverse socio-economic groups (hence the name ‘Social Accounting’) in constructing the data, and the detailed treatment of multi-sectoral interdependencies. Provided the relevant databases are disaggregated to capture key patterns between different groups of women and men (with regard to income, time and use of other resources), the SAM can offer a good representation of the gender structural features of an economy. In sum, the SAM/computable general equilibrium (CGE) methodology lends itself well to the analysis of the effects of fiscal policy on different dimensions of gender inequality and the gendered nature of linkages between market and non-market sectors of an economy.

CGE models that are explicitly concerned with the gender-differentiated impact of policy (gender-aware CGE models, or CGGE), have been developed since the late 1990s. However, most of these existing models incorporate gender features in limited ways and are used for trade policy analysis, largely in the form of comparative static exercises. They are rarely applied to studying the gender implications of public spending. A recent review of gender-aware CGE models indicates possible avenues to strengthen their gender analytical lens and policy relevance (M. Fontana, 2014). In particular, Fontana notes that earlier CGE representations of unpaid care work succeeded in making women’s contribution more visible but were too stylized to enable identification of specific policy options to reduce and redistribute their work and improve their earning opportunities. Suggested refinements in the treatment of the unpaid non-market sphere and its interconnection with the market include: (a) distinguishing between different types of unpaid care activities (e.g. cleaning vs. direct care of people, and childcare vs. elderly care) and different types of public or private infrastructure that can complement, or substitute for, unpaid care; and (b) linking care provision to labor productivity and human capacity development, to expose the long term costs of human resource depletion likely to be associated with economic strategies that do not
recognise the value of care to society. Including explicit representation of structural rigidities in the labor market (such as a clear articulation of gender-based occupational segregation), is also needed, given what we know about persisting gender inequalities in the world of paid work, in both high-income and low-income economies (ILO, 2018; ILO, 2019).

This present paper further reviews the CGE literature with the purpose of providing suggestions on how to better incorporate feminist economics principles into the specific framework of a MAMS model. MAMS (Maquette for MDG Simulations, (Cicowiez, Diaz-Bonilla, & Lofgren, 2013) is a variant of a CGE model with two innovations of potential use for gender-aware analysis of care-related public investment: a dynamic component and a more detailed specification of government accounts. The dynamic component takes the form of a ‘recursive’ model with annual updates of parameters relative to not only capital stock but also the size and composition of the labor force. The specification of government accounts entails disaggregating government spending by function, and explicitly modelling government services as linked to economic performance (e.g. public investment in education affects the skill composition of the labor force in subsequent periods as well as total factor productivity). These features taken together make it possible to analyse long term impacts (on both output and its distribution) of alternative scenarios for government spending/investment, resource mobilization and provision of services supplied by either the government or private producers, or both. More in general, MAMS offers flexibility regarding the choice of rules for factor market specifications and macro-balances and can be programmed to include a number of extensions. If properly designed, MAMS may thus offer a useful starting point for the analysis of how public policies can foster equitable systems of care provision across gender, income, class, age, and place of residence.

We imagine this MAMS model to be constructed to represent a middle-high income ageing economy in Asia. This emphasis is dictated by the need to complement another component of the project of which this paper is a part, and which centres on South Korea. Although our focus is on a middle to high income country, we hope some of our insights to also be of relevance to economies with different production structures and gender structures (for example countries with different gender distributions of paid work and different demographics, and/or limited physical infrastructure). Our review considers different types of CGE models, ranging from comparative static models to recursive dynamic models to overlapping generation ones, and include both neoclassical and structuralist approaches. In the section reviewing models of ageing economies, we also include a few microsimulation models, which are not strictly CGE models but are increasingly used in combination with CGE models to refine the level of distributional analysis. Our review is highly selective, the aim is not to provide a complete survey of the literature on applied macro-models, which would be a near impossible task. The paper is organized as follows. Section 2 critically reviews the existing gender-aware CGE literature and sketches out an initial list of what might constitute useful components of a gender-aware model. Section 3 examines the wider CGE literature with particular attention to representations of labor market imperfections and wage determination mechanisms. Section 4 reviews policy modelling efforts concerned with ageing societies and the role of the elderly in the economy. Section 5 draws lessons from these streams of the literature to make final recommendations.
2. Existing gender-aware CGE models

More than 20 years ago, a special issue of *World Development* called for the ‘en-gendering’ of macroeconomic modelling (Cagatay et al., 1995). Many responses followed and gender-aware macro-models now constitute a significant body of work, which includes several gender-aware CGE models among other modelling methodologies. The majority of existing Computable Gender General Equilibrium (CGGE) models investigates distributional impacts of trade policies, mostly in the form of comparative static exercises involving tariff changes, coupled with exchange rate depreciation (the default closure for the external balance is usually that the trade balance is fixed) and endogenous adjustments in domestic tax revenues (the default closure for the government balance is usually that both government spending and savings are fixed). These models are mainly applied to export-oriented low and middle income countries (Cockburn et al., 2007 for South Africa; M. Fontana, 2004 for Bangladesh and Zambia; Siddiqui, 2009 for Pakistan; Terra et al., 2008 for Uruguay). A few models are applied to the study of technological innovation and change in crop production mixes in agricultural settings (e.g. Al-Haboby et al., 2016 for Iraq; Arndt et al., 2011, Arndt et al., 2006 and Arndt & Tarp, 2000, all for Mozambique). None deals specifically with possible gender implications of alternative public spending priorities.

These CGGEs integrate a gender analytical lens in different ways and varying degrees, with some models only limited to gender disaggregation of standard variables. Cagatay et al. (1995) stress that operationalising gender relations in macroeconomic models must involve not only disaggregating existing variables by sex (the ‘gender-disaggregation method’), but also modifying some of the model behavioural specifications in order to reflect some plausible explanation of the processes causing gender-based inequalities (the ‘gendered macroeconomic variable method’). Importantly, a gender-aware model should also include a representation of the non-market sphere alongside the market sphere, as a sector which uses women’s time most intensively and has important implications for people’s well-being as well as the functioning of the overall economic system (the ‘two sector/system method’). Within these broad principles, model features need evidently to be constructed to best reflect the gendered economic structure of a particular country and the specific policy questions of interest. Section 2.1. reviews selected examples of the gender-disaggregation approach and outlines criteria for choosing useful gender categories. Section 2.2. describes early CGGE models that combine the gender-disaggregation approach with the ‘two sector method’ but remain within a comparative static framework. Section 2.3. examines models that add a dynamic component to their gender general equilibrium framework.

2.1. Gender disaggregation of variables

The minimum common denominator of all existing Computable Gender General Equilibrium (CGGE) models is disaggregation of standard economic variables by sex. For example, production activities are often disaggregated to highlight female-intensive sectors, in agriculture (e.g. food subsistence crops), manufacturing (e.g. garments), or both; labor factors are usually disaggregated not only by gender, but also by context-relevant categories such as education or race; households are sometimes split between female-headed and male-headed ones. This is the simplest approach, but the least useful unless accompanied by behavioural specifications that adequately reflect the underlying causes of unequal gender patterns. For example, if employment data show that women in a certain country are overrepresented in
poorly paid sectors and/or occupations, care must be put in choosing the mechanism that most plausibly explain such pattern: is this largely due to widespread stratification in labor markets and employers’ divide and rule strategies (Rubery and Grimshaw, 2007), a lack of public resources to support women in their caring roles, women’s lower formal education or opportunities for training on the job, or perhaps a combination of these? In many of the current CGGEs limited to the gender-disaggregation method, gender categories tend to be used simply to classify results with exclusive reference to the market sphere and with the rules of behaviour of various agents remaining mostly based on neoclassical principles. But there are a few useful exceptions.

**Labor factors**

Treating men and women as separate factors of production must be an obvious first step in any gender-aware CGE model. Segmentation by gender, and women’s concentration in a narrower range of sectors than men, is a well-documented feature of most labor markets in both low-income and high-income countries, as are women’s lower levels of labor market participation and their different labor supply elasticities relative to men’s (Cain, 1986; Grimshaw et al., 2017; ILO, 2019). Gender wage gaps are also a distinctive feature of most labor markets, for which different schools of thought give different explanations (Blau et al., 2014).

According to the neoclassical tradition, wages are determined through the workings of market forces according to the marginal revenue product of labor. The main contribution of feminist economics is to point out that gender relations, along with racial and other social relations, have important effects on wages, by affecting bargaining power between different social groups as well as norms and perceptions regarding the relative worth of their labor power (Figart et al., 2005). In other words, it needs to be acknowledged that wages do not necessarily reflect the marginal productivity of labor.

The neoclassical school explains gender wage gaps through gender differences in productivity-related endowments, on one hand, and labor market discrimination, on the other hand. Feminist scholars stress that differential accumulation of skills and education by men and women should also be seen as the result of (pre-entry) discrimination, and tend to be dissatisfied with the fact that neoclassical economists interpret only unequal remuneration of productivity-related individual endowments as ‘real’ discrimination. The fact that women enter the labor market with lower education may constitute in itself a form of discrimination, as does the fact that labor markets tend to better reward sets of skills more likely to be associated with men’s jobs (e.g. financial brokers vs. caring nurses).

Becker (1971) is the most well-known contribution to the neoclassical analysis of labor market discrimination. He conceptualizes discrimination as employer’s prejudice (i.e. resulting from employers’ ‘taste’ for discrimination). A discriminating employer would act as if there were a non-pecuniary cost of employing women in particular sectors or occupations. Assuming men are paid according to their productivity, women will therefore be hired only if they can be paid less than their productivity. According to Becker, prejudice-based discrimination effectively costs the discriminating employer money and represents a departure from profit-maximizing behaviour. He suggests that the more discriminatory firms would be driven out of business by non-discriminatory firms in the long term. On the other hand, other approaches such as labor segmentation and feminist theories (e.g. Grimshaw & Rubery, 2007) emphasize the exploitative aspect of employers’ practices who use divide and rule strategies, particularly towards women, to secure access to a higher quality of labor for a
given wage (in other words, the discriminating employer indeed benefits from his power over workers, including in terms of higher profits). Partly reflecting these alternative theories, institutional theories develop an analysis of the wage gap that gives a more central role to employment segregation. More specifically, Barbara Bergman’s ‘overcrowding model’ (1974) suggests that the crowding of black people and women into a limited number of occupations can cause wage differentials between equally skilled occupations, and that racial and gender wage differentials may be maintained by occupational segregation rather than by overt wage discrimination. Because of women’s overcrowding in a few segments, jobs opportunities (demand) in the ‘female’ segment are small relative to the supply of women available for work. As a result, earnings tend to be lower in the predominantly female secondary segment of the labor market than in the primary male segment. The implication of this theoretical approach is that both equity and efficiency can increase in the long term if women are allowed to enter previously male dominated segments.

Deciding which theory has greatest explanatory power in different country settings is of course not easy. And translating labor market behaviour that deviates from perfect competition and conventional profit-maximization in a CGE environment (largely based on the smooth functioning of prices and markets) poses some challenges. In the context of policy questions regarding alternative modalities of care provision to promote gender equality, explicitly representing the existence of both ‘bad’ and ‘good’ jobs in the paid labor market would seem salient. This good/bad jobs segmentation would be best explained as resulting from the interplay of workplace and household unequal power relations.

Most existing CGGEs explore trade related policy questions, not public investment questions, and mainly focus on labor sectoral reallocations by gender mostly in the spirit of the Stolper-Samuelson theorem (Stolper & Samuelson, 1941)) such as that women workers gain if they are disproportionately employed in the export sector that expands (and vice versa). Some models, but not all of them, at least use different elasticities values (within nested production functions) to reflect gender rigidities in the substitutability between female and male labor in market sectors and between paid and unpaid work (for instance M. Fontana, 2001b; W. Fontana, 2002). A few of these examples are reviewed in detail in later sections.

Representative households

The first stage of capturing distributional effects in a CGE model involves constructing representative households. These are in effect aggregate groups, usually chosen with the purpose of exposing inequalities in living standards arising from differences in ownership of factors of production (e.g. capitalist households vs workers households) and/or consumption needs (e.g. households that need to spend a large income share on health services vs households that spend nothing on health). This approach enables only analysis of between groups distribution. Increasingly, CGE models are therefore complemented with microsimulation modules, in which the information on extended functional distribution generated by the core CGE is mapped to individual households to generate information on size income distribution (and other measures of inequality as required). In principle, this latter approach could also enable analysis of intra-household income inequalities but, in practice, many microsimulation models still use the household as unit of analysis (largely because of data limitations). Providing aggregate patterns is a drawback of the representative household approach, however it is still possible to classify representative household types in ways that are useful for gender analysis.
Many of the existing CGGEs indeed claim to disaggregate household accounts ‘by gender’. This, in some models, however, takes only the form of distinguishing between female headed and male headed households. Tracking income changes between female headed and male headed households is taken by some authors (e.g. Filipski et al., 2011) as the main way to capture total gender effects in policy impact. Other models are more nuanced and disaggregate households by a range of other characteristics— not just sex of the household head, but also place of residence, employment status of the head, ethnicity and income quintiles (M. Fontana, 2004; Cockburn et al., 2007; Siddiqui, 2009), reflecting the authors’ judgment over the dimensions that best capture unequal distribution of resources in the economy concerned.

Distinguishing representative households by sex of the head is useful only if there is sound evidence that female headed households have fewer resource endowments (e.g. total labor pool and/or capital) and rely on different sources of income than corresponding male headed ones (e.g. more reliance on home-based self-employment of the low productivity kind) in a particular country or region. Women heads of households, however, are not necessarily at greater disadvantage than women living in male headed households (Chant, 2004).

Distinguishing representative households by the number of dependents, care needs (e.g. presence of young children, or households only constituted of elderly people), or differential access to basic infrastructure (such as electricity, piped water or health services) is a more helpful approach for exposing gender relevant dimensions than simply differentiating by headship. The United Kingdom Women’s Budget Group, for instance, constructed a microsimulation model in which gendered household types were classified as: working age adults in couples, with or without children; working age single female and single male adults without children; working age female and male lone parents; retired couples; retired single females and single males. They used the model to assess the impact of austerity policies on living standards in the United Kingdom and found that that female lone parents and female lone pensioners were more negatively affected than other household types (Women’s Budget Group, 2016): the first household type was especially affected by unfavourable changes in the tax and benefit system, while the latter household group was especially affected by cuts in health and social care spending.

In a CGE environment, disaggregating representative households by gender-relevant socio-economic characteristics should be accompanied by an attempt to describe behavioural differences between household types. For example, depending on the country and context, it may be plausible to assume that women in some households have a lower reservation wage than in other households, and/or different reservation wages for different types of work. In an analysis of foreign direct investment in Indonesia, Braunstein (2000) for example suggests that women heads of households are prepared to work for lower wages than women in male-headed households. She also notes that even in situations where male heads prefer their wives to stay at home, wives’ reservation wages for industrial home-based subcontracting work might be low while those for waged employment outside the home are still high (Braunstein, 2000: p. 1164). One first step towards capturing this diversity of labor supply responses by household type could involve running sensitivity analysis in which different elasticity values, regarding substitution between male and female labor in non-market work as well as household demand for care, are assigned across different ‘gendered household types’ (such as in Fontana (2003)).
Selected examples

Three CGGE models belonging to the gender-disaggregation method that deserve mention include Arndt & Tarp (2000); Latorre (2016) and Severini et al. (2018) and are reviewed in detail below.

The model of Arndt and Tarp (2000) is used to describe women’s crowding in cassava production and simulates technological innovation in Mozambican agriculture. The authors account for labor inputs, separately for women and men, in eight agricultural sectors and find that female labor inputs are heavily concentrated in cassava production, while male labor inputs are more evenly distributed across sectors. They interpret this high concentration of female farmers in cassava as the result of women having primary responsibility for feeding their families as well as limited access to fertile land and other productive inputs. Rural women cannot therefore take risks, and opt for cassava for its properties as a ‘famine reserve crop’ and basic food staple in home consumption.

The distinctive feature of Arndt and Tarp’s model is an endogenous risk variable to explain these observed unequal gender patterns in the distribution of agricultural labor. More specifically, an endogenous variable representing a risk premium is added to the equations for cassava production and set greater than one in the base case. This premium results in more female labor inputs being allocated to production than profit maximisation would require, and thus in returns to female labor in the cassava sector being lower. When technological innovation is simulated, this increases overall production and reduces risk, and hence induces reallocation of female labor away from cassava. Female participation in market-oriented crops rises and so does the female wage.

Although Mozambique has evidently a different gendered economic structure than a middle income industrialized country, this particular feature of Arndt and Tarp’s model could perhaps be usefully adapted to describe processes related to other forms of overcrowding, such as women overcrowding in informal sectors and occupations in either manufacturing or services along the lines of Barbara Bergman’s theoretical insights.

The distinctive feature of Latorre’s analysis of the effects of foreign direct investment (FDI) and tariff reform on female and male workers in Tanzania (Latorre, 2016) is its treatment of imperfectly competitive sectors, according to a Dixit–Stiglitz–Ethier framework with endogenous productivity gains effects, and the distinction of foreign and national firms in the provision/production of business services. In other words, this modelling approach allows for the entry of new firms in previously non-competitive markets and, in particular, the incorporation of multinationals, which tend to be less labor-intensive than local firms, in specific business sectors. Differently from other CGGE models analysing gender effects of trade policies, trade liberalization in this study is modelled not only as a reduction/change in tariffs but also as reduction of regulatory barriers to the provision of specialized services by domestic or foreign firms. As a result, more substantial changes in production structures and modus operandi of firms take place when various policy simulations are run. Only business services and a few manufacturing sectors produce under imperfect competition and with increasing returns to scale, while all other sectors operate under perfect competition and constant returns to scale. The model assumes full labor mobility and eight type of remuneration for each skill and female/male category. Remuneration rates do not differ across sectors for the same skill and gender combination. Moreover, there is only one representative household and therefore the only gender differences that can be exposed relate to the functional distribution of income and are limited to the sphere of market production.
Model simulations examine how the entry of new domestic or foreign firms affect the reallocation of men and women across sectors as well as their remuneration. Trade liberalization under these model assumptions results in productivity gains, which increase remunerations across all worker categories. Women benefit less than men since the sectors that expand the most disproportionately employ men/higher skill workers. None of the policies analysed manage to improve the substantial gender-based wage gaps evident in the underlying SAM database, which remain largely unchanged across simulations and different occupational categories. Gender results are essentially driven by the initial gender composition of sectors in the SAM structure, but this in itself an interesting result. Even if not explicitly anchored to any specific gender mechanism, the representation of a production structure departing from usual perfect competition is valuable and may have potential to be further developed in a more gendered-way.

Severini et al (2018) is to our knowledge one of the few CGE models that analyses fiscal policies explicitly aimed at boosting female labour force participation, but it uses the simplest gender disaggregation approach, which is therefore a major limitation. More specifically, the model is applied to Italy within a comparative static framework, and simulates tax incentives to firms in sectors of the economy where gender wage gaps are particularly high. By lowering employers’ cost of hiring women, this tax reduction has the effects of slightly reducing women’s unemployment rate. However, it also leads to a process of ‘equalizing down’ rather than ‘equalizing up’, since in the experiment male unemployment rates increase, albeit moderately. Given the chosen closure for the government account, this simulation also results in an increased public deficit. Markets are assumed to be perfectly competitive except in the case of the labour market, where there is involuntary unemployment due to wage rigidities caused by bargaining between employers and trade unions, an odd modelling choice given that female workers in Italy (and often elsewhere) are usually less unionized than male workers. There are only two types of representative households in the model called male-headed households and female-headed households, which are defined in terms of the sex of the main income earner.

The emphasis of this study is welcome, and one lesson that one could take from this exercise is that, in the context of Italy, subsidizing firms to hire more women would not appear to be a successful strategy for rising female labour force participation-other policy alternatives need to be considered. However, this paper is also a clear example of the misleading results that are obtained when gender-disaggregation of variables is carried out mechanically and key aspects of the gender structure of the economy are omitted or misinterpreted. For example, the way the model and simulations are designed seems to (implausibly) suggest that a major cause of low female labour force participation in Italy has to do with limited demand for female labour due to the higher cost to firms. No consideration is given to women’s difficulties in combining market and non-market work in a country where the welfare system is weak and much of care provision is still expected to be done by women within the family, as acknowledged by a sound body of literature (15). Moreover, the model focuses exclusively on the female (and male) unemployed, with no attention to those women who remain outside of the official labor force as discouraged workers, and who constitute a higher proportion of women of working age than the officially unemployed, particularly in Southern Italy. A model structure including both market and non-market activities as well as a more detailed characterization of the government, and the role it can play in the provision of care-related services to reduce and redistribute non-market care work, would have enabled a more meaningful policy analysis. Finally, the distinction between male-headed and female-headed
households is not especially enlightening given that, as the authors note, each of these two
groups is constructed to include very heterogenous household typologies. Female-headed
households, for instance, comprise single mothers as well as widows, some couples with
children and some couples without children.

2.2. Representation of non-market sectors

Models that combine the gender-disaggregation method with the ‘two-sector’ method extend
the conventional representation of the economic system to include unpaid non-market
activities and thus allow one to capture a wider range of interactions and linkages between
unequal gender patterns in household work and inequalities in the market sphere. The social
accounting matrix underlying these models is augmented to include information on time use
patterns by type of worker (or labor factor of production) and type of household, and thus can
expose differences in unpaid care burdens, and overall work burdens, between different
groups of women and men, in addition to differences in factor endowments and spending
patterns. This augmented SAM approach for organizing the data could usefully highlight
where time gaps and deficits are most acute and hence provide initial indication to inform
targeted policy interventions to reduce and redistribute unpaid care work.

The first CGE model including representation of unpaid care activities in addition to sex-
disaggregation of factors and households was constructed by Fontana & Wood (2000) and
Fontana (2001, 2002, 2004) to analyse the gender effects of trade policies in Bangladesh and
Zambia. The Bangladesh and Zambia models have several market sectors, differentiate
workers by gender as well as education, and distinguish a number of representative
households. 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 care work (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. This is captured by setting a low value for the price elasticity of
demand for care in the linear expenditure system (LES) household consumption function. In
addition, the greater rigidity of the gender division of labor in unpaid care work than in
market sectors is captured by setting a lower elasticity of substitution between female and
male labor. Members of each type of household are assumed to ‘produce’ particular kinds of
unpaid care, which is not traded among households but consumed by the members of that
household group only. Care in the household is assumed to be produced by only labor time
and provided overwhelmingly by women. It is ‘consumed’ 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 computational procedures or different disaggregation of sectors, factors and households
(e.g. Cockburn et al., 2007; Siddiqui, 2009; Terra et al., 2008) but the overall approach and
assumptions remain similar.

The integration of unpaid household work and leisure allows emphasis on a range of trade-
offs that are neglected in conventional trade models. In addition, the great level of detail in
the disaggregation of factors, sectors and households permits an understanding of how policy
effects on female workers may vary, depending on whether or not they have education, live
in rural or urban areas, and belong to low-income or high-income households. Simulations
illustrate that the gender effects of trade can have different results for different groups of
women and men. For example, the expansion of garment exports in Bangladesh leads to an
increase in both market participation and wages of women with primary and secondary education, but also to 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 with the same educational level increase their total workload (market work combined with housework) in poor households but enjoy a moderate rise in non-work time in rich households.

In all the models described here the general rules governing how various economic agents and markets respond to policy change largely 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, empirical evidence show strong export performance in a female-intensive sector is not necessarily accompanied by a reduction in the gender wage gap, as Stolper Samuelson would predict [ref]. In the family of models developed by Fontana, there is an attempt to capture different degrees of gender bias among employers and/or household members by assigning different values to key parameters and undertaking sensitivity analysis. Simulations run with alternative gender-related parameter values show that a less rigid gender division in the paid labor market (proxied by high elasticity of substitution between male and female labor in market production) 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 (proxied by high elasticity of substitution between female and labor in non-market care production) result in a higher female labor 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 representation of the mechanisms that are at play in these interactions would be desirable.

One of the main limitations of this early modeling approach is that unpaid care work is treated as a homogenous activity without differentiating between tasks fulfilling different needs and/or that are carried out using different technologies (e.g. processing food vs. helping an elderly parent to bed). Each component of unpaid care requires public support through a different mix of policy interventions. In order to analyze targeted measures to reduce and redistribute unpaid care, it would be important to disaggregate these components, and account for the fact that they can be provided not only by households but also by the public and/or private sectors, through greater investment in social and physical infrastructure.

Another limitation of the class of models reviewed in this section is that they treat unpaid care work 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. Unpaid care work constrains (mostly) female labor supply to market sectors but is not linked explicitly to the productivity of either the current or future labor force. Making this link would be an important step for considering medium to long term distributive effects related to human capacity development, and gendered processes associated with it. A dynamic CGE framework seems thus more appropriate for representing gender impacts than the comparative statics exercises described in this section. A number of computable general equilibrium models with dynamic characteristics that claim to be gendered exist for a few developing countries, but their gender analytical lens remains limited. Next section reviews a few of them.
2.3. Dynamic CGGEs

Three types of dynamic CGGE models are reviewed here: a simple dynamic recursive CGE, the MAMS approach and a gender-aware version of an overlapping generation model (OLG).

'Simple' recursive

Some of the so-called neoclassical-structuralist ‘recursive dynamic’ CGE models (Arndt et al., 2011; Cockburn et al., 2009) include a few sex-disaggregated variables. 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 sequence of static equilibria that are linked between periods by behavioural equations for endogenous variables and by minimal updating procedures for exogenous variables. But these ‘dynamics’ are designed without any gender analytical lens.

In their multi-country modelling of tariff liberalization in Ghana, Senegal, Uganda and Honduras, Cockburn et al (2009) measure gender effects only in terms of wage differentials between women and men, under rather stringent and gender-blind assumptions. They treat only physical capital stock as endogenous variable 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 & Cagatay (2004) and male/female differentials in saving rates). An even more problematic limitation in their model is the assumption that the population rate is exogenous and female and male labor supplies are constructed simply to increase at the exogenous population rate. Labor market participation rates and unemployment rates are fixed over time. It follows that the only gender impact of trade liberalisation captured in the simulations comes from wage effects driven by the initial import and export composition of the economies concerned. This is a missed opportunity. This ‘dynamic’ component could be in principle be used to endogenously update both the ‘stock’ and the skill composition of the labor force, for instance by making it a function of the level of public and private care provision in earlier periods. Interactions between population dynamics and macroeconomic outcomes have important gender connotations that would be useful to highlight, especially when modelling ageing economies. For example, women’s costs of having and raising children are affected by public policies and the extent to which systems of care provision in a country are gender-equitable. In turn, below-replacement fertility rates such as those currently observed in many East Asian and European countries, can put pressure on pension and health systems with macro and distributional consequences.

Within the heterodox school, Gibson’s CGE framework (2005) 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 globalised 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 labor will be reduced, with serious consequences for a country’s competitiveness in the export market. Human capital accumulation in Gibson’s model 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
spending on education can encourage higher rates of skill formation by lowering the private 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/development 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 in the medium to long term. It is therefore unfortunate that Gibson’s model has no gender lens.

MAMS

A particular variant of a recursive dynamic CGE model called MAMS (Maquette for MDG Simulations, Cicowiez et al., 2013) has two innovations of potential use for gender-aware care policy analysis: a dynamic component that involves not only endogenous capital stocks (as in previous simple dynamic recursive models) but also endogenous labor force characteristics, and a more detailed specification of government accounts. The dynamic component takes the form of a ‘recursive’ model with annual updates of selected variables, including the skills and gender composition of the labor force, which would be of particular relevance for our policy research purposes. The detailed specification of government accounts involves disaggregating government spending by function, and explicitly modelling government services as linked to economic performance (e.g. government infrastructural investments can influence factor productivity; public investment in education affects the skills and composition of the labor force in subsequent periods; and so on). These features taken together make it possible to analyse long term impacts (on both output and its distribution) of alternative scenarios for government spending/investment, resource mobilization (from taxes, borrowing and/or foreign aid), and provision of services that can be supplied by either the government or private producers, or both.

Ruggeri-Laderchi’s model (Ruggeri-Laderchi et al., 2010) appears the be the only MAMS application so far to include a gender lens. Their model (and the underlying SAM) is applied to the analysis of educational and labor market policies in Ethiopia. The core static model used in this application is theoretically close to the ‘IFPRI Standard Model’ (Lofgren, Harris, & Robinson, 2002), which is also what provides the foundations for the gendered CGE model developed by Fontana and Wood (2000). The Ethiopia MAMS model includes both market and non-market sectors and fully accounts for time use (excluding personal care time), for the working age population who is not in school. Simulations include investment in increased quality of education, reduced barriers for women in search of market jobs (proxied by increased elasticity of substitution between men and women in market production) and increased productivity in non-market household care production. There is only one single representative household. The analysis is insightful but remains, however, at an aggregated level. Similar to other gender-aware models within the IFPRI family (as reviewed earlier in this same section), the unpaid care sector in the Ethiopia MAMS model does not distinguish between different activities such as for example water and fuel collection, food processing and child care. Each of these activities indeed takes a lot of women’s time in Ethiopia, but involves different degrees of drudgery and different combinations of infrastructure and labor time. Moreover, in subsequent periods, the model does not link the level and quality of unpaid care work to the skill composition and productivity of the labor force, which is assumed to be only affected by formal education policies. In other words, unpaid care work is
constructed mostly as a constrain to women’s labor market participation but its long-term contribution to human capacity development (via effects on skill formation and the labor force is neglected, and to a more gender-equitable distribution of income and time).

Further developing a gender-focused variant of MAMS, particularly focusing on how to make gender aspects of its dynamic component more explicit, could constitute a way forward for addressing some of the limitations of the early static gender-aware modelling, and could be used to run simulations specifically focused on care policies.

OLGs

Another group of dynamic CGE models that consider gender aspects include a few overlapping generation models (OLGs) applied to developing countries. In recursive dynamic models, results are presented as occurring along a time path, but this path is a sequence of static equilibria with only a few variables endogenously updated to reflect changes in previous periods. In the structure of recursive dynamics models such as MAMS, the decisions of economic agents depend on the past and the present, not the future. Dynamic overlapping generation CGE models include more complex dynamics. These usually involve a number of adult cohorts who make production and consumption decisions over different lifetimes that are both intra and inter-temporally optimal (Diamond & Zodrow, 2013). The modelling of how these different cohorts (such as parents and their adult children) make decisions is often based on strong assumptions such as perfect foresight and joint utility maximization. A strand of the OLG literature uses bargaining models to determine optimal decisions at the household level (e.g. Barczk & Kredler, 2018a for fully-dynamic, non-cooperative models with commitment; Barczk & Kredler, 2014 for altruistically motivated fully-dynamic model without commitment), an approach that tends to be chosen when the issues to be investigated concern generational policies and ageing. Unfortunately, as better discussed in Section 4, most existing overlapping CGE models concerned with ageing societies do not give sufficient consideration to possible gender biases. The family of models developed by (Agenor & Canuto, 2013a, 2013b; Agenor, Canuto, & Jelenic, 2012) to study investment in physical infrastructure in countries as diverse as Benin and Brazil introduces a gender lens and is reviewed here.

Agenor and Canuto’s framework is novel and has potential for addressing some limitations of other CGGE models reviewed earlier. Their approach could be of particular relevance for country settings characterized by a lack of water and electricity infrastructure, or other infrastructure with the potential to reduce women’s drudgery work, in other words, physical infrastructure. Canuto et al’s approach involves differentiating between kinds of unpaid work and linking improvements in infrastructure that reduces the drudgery of housework to long-term health and productivity. The computable overlapping generations model thus constructed aims to assess the impact of various ‘gender-based policies’ on GDP growth. Women allocate their time between three alternatives: market work, raising children and ‘home production’ (by which the authors essentially mean unpaid housework) while men allocate their time exclusively to market work. The model also assumes that fathers have a higher preference for current consumption whereas mothers have a higher preference for children’s health. Home production combines women’s time allocated to that activity (for instance food preparation) with infrastructure services (for instance electricity and labor-saving cooking devices). The underlying hypothesis is that if access to infrastructure improves, women can allocate more time to the care of their children hence contributing to
their better health and human capital accumulation in the long run. The assumption built in the model is that if mothers are not biased towards their boys and instead support their boys and girls equally, this is likely to improve women’s bargaining power within their households in the next generation. This is because the model also assumes that women’s bargaining power depends on the relative levels of human capital of husband and wife.

Differentiating women’s uses of time and linking these to health outcomes and productivity of the future labor force is a welcome feature, but other aspects of the model would merit further refinement. In particular, the model does not allow for any participation of men in the unpaid activities of childcare and housework, and hence rules out the possibility that any policy intervention, or shock, may induce a more equal sharing of men and women in meeting their families’ needs. Moreover, while there is emphasis on one channel likely to affect the productivity of the future labor force (the time that mothers are able to devote to child rearing), the issue of how overwork for women might affect their current productivity and well-being and, by extension, the overall sustainability of the economic system, is neglected. Finally, modelling women’s bargaining power in the next generation solely as a function of their mother’s propensity to invest in their health and education, while assuming that public spending in health and education would always be ‘gender-neutral’, is somewhat problematic.

This preliminary review has highlighted strengths and limitations of existing CGGEs. It helped to identify desirable ingredients in a gender-aware economy-wide model for the distributional analysis of fiscal policies as well as aspects that need refinement. The next few sections explore whether studies in the broader non-gender economy-wide modelling literature offer insights that could be borrowed and adapted in the construction of a care-focused gender-aware MAMS model for South Korea (or country with similar structure).

3. Labor market imperfections in CGE models

In broad terms, CGE models can be categorized in three schools: the neoclassical school, the neoclassical-structuralist school and the structuralist school. The neoclassical CGE models, which were the first developed following the Walrasian general equilibrium theory, assume that markets operate with no frictions and that there is no excess capacity in the economy, i.e. output is supply-constrained. In labor markets, wages adjust so that labor supply, which usually is considered fixed, equals labor demand. Labor is assumed to be homogenous and perfectly mobile across sectors, which means that labor reallocates among sectors of activity when the economy receives any shock. Some of the first neoclassical models applied to policy evaluation are Dervis et al. (1982) and Shoven & Whalley (1984).

On the opposite side, structuralist CGE models, developed from the works of Taylor (1983, 1990) and Gibson et al. (1986), are demand-constrained and assume that markets operate with excess capacity and that quantities adjust the markets. Prices are not determined competitively; they are determined with a mark-up over costs. Labor markets present frictions and there is usually unemployment of factors. Wages are not equal to the marginal productivity of labor, but they are result of bargaining processes among employers and employees. In many structuralists models, a dual labor market is assumed, with an informal sector with a lower labor productivity.
The neoclassical-structuralist school is located between these two approaches and includes a range of different CGE models that depart from pure neoclassical models to incorporate frictions and rigidities but still within a framework in which prices are the main adjusting mechanism of markets. The majority of recently developed CGE models fall under the neoclassical-structuralist approach, incorporating frictions and imperfections in labor markets such as imperfect labor mobility across productive activities; non-homogenous labor (which is sometimes referred to as segmentation); involuntary unemployment; and wage bargaining mechanisms. Also, some models depart from the assumption of fixed labor supply and assume endogenous labor supply. These features are introduced to CGE models with the aim of representing actual economies in a more realistic way, and analysing policy questions in countries in which labor markets present frictions and imperfections. The aim to introduce labor market imperfections in CGE models is, as presented by Boeters & Savard (2011), two-fold: to either analyse changes in labor market institutions or policies or to take into account labor market consequences of a different type of policy.

In this section we present some of the innovations in labor market modelling found in different CGE models that fall into the neoclassical-structuralist school, but we also present some labor market mechanisms included in structuralist CGE models. Our aim is to discuss to what extent these innovative modelling options could be incorporated into a computable gendered general equilibrium (CGGE) model. With that in mind, we review models that consider the following labor market imperfections: labor segmentation and labor mobility; dual labor markets and the informal sector; involuntary employment; wage setting mechanisms; endogenous labor supply; and labor market regulations.

3.1. Labor segmentation and mobility

One of the simplest ways of adding complexity to labor markets is to depart from the assumption that labor is a homogenous factor of production and to consider different labor categories according to the workers’ characteristics. This assumption, often referred to as “segmentation” of labor, implies that firms do not treat labor by workers’ characteristics homogenously and that there is an imperfect substitution among them. This implies that in the labor market, workers receive different wages according to their characteristics, many times revealing some sort of discrimination. Usually, segmentation is defined in terms of skills or qualifications of workers, but other categories such as ethnicity (Berrittella, 2012 for United Kingdom; Flaig et al., 2011 for Israel; Maissonnave et al., 2009 for South Africa), migration status (Filipski et al., 2011 for Dominican Republic) and age (David & Marouani, 2015 for Tunisia) are also introduced. Also, as presented in the previous section, all existing CGGE models incorporate disaggregation of labor by sex.

Formally, the differentiation of labor by different categories is introduced in the model through Constant Elasticity of Substitution (CES) functions that assume imperfect substitution between them. Labor demand by firms depends on the different wage rates and the elasticity of substitution among labor categories. If labor is differentiated in more than one category, e.g gender and skills, a nested CES function is assumed, with different elasticities of substitution for the various levels. Usually, a more inelastic substitution among workers with different skills is assumed than among workers with different genders (e.g. Arndt et al., 2011; Barreiro & Domínguez, 2014). The order in which the nesting structure is presented is not irrelevant; as Boeters & Savard (2011) show, it can lead to different demand
Another key element is the value of the elasticity of substitution itself: in very few cases researchers rely on estimations for the country of analysis. More often, values of elasticities are taken from the literature or are “guesstimates”. For this reason, a sensitivity analysis is recommended. Lofgren & Cicowiez (2017) apply a systematic sensitivity analysis to check for robustness of results.

In countries where there is high discrimination in labor markets, usually by ethnicity, a more inelastic substitution among workers’ segments is assumed. Maisonnave et al. (2009) assumes a more rigid structure of production in their analysis for South Africa, with a Leontief function combining workers of the same skill but of different race in order to consider the systematic bias against non-white workers due to social behaviour. The same assumption is found in Berrettella (2012) in her analysis of the labor market in the UK. The author considers seven minority groups in the country (Indian, Pakistani and Bangladeshi, Chinese, Black Caribbean, Black African, Black other and Other), and assumes a rigid labor demand substitution to model persistent discrimination in labor markets.

In summary, incorporating labor segmentation in CGE models that account for relevant workers’ characteristics may add useful insights into how labor markets operate, by allowing for complementarity or substitutability among workers, and by allowing to consider the different situation of workers in labor markets, in terms of informality, wage differentials, unemployment, as we will review in the next sections. However, complex nested structures in the production function require more values of estimated elasticities, which often need to be taken from literature.

CGE models also differ in the treatment of labor mobility between activities of production. On one side, neoclassical CGE models assume that labor is perfectly mobile across sectors of production, which implies that there is one wage rate per type of labor, regardless of the sector in which the labor factor is employed. On the other side, some models treat labor as specific factor, which is fixed and can only be employed in one sector, which leads to different sectoral wages. This rigid assumption is found in CGE models that include regions within a country to account for regional immobility, such as in the study of the Quebec region by Decaluwe (2010). However, in reality workers move imperfectly among sectors. For example, if we consider a case of a worker employed for several years in the retail sector that searches for a new job, he/she may have more chance to be employed in another activity related to services than in the agriculture sector.

Lofgren & Cicowiez (2017) provide a useful model innovation that is located between the two labor mobility extreme assumptions. The authors develop a “proximity framework” that assumes that workers have certain capabilities that allow them to be more or less efficient in the different sectors. Workers can move from one sector to another when the economy faces any shock, but they become less efficient the further they move from their sector. When workers move to a sector in which they are less efficient, they receive a lower wage per physical unit. The sectoral proximity is defined following the product-space approach, based on revealed comparative advantages of each sector. In their model, the authors apply the

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1 The authors present a simple example in which they assume labor market segmentation by skills, with an elasticity of substitution among skilled and unskilled labor of 0.5, and by gender, with an elasticity of substitution among male and female labor of 2. Computing the own price elasticity for each labor category differs according to the order of the nests (and also the share of each labor category in total labor demand).
proximity framework to an illustrative Sub-Saharan African country, in which they identify 25 sectors of production and one type of labor. For example, one of the identified sectors, agriculture, is close to food production and far from machinery manufacturing. The authors simulate an exogenous price shock that expands the food sector. As a consequence, the sector expands and attracts workers from other sectors, partly due to the sector proximity (for example, workers move from the beverage sector) but also due to how the exogenous price shocks affect the other sectors (for example, the agriculture sector). This framework is particularly relevant to the implications of labor reallocations after price shocks, and adds a more realistic approach on labor mobility, as it considers that workers move to sectors that require similar capabilities. The authors only consider one type of labor, but acknowledge the usefulness of developing the framework in order to consider labor market segmentation by education levels and gender, as well as estimating the proximity parameters on the basis of labor disaggregation. Such a framework could be extremely relevant to incorporate into a CGGE model, in order to reflect sectoral segmentation by gender in labor markets.

3.2. Dual labor markets

The dual labor market theory proposes that labor market operate with two tiers. In the upper tier (or primary sector), workers enjoy better labor conditions, higher wages and employment security; while workers in the lower tier (or secondary sector) receive lower wages and fewer benefits, such as lack of access to retirement or to health (Saint-Paul, 1997). Access to the upper tier by workers in the lower tier is limited by non-economic barriers. Although not exclusively, jobs in the lower tier are usually filled by minority workers, women, and youth (Reich et al., 1973).

The formal-informal dichotomy in labor market fits into the dual labor market theory. The informal sector is linked to the lower tier, and for this reason, the informal sector is understood as an employer of last resource to workers who cannot access the formal sector. Under this view, informal workers are considered to be “excluded” from the formal modern sector. However, a different hypothesis understands that some workers and firms chose to operate in the informal sector, as a consequence of a cost-benefit analysis (“exit” hypothesis). The two hypotheses are presented and tested in (Perry et al., 2007) analysis of informality in Latin America, where they find that women, especially married women with children, prefer to work in the informal sector, as informal jobs allow more flexibility to balance home and work responsibilities. Thus, the incorporation of an informal sector in a CGGE model to explain the existence of a secondary labor market should take into account the two views of how the informal sector operates and how women are affected in dual labor market systems with informality.

The exit hypothesis of informal labor markets has been introduced in CGE models through the Harris-Todaro (1970) framework, originally developed to model domestic migration between the rural and urban sectors. This framework assumes a two-sector economy with limited migration from one sector to the other; originally in one direction from rural to urban sector, but more recent versions include two-way mobility. In the original model by Harris-Todaro, workers migrate from the rural sector into the urban sector, where wages are higher but there is unemployment. In the rural sector, wages are equal to marginal productivity. Migration takes place until the rural wage rate is equal to the expected urban wage rate, which is the urban wage rate multiplied by the unemployment rate (Harris & Todaro, 1970).
Hernandez (2012) applies the Harris-Todaro framework to analyse the potential impact of a payroll tax reform in Colombia, where the informal sector accounts for more than 60% of employment. The author highlights the need to incorporate a non-competitive labor market to analyse possible shifts in employment due to the tax reform. Payroll taxes are non-wage costs that the employer pay to hire workers (health benefits, social security, insurance), and account for more than 50% of the workers’ salary in Colombia. Thus, a reduction in payroll taxes will have an impact on wages and employment, but the effect will depend on labor supply and demand elasticities. If supply is inelastic and demand is elastic, the fall in payroll taxes will benefit entirely workers and there will be no change in employment. But the existence of an informal sector makes supply not inelastic and a reduction in payroll taxes increases employment and lowers the positive impact on wages, as workers migrate from the informal to the formal sectors of the economy. However, the author finds that informality falls slightly, which shows that the informal sector in Colombia is explained by the exclusion hypothesis: in spite of an improvement in wage conditions, informality persists, due to a more rigid institutional framework.

The formal/informal segmentation in labor markets has also been addressed through the efficiency wage approach, which relies more on the exclusion hypothesis of informality. Thierfelder & Shiells (1997) develop a framework with an endogenous wage differential in which there are two sectors in the economy: an informal sector with lower productivity and a competitive wage setting, and an efficiency wage sector in which workers are paid a wage differential due to higher productivity and/or higher skills. It is assumed that employers cannot supervise workers and when these are caught shirking, they get fired and go to the low-productivity sector. In this setting, the wage differential is endogenously determined and depends positively on labor demand by each sector and negatively on the workers’ quitting rate in the sector. Compared to the Harris-Todaro framework, in the efficiency wage approach no unemployment is assumed in the formal sector and the wage differential is endogenously determined. In Lofgren and Cicowiez (2017) proximity framework based CGE model, efficiency wages determine the wage differential among workers with different capabilities. Thus, the efficiency wage framework may be applied to other model specifications apart from models with informality.

In structuralist CGE models, the dichotomy is presented as modern versus subsistence sectors, and in these models, the subsistence or informal sector is linked to both the exit and exclusion views of informality, and understood as a fundamental part of the capitalist system (Gibson & Kelley, 1994). In spite of the differences, the informal sector in structuralists CGE models share some similarities with the informal sector in the efficiency wage approach, in that the sector operates without excess capacity and is supply constrained. Labor productivity is lower in this sector and wages are determined by labor productivity and its value-added price. In contrast, the formal or modern sector is demand-constrained and operates with excess capacity. These features are incorporated into a CGE model to analyze distributive policies in Brazil (Morrone, 2015), in which three classes are considered: capitalist, modern and subsistence household. The aim of Morrone’s study is to focus on the interaction of both sectors, the formal and the informal, in times of economic expansion, and analyse the impact on income distribution due to economic growth. The empirical results show that the expansion of the demand when the economy expands leads to an increase in production in the modern sector, and labor moves from the subsistence sector to the modern sector, increasing
productivity in the economy. Redistributive policies boost economic activity through the increased demand in the economy. Structuralists CGE models differ in many other aspects from neoclassical models. However, some of the features, especially regarding informality, have similarities. Specifically, the informal sector is usually depicted as a sector which serves as an employer of last resource, in which wages are set competitively and productivity of labor is lower. The main differences stem from the modelling of the modern sector, as in the structuralist tradition, this sector is demand-constrained. Both traditions of CGE models provide useful insights into how the two sectors interact and provide different modelling choices depending on the nature of the informal sector. If the exclusion view predominates and the model is aimed at explaining wage differentials between the formal and the informal sectors, the efficiency wage approach would be more relevant. If the exit view predominates and there is unemployment in the economy, the Harris-Todaro framework may be more useful.

3.3. Involuntary unemployment and wage setting mechanisms

Neoclassical CGE models assume full employment in labor markets, or they treat unemployment as fixed or non-existent. However, unemployment is a common problem in labor markets in both developed and urban developing economies, and for this reason, many CGE models incorporate unemployment, even when they are not aimed at analysing labor markets. Some segments of population, among them women, the youth and the elder working age population, as well as ethnic minorities, usually show higher unemployment rates. Incorporating unemployment in CGE models allows the labor market to adjust through employment levels and not just through wages. At the same time, it helps models look more realistic and less prone to criticism.

One of the most used modelling choices to introduce involuntary unemployment in CGE models is through a wage curve that negatively relates wages and unemployment, following Blanchflower & Oswald (1994). Empirical evidence from more than 40 countries showed a long run elasticity of wages to unemployment of around -0.1. Theoretically, the wage curve is supported by bargaining-power effects or no-shirking conditions. That is, in labor markets with high unemployment, workers have a lower probability of finding a job, so employers pay lower wages (Blanchflower & Oswald, 2005) or workers are willing to supply additional hours for free (Pant & Warr, 2016). In CGE models, the wage curve is defined for each labor category for which there is unemployment. The wage curve approach to model unemployment is attractive due to its simplicity and because it avoids modelling explicitly the mechanisms that generate unemployment, as Persyn et al. (2014) argue. For this reason, this approach has been applied in many CGE models that analyse diverse policy questions.

When a wage curve is introduced in CGE models with segmented labor markets, different assumptions can be considered for the different labor categories. For example, Carneiro & Arbache (2003) analyse the impact of trade liberalization in the labor market in Brazil and consider two types of unemployment depending on the workers’ qualifications and sector of employment. Among formal urban medium and high skill workers, as well as rural informal worker, they assume a wage curve, which, according to the authors, reflects that firms take into account the state of the labor market when deciding remunerations to their own employees. Among the rest of labor segments (formal rural, low skill urban formal and public workers) the authors assume a more rigid wage determination, with nominal wages set...
exogenously and adjustments in the labor market made through employment levels. The introduction of unemployment and of labor segmentation by skills allows the authors to focus their analysis on the impact of trade liberalization on employment and wages.

In a CGGE model for Uruguay that analyses the differentiated impact of trade liberalization on male and female workers, Terra et al. (2008) assume that unemployment only affects unskilled workers, and it is particularly high among unskilled female workers. Thus, they introduce a wage curve for unskilled males and another one for unskilled females. In order to calibrate the wage curves, they take wage curve elasticities estimated by Bucheli & Gonzalez (2012), which are higher among female workers, i.e., there is a stronger link between unemployment and female wages.

Applying a CGE model with endogenous labor supply, international migration and unemployment in labor markets in Tunisia, David and Marouani (2015) introduce an extended wage curve, in which public wages are incorporated, positively related with private wages. This extended version of the wage curve assumes that private wages decrease with unemployment, as in standard wage curve applications, but they also increase with public wages. Unemployment is defined by skills and age in the model, but the same value of the wage curve elasticity is determined for all labor segments.

Other set of approaches introduces unemployment in CGE models as a consequence of rigid wage setting mechanisms. Maecheler and Ronald Holst (1995) test different wage setting mechanisms in a prototype CGE model calibrated to Mexico. Their objective is mostly methodological, in order to present a series of wage setting mechanisms, from a very simple exogenous wage rigidity, with exogenous minimum wage set by occupation or sector, to more elaborate mechanism of wage bargaining. They present two different wage bargaining models: the monopoly union model and the efficient bargaining model. Under the monopoly union model, firms have no power in wage setting and unions have no power in employment. The outcome is not efficient. Under efficient bargaining models, firms and unions have equal powers both in wage and employment setting. Unions may have more or less power, the most powerful the unions, the closer to the firm’s zero profit outcome. The different wage bargaining models led to different results; the stronger the power of unions, the higher the impact on wages, but at the expense of the segment of workers not unionized.

Severini et al. (2018) introduce wage bargaining mechanism between unions and firms to

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2 This pattern is not observed for all countries. The review by Terra et al. (2008) shows that the stronger elasticity among women is found in empirical studies for East Germany (Baltagi et al., 2000), Turkey (Ilkkaracan & Selim, 2003) and Chile (Berg & Contreras, 2004), but an opposite or insignificant effect is found in USA and the UK (Blanchflower & Oswald, 1994), Spain (Sanroma & Ramos, 2003) and the Netherlands (Groot et al., 1992). As Groot et al. (1992) explain, the ambiguous results on women is due to two opposite effects: pure wage effect and discouraged worker effect. In the first effect, the usual wage curve behavior applies: unemployment has a negative effect on wages as workers have a weak bargaining power. In the second effect, unemployment has a positive effect on wages as high unemployment levels discourage workers from entering the labor market. This last effect appears to be more important among women.
analyse labor market policies increase female employment in Italy. Even if, as discussed in Section 2, their model does not seem to reflect accurately the gender dynamics of the Italian labor market. It nonetheless incorporates interesting features regarding the modelization of unemployment in labor markets. Specifically, the paper assumes that the presence of trade unions affects the formation of nominal wages, via a Nash bargaining approach in which trade unions choose the nominal wage that maximizes their utility function and firms choose the level of employment that maximizes their profits, taking the negotiated wage as given. As a result, there is unemployment in the economy. Their approach follows Bohringer et al., (2005), which assumes that bargaining power of firms and union are different by sector, as sectors face different economic conditions. The authors simulate the introduction of subsidies to female employment. As labor supply is exogenous in the model, the simulation of female labor subsidy leads to an increase in female labor demand, an increase in nominal wages, and a reduction in female unemployment rates. However, this is done at the expense of male employment. As already explained, this modeling assumption presents limitations, as it does not consider the possibility of increasing female employment among women discouraged from participating in the labor market.

Another interesting model with structuralist features which introduces alternative wage setting mechanisms, as well as price setting mechanisms, is Gibson, Lustig and Taylor’s model on class conflict in a CGE model for Mexico (Gibson, B., Lustig, N., and L. Taylor, 1986 ‘Terms of Trade and Class conflict in a computable general equilibrium model for Mexico’ Journal of Development Studies 23 (1): 40-59). Although the paper is now 30 years old, it remains one of the best examples of distributional analysis carried out with a CGE model for a middle income country in the global South. Both data construction and model features are carefully designed to reflect the authors’ understanding of the socio-economics of inequality and class conflict in Mexico. Simulations involve an increase in nominal urban wages (by 15%), an increase in real investment (by 10%) and a doubling of the guarantee price for corn and beans. The authors focus their analysis on the impact of each of these measures on the distribution of real income by social class and associated structure of private, government and foreign savings, under alternative assumptions regarding price and wage formation, and reflect on the political viability of such interventions.

The model includes a number of sectors, distinguished according to whether they use agricultural land/natural resources or only ‘reproducible capital goods’ as means of production. Flexible prices are assumed to clear markets only in those sectors where land or other natural resources limit supply. Prices in the remaining sectors that use only capital and labor are equal to the sum of wage and intermediate costs plus profits. Under the ‘Keynes-Kalecki closure, profits depend upon a fixed mark-up, independent of the level of wages. The assumption is that the owners of capital (the capitalist class) attempt to protect their real incomes from wage and commodity prices increases, which are fully passed along. Under the
'Marx-Sraffa closure', there is a more complex determination of prices based on 'class conflict over the distribution of surplus', reflected in an inverse relationship between wages and the rate of profit. The assumption is that capitalists exploit workers 'by virtue of ownership of the means of production and a reserve army of unemployed workers'. Under both closures, output in non-agricultural sectors is determined by the level of effective demand with real investment given exogenously. In neither closures labor is a constraint. The model is distinctly non neoclassical in the sense that the distribution of income is explicitly determined by class conflict and not by marginal productivities and factors endowments. In both closures investment and money wages are taken as given, and not determined by model parameters. Significant differences emerge from the simulations in terms of which groups are most affected.

3.4. Endogenous labor supply

In neoclassical models with exogenous labor supply, there is a strong constraint on growth, which only responds to reallocation of resources among sectors. Endogenizing labor market participation decisions allows for changes in participation rates due to changes in labor market conditions. This can be particularly important among women, who usually present lower participation rates in labor markets and engage to a larger extent in non-remunerated activities.

Different strategies have been followed in order to make labor supply endogenous in CGE models. Annabi (2003) introduces leisure in the household utility function, with an opportunity cost equal to the wage rate. Labor supply has two opposite reactions to an increase in wage rates: a substitution effect (the opportunity cost of leisure increases) and an income effect (the worker has an incentive to increase labor supply). Most CGE models assume extended LES utility functions, which lead to non-unitary income elasticities (Annabi, 2003; David & Marouani, 2015; Fofana, Cockburn, & Decaluwe, 2005), but other simpler functional forms, such as Cobb Douglas can be assumed in order to avoid taking estimated parameters from the literature (Terra et al., 2008). Households maximize their utility subject to a budget constrain and a time constrain, in which total time comprises working hours and leisure hours. This framework can be extended to incorporate other non-market activities other than leisure, such as social reproduction activities, as presented in the previous section.

A novel approach on labor supply was developed by Boeters & van Leeuwen (2010) in a CGE model aimed at analyzing trade policies in Europe. The labor market extension includes endogenous unemployment and endogenous labor supply. Their novelty is to model both the extensive margin (the decision of the individual whether to participate or not in the labor market) and the intensive margin (the number of hours she works). It is modeled as a two steps procedure solved backwards: assuming that the individual participates in the labor market, she first determines the optimal number of hours worked. To do so, the household maximizes a CES utility function with consumption of goods and leisure, which is valued at the marginal wage. The decision to participate is based on the expected utility of participation, with a fixed cost of entering the labor market. The fixed costs are different among households, and may be explained by the household characteristics, for example, family coordination costs if both partners have a paid job, or the commuting costs between home and work. However, the authors explicitly avoid specifying the precise nature of the
fixed costs. Fixed costs are distributed uniformly across households. The authors apply the model, which also incorporates wage bargaining mechanisms and labor market segmentation by skills, to EU countries to evaluate energy policies. Apart from having detailed labor market results on employment, unemployment and participation rates, the model also allows a more precise focus on other variables, such as productivity, which is affected by employment. However, in spite of these advantages, the authors find that empirical calibration of such a complex model presents some problems, such as the lack of compatibility among the parameters from the LES function and the empirical wage differentials and replacement rates. In spite of these complexities, this labor supply extension was applied in a spatial CGE model for Europe to evaluate regional labor market dynamics (Persyn et al., 2014) and could be a potentially interesting approach to introduce in a CGGE model, as women not only present lower participation rates, but often they engage in part-time jobs to balance better the non-remunerated and care activities.

3.5. Labor market dynamics and regulations

In this subsection we present some innovations in terms of modeling of labor market regulations, social security policies and education policies, which are interlinked to labor market mechanisms. We focus on two papers that incorporate several innovations in labor markets in CGE, with some features that were presented above.

Marouani & Robalino (2012) develop a CGE model to assess labor market policies in Morocco. They incorporate an informal sector, education dynamics, and a social security system. They model the choice of being in the informal sector as a decision of the worker, and they do so with an extended Harris-Todaro approach in which they consider mobility between urban and rural sectors, and they also include mobility between a formal and an informal sector. They introduce a “mobility elasticity” in each migration function (rural-urban and formal-informal) that allows the model to account for a lower cost of mobility between formal and informal sectors compared to the cost of mobility between rural and urban labor market. This combined Harris-Todaro functions could be useful in a CGGE model to introduce several migration choices for workers. Another interesting feature of Marouani and Robalino’s model is the separation of the social security account from the government account. This account receives social security contributions by employers and employees and pays old-age pensions, disability pensions and other benefits to households. Lastly, in the model labor supply by skill in each year is determined with a projection model that projects labor force by age, gender and skills, based on mortality and fertility rates, labor force participation rates, and indicators of enrolment, repetition and dropout rates at each level in the education system. Using this framework, the authors evaluate employment policies. Their results show that employment policies that are not combined with a reform of the social security system and an improvement in the efficiency of the education system are not sufficient to reduce unemployment rates, and might even increase unemployment among unskilled workers. These results highlight the need to consider the links between the education system, the social security system and the labor market dynamics in order to evaluate employment policies. The authors emphasize the need to count with a CGE model with a detailed labor market, but they acknowledge the fact that the empirically validation of some mechanisms, mainly regarding rural-urban and formal-informal dynamics, would be desirable.
In Gibson (2005)’s structuralist model presented in section 2, there is also an informal sector that plays as an employer of last resort for some sectors. Unlike the previously reviewed dual-economy models, Gibson’s approach considers the existence of both formal and informal activities within a same “branch of production”. The informal sector, for the branches where it exists, operates in full capacity, does not pay taxes and sells at the price determined by the formal sector. Labor supply of the economy and the level of productivity determine the output of the informal sector. Thus, the output of the formal sector is residual to the informal sector. The author applies the model to simulate a long-term path of transition into a globalized economy, by simulating changes in human capital accumulation, and investment and fiscal policies. The interaction of the modern and the subsistence (informal) sectors, together with the path of the households’ investment in human capital, explains how two different trajectories of transition to openness lead to different outcomes of poverty and income distribution. As already presented, in this model family members also have dependents, which are engaged in the accumulation of human capital, through participation in formal education or by learning by doing. Households maximize their discounted value of utility of income, reducing their participation rate in the present if the expected income in the future is higher. In this context, public policies aimed to lower the cost of education leads to a decline in the labor force participation rate and an increase in the rate of human capital accumulation.

4. Modelling demographic transition and eldercare

This section reviews select studies that use OLG/ CGE to model ageing and eldercare in a general equilibrium setting. To the best of our knowledge, very few CGE models incorporate consideration of eldercare, or long-term care, and virtually none examine gender distributional effects of public investment in caring for the elderly. Our aim is to learn from the relevant features related to ageing and eldercare of the existing studies and inform a MAMS model with gendered nature of these features. First, we provide a rationale behind the growing need for studying demographic transition and long-term care arrangements and why these features have gender distributional concerns. Second, we examine studies in two broad categories: population projection models and structural eldercare models. Although some of the models reviewed have gender disaggregated features and unpaid caregiving parameters, these papers lack “two-sector method” where unpaid care and time use are explicitly modelled as a functional form as described in Section 2.2.

4.1. Global ageing and gender

Global ageing is on the rise and has significant implications for public investment and state policies around the world. Persons aged 60 years or over are growing faster than all younger age groups world-wide (United Nations, 2017b). Until recently, ageing has been a policy concern of high-income countries in mostly Europe and Asia. However, recent projections have demonstrated that this demographic transition will be relevant to many other parts of the world across income levels. In fact, between 2017 and 2050, the older population is expected to grow fastest for lower-middle and upper-middle income countries in Africa and Asia (United Nations, 2017a). Thus, ageing will not only be consequential on a global scale; it also requires countries to prepare for this transition with adequate social policies. Incorporating
eldercare and population dynamics into MAMS models can provide meaningful ways to test alternative policy measures to address the current and future challenges rising from global ageing. Moreover, global ageing has significant gender distributional consequences. This requires the need for strong gender analytical lens when we test alternative policies. Specifically, older women face economic disadvantage compared to men and at greater risk of falling to poverty. The literature that has studied ageing and pension reforms mostly neglects this feature. Additionally, ageing of societies raises the demand for eldercare. Without adequate eldercare policies, the care burden will fall on informal, unpaid caregiving, especially working-age women.

**Older women**

Many studies have examined the fiscal and welfare consequences of pension financing and the increasing cost of ageing on the aggregate economy (e.g. Tran & Woodland, 2014 for Australia; Diaz-Saavedra, 2017 for Spain; McGrattan & Prescott, 2017 for the U.S.). Their main features include heterogeneous agents with idiosyncratic shocks (e.g. earnings, lifetime uncertainty and productivity) in dynamic overlapping generations models to analyze retirement behaviour and simulate pension designs and policies. For example, Diaz-Saavedra finds that tax and transfer programs encouraging older workers to delay retirement can lead to lower output per head due to individuals smoothing their aggregate work hours and consumption over their life cycles. Though modeling heterogeneous agents with stochastic components is a promising feature for gender analysis, these studies assume a representative, competitive firm. This is problematic given the gendered nature of overcrowding of certain industries and labor market imperfections that are outlined in Section 3. Moreover, in analysing the welfare effects of ageing and pension policies, these studies neglect the distributional consequences of pension designs that are already prone to gender gap. As described in Section 1, older women are particularly vulnerable as they increasingly live on their own with less income security (Horstead & Bluestone, 2018; United Nations, 2017a). This is partly due to the discrepancy between life expectancies for men and women across countries with most notable difference in Republic of Korea at 13.7 years of gap whereas Japan and Thailand with 6-7 years of gap (UN ESCAP, 2017). In fact, controlling for average age at marriage and longer life expectancy of women, women are expected to outlive their spouses on an average by a range of 4 to 10 years (UN ESCAP, 2017). Studies have shown that older women receive lower pension due to an existing gender wage gap in the marketplace and less active years of labor participation compared to men, which increasingly puts them at risk for impoverishment (Inagaki, 2018; Legendre, 2009).

As mentioned in Section 2, older women are also caregivers to their grandchildren and their spouses. Samuels et al. (2017) notes that although older women in high income countries tend to provide unpaid care out of choice, this is mostly not the case in low income countries which tend to completely lack adequate care infrastructure. With the rising demand for elderly care and coverage deficits of long-term care globally (Scheil-Adlung, 2015), the burden of care rests on family members as primary caregivers. Using comprehensive data on informal caregiving in the U.S. and Europe, Barczyk & Kredler (2018) shows that informal care towards elderly couples almost always comes from the spouse. The heavy-helper spousal caregivers are mostly female due to marriage age and longevity differences as

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3 They spend more than 21 hours or more per week in providing informal care to their elderly.
mentioned above. This is in line with Yoon (2014) who finds elderly men receive 80% of the care from their spouse in South Korea. On the other hand, elderly women receive the greatest amount of care from female relatives at about 42%, followed by 8% by the spouse in 2002 (Yoon, 2014). This implies that women needing care is likely to be on their own as they outlive their spouses to whom they provided care in earlier years and most likely have depleted their family resources to the medical needs of their husbands (Yoon, 2014). Thus, in the absence of gender-aware pension reforms and adequate eldercare policies, older women are at simultaneous risks of economic disadvantage and care burden during their frail years of ageing.

**Informal care**

Another aspect of ageing that is highly gendered is the demand for and the provision of eldercare, or long-term care, by working-age women in an informal setting. Some countries, such as Sweden and the Netherlands, spend around 4% of their GDP on long-term care (Barczyk & Kredler, 2018b) as opposed to countries such as South Korea whose LTC scheme is still in its nascent stage with a coverage rate of only 7.2% of the elderly (Jeon & Kwon, 2017). Despite the recent reforms and policies to provide care for the elderly, many countries are still not adequately prepared for the projected demand for long-term care. At the global level, more than 48% of the world's population is not covered by any LTC coverage with another 46.3% excluded due to strict means-tested coverage (Schei-Adlung, 2015). This type of public neglect of LTC coverage shifts the burden of eldercare to informal (unpaid) caregiving by family members and particularly female family members. In fact, three quarters or more of adult children that heavy-helper caregivers are female, and they are less active in the labor market than other comparable children (Barczyk & Kredler, 2018a; Mommaerts, 2016). Empirical studies have also demonstrated that working-age children that are caregivers face heavy demands on their time, and informal caregiving can come with significant opportunity costs (Mommaerts, 2016; Skira, 2015; Van Houtven, Coe, & Skira, 2013). Moreover, Mommaerts & Truskinovsky (2019) also finds that elasticity of time is higher for informal caregiving to adults as opposed to childcare. Additionally, caregivers can face not only time and monetary costs, they may be prone to depressive symptoms and negative health effects due to heavy care burden. In fact, studies have shown the negative effects of caregiving on the health and mental status of informal caregivers (Do, 2008; Malhotra et al., 2012; Do et al., 2013; Jeon & Kwon, 2017).

Caring for their loved ones is done out of choice in many cases; however, care policies need to adopt to the changing needs of families and support them in providing quality care to their elders without having to compromise the health and economic prospects of women. In fact, the conventional approach in Asia that elderly care is the responsibility of sons and daughters is changing as people's attitudes towards long-term care shift and policymakers encourage high labor force participation (Ansah et al., 2016; Choi, 2006). In Southern European countries, the rising female labor-force participation may shift countries such as Spain, which have relied heavily on family caregiving, to take larger responsibilities to provide care for the elderly (Barczyk & Kredler, 2018). Barczyk & Kredler (2018) observe that countries with high public spending on LTC (Sweden, Denmark, the Netherlands and Belgium), informal care hours account for 28% of all care hours. This is compared to 49% for countries such as Germany, France and Austria that have medium-sized public spending on LTC; and 85% for

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4 Long-term care, elderly care and eldercare are used synonymously.
Italy and Spain, in which governments spend the least on LTC (Barczyk & Kredler, 2018; Figure 4). As for the U.S., which is also a low public spender on LTC, an informal care share is 64% of all care hours. This implies the importance of care policies that are adoptive to the emerging and complex nature of eldercare arrangements and family well-being. Additionally, macroeconomic models that examine alternative care policies must incorporate informal caregiving in a structural form. Neglecting informal caregiving in macroeconomic models can lead to misleading results that will overestimate the impact of care policies funded by the government or care arrangements provided by the market. For example, Yoon (2014) imputed monetary value of informal care hours and estimated the care expenditure decompositions to show that 27% of the LTC costs were by the government and the market as opposed to 73% were estimated to be provided by informal caregiving (Yoon (2014), Table 5).

This section demonstrated the rationale behind why modelling eldercare policies is in emergent need and how gender is at the intersection of ageing and eldercare policies. As mentioned earlier, there is very few OLG/CGE model that include eldercare and gender in a structural way. However, the MAMS model for the care economy still can learn lessons from existing efforts at modelling demographic transition and eldercare.

4.2. Demographic transition models

This first strand of OLG/CGE literature mostly deals with features related to ageing and population projections. Many of these models use some variant of Cohort-Component Method to incorporate ageing dynamics and analyse the impact of the population projection on aggregate indicators such as growth, consumption, migration and labor force composition. The conventional Cohort-Component method starts with a base population decomposed by age and gender. Each year, age-gender cohorts are adjusted after year-by-year deaths are subtracted and births and net migration are added to the population. Essentially, the method allows researchers to project demographic transitions by age and gender structure based on a base-year structure and additional assumptions about the main demographic (exogenous) variables such as mortality, fertility and migration. Studies using the conventional projection model (otherwise, neoclassical in principle) applied to Scotland have estimated tighter labor market and depressive effects of ageing on labor supply, output and consumption (Lisenkova et al., 2010; Lisenkova et al., 2013b). Lin et al. (2012) uses the same method but endogenizes fertility and mortality rates within the cohort-component model in addition to a dynamic investment function based on neoclassical assumptions. Specifically, the population model includes the per capita income endogenously affecting birth rate of the specific age and mortality rates by age and gender. The results are similar to Lisenkova’s findings where the labor force declines due to the projected population decline and this leads to lower GDP and total consumption.

Adding more complexity to the population projection models, some studies have used OLG-CGE to capture age-specific effects in labor force participation, productivity, consumption and government expenditure on health and education. This is under the assumption that workers of different age are not perfect substitutes. Lisenkova et al. (2013a) considers, in line with Auerbach & Kotlikoff (1987), 21 representative age groups in an overlapping generations structure and adjusts labor force composition not only by fertility and mortality rates but also by age-specific productivity. One interesting result is that including age-specific effects lead to higher government deficit and thus government debt. Neglecting age heterogeneity in general equilibrium models therefore can lead to misleading aggregate
results (in this case, an underestimation of government deficit) and these results will be even more nuanced for countries going under rapid transition to ageing. To capture age-specific effects on the aggregate economy in China, Wang et al., (2004) uses a recursive dynamic CGE model to study distributional effects of pension policy in China. The model differentiates seven productive activities and two representative households, rural and urban. The productive activities include: agricultural sector, public service and five types of non-agricultural sector, namely village enterprises, rural informal sector, state and collective enterprises, other urban formal sector and urban informal sector. The dynamic growth in the model is driven by the rate and demographic structure of labor force growth, the accumulation of capital stock and the improvement in total factor productivity (Wang et al., 2004). As for the population dynamics, economic growth is assumed to affect the fertility and mortality rate via an exogenously specified total fertility rate and changes in life expectancy. Additionally, rural-to-urban migration is exogenous to demonstrate China’s rapid urbanization. For each year, the labor supply is calculated such that the population at each age from 15 to 70 years is multiplied by an age-gender specific labor participation rate for that year. These age-specific labor supplies are then aggregated to 22 groups (i.e. 11 age groups disaggregated by gender) of labor inputs in the cost and demand functions. Workers are assumed to start retiring at age 40 and retirees are differentiated by sectors to reflect the segmented pension coverage for workers in China. Additionally, labor is fully mobile within each region (urban and rural); however, rural-to-urban (or urban-to-rural) labor mobility is not allowed and only specified through the exogenously specified rural-urban migration. This paper demonstrates great details in terms of productive activities and labor disaggregation to reflect age and gender heterogeneities; however, there is a missed opportunity in terms of bringing structural gendered lens to test pension structures. For example, labor mobility across informal and formal sectors, or across sectors based on gender/occupational overcrowding, that are examined in Section 3 could have been considered. Moreover, the model assumes full employment, which means any increased labor supply (e.g. from closing the retirement age gap between men and women) is assumed to be fully absorbed by the labor market. This is an unrealistic assumption that neglects the fact that women face more time and social constraints to enter or remain in the labor force compared to men.

More studies have moved from mere population projection models to study intergenerational inequality and allocation of resources. Choi & Shin (2015) develops an OLG model with endogenous accumulation of human capital to study the effect of ageing population on labor supply, capital stock and economic growth in Korea. They use household utility function by Kimball & Shapiro (2008) with survival probability to endogenize savings and labor supply in addition to letting elasticity of long-term labor supply equal to zero and consumption pattern to be hump-shaped. Social transmission of human capital is also an innovative feature where each new generation starts with an initial level of human capital that includes weighted mean of aggregate human capitals of all previous generations. The paper finds that ageing shrinks labor supply, which drives wage rate to rise and thus increases investment in human and physical capital. However, investment in human capital is lower under ageing scenario but the growth in physical capital offsets the contraction in labor supply.

Here, we emphasize that gender-blind policy simulations regarding pension and ignore important dimensions of inequality and dire implications for older women, as illustrated by (Legendre, 2009). The author analyzes the demographic transition in France with eight heterogeneous social groups – four professional or social groups, namely, disaggregated by gender. They test the hypothesis that lower age dependency ratio due to ageing leads to lower pension and evaluate how this reflects in inequalities across the eight social groups, across
working population and retirees, and across men and women. (Legendre, 2009) finds that inequalities remain stable between the social groups; however, the income gap between workers and retirees as well as men and women worsens under the demographic constraints. Among retired men and women, their findings provide evidence that older women are in a particularly vulnerable position. This reflects many other studies that find lower pension for women is indicative of inactivity or disparity of the job market (e.g. Bonnet, Buffeteau, & Godefroy, 2006).

4.3. Eldercare models

In an effort to model caring for the elderly in the United States, (Kydland & Pretnar, 2019) is currently developing an OLG model with American Time Use Survey data. Young agents face idiosyncratic disease shock and have an altruistic preference to take care of their infirm elders, which endogenously determines GDP growth. Since young agents face a trade-off of caring for their elderly and participating or remaining in the labor market, they can analyze how informal care affects labor market participation at the intensive and the extensive margins. They find that projected ageing will reduce GDP by 17% by 2056 and 39% by 2096. This happens through two main channels. At the intensive margin, less work hours means a decrease in permanent income, which reduces investment and thus aggregate output and tax revenue from social insurance. Although they observe that, in a reaction to age-dependency ratio falling, workers increase market time, this increase does not offset the greater labor participation loss at the extensive margin (Kydland & Pretnar, 2019). The study is novel to use time use data to answer important policy question rising from ageing phenomenon; however, gender distributional effects were not part of their consideration. They argued that the adverse effects of incomplete markets on the elderly welfare can be mitigated by informal care by their altruistic children, which they conclude that simulations demonstrated the supply of informal care was not enough to offset the negative impacts (Kydland & Pretnar, 2019).

In addition to modelling ageing population growth, (McGrattan, Miyachi, & Peralta-Alva, 2018) tests seven different financing options related to healthcare, long-term care and pension needs of an ageing population in Japan. They employ a dynamic general equilibrium OLG calibrated to macro and micro data (i.e. disaggregation of labor income and health status). Throughout the simulations, debt-to-GDP ratio is fixed and to maintain this ratio, different fiscal scenarios adjust to keep up with the rising costs of ageing. Consumption tax is used as a baseline, which turns out to be the preferred scenario, as compared to other options such as increasing social security contributions and progressive health and co-payment rates. Both studies attempt to simulate reductions in labor supply and thus output in addition to increasing healthcare and pension costs associated with ageing population in their respective countries; however, they ignore gender distributional effects and unpaid care needs completely. In addition, policy scenarios under (McGrattan et al., 2018) are more directed at offsetting costs associated with ageing of an economy but not necessarily with increasing investment in social and physical capital to provide for the ageing.

Kydland & Pretnar (2019) have included informal caregiving to the elderly in order to test policy scenarios that will help mitigate the rising costs related to ageing of the society. In their model, young agents face idiosyncratic disease shock and have an altruistic preference to take care of their infirm elders, which endogenously determines GDP growth. As a result,
they argued that the adverse effects of incomplete markets on the elderly welfare can be mitigated by informal care by their altruistic children. Barczyk & Kredler (2018a) also includes time use data on informal caregiving in an OLG framework with household bargaining model between parents and children. In that way, they included transfer of informal care time from children to parents not only as altruistically motivated but also as exchange motivated where adult children provide informal eldercare in anticipation of bigger bequests from their parents. As commonly postulated in these papers, it is welfare improving and fiscally appealing if eldercare is borne by the altruistic children. Moreover, the loss in output and tax revenue from labor market withdrawal due to informal caregiving is less costly than publicly providing adequate formal care because informal care is taken up by low-productivity adult children to start with. I argue that this line of reasoning and policy decisions neglect another important indicator of social welfare; that is, the distributional effects of relegating care burden to the family, and the inequalities between and within households that already exist, which can be aggravated through expected distortions in labor supply.

5. Recommendations

CGE models are representation of the functioning of an entire economy drawing on detailed empirical data, and can be fairly disaggregated in terms of sectors, factors of production and household categories. For this reason, they can be a good tool to answer questions about gender inequalities related to particular socio-economic structures, multiple interdependencies and first/second round effects of policy interventions. Because they are applied to detailed empirical data, CGE models can offer a concrete framework for Ministries of Finance and/or Planning to draw upon in their planning, and hence have the potential, if adequately designed, to influence policy dialogue on gender equality.

In this paper we have suggested the use of a specific type of CGE model called MAMS, a versatile modeling framework that could constitute a starting point for the analysis of the gender distributional effects of alternative policy strategies for care provision. Most of the existing so called ‘gender-aware’ CGE models have focused so far on trade policy analysis and are largely static models. Those few CGE models that have included unpaid care sectors alongside market sectors, have done so in stylized ways that do not permit identification of the full range of gender dynamics associated with a particular policy change. MAMS has two features in particular that could help to overcome some of the limitations of the earlier models and enable simulations specifically focused on care policies: a recursive dynamic component, in which the size, composition and productivity of the labor force can be expressed as a function of investment in human capacity development; and a detailed treatment of government functions: government services such as education or health for instance can be modeled as influencing economic performance (hence capturing not just the costs, but also the benefits of public spending in the medium to long run).

Having spelt out in the introduction the specific policy questions and emphasis that interest us, and having reviewed various bodies of the CGE literature in subsequent sections, we summarize here a few ideas on how to strengthen the gender lens of a MAMS model. These suggestions also reflect what we know of the gendered structure of the South Korean economy specifically, but we hope they may have wider applicability.
a. Disaggregation of sectors, factors and socio-economic groups

In the context of middle/high income economies with economic structures dominated by services and ageing population structures, it would be important to provide a fine level of disaggregation for services sectors and in particular to single out care-related services: those relevant for both childcare and elderly care (and which can partly substitute or complement unpaid care within families). It would also be useful to highlight any possible difference in the structure of publicly provided services relative to privately provided ones (e.g. some empirical evidence suggests lower quality of employment especially for women in privately-run care sectors).

With reference to the disaggregation of labor factors, labor should be disaggregated not only by gender but also by employment status, age (and other relevant categories when appropriate). For example, the review of the literature in this paper made it clear that mothers of young children and older women after retirement are two groups, which face particular challenges in many countries. This should be exposed in model design.

In South Korea, in particular, services employ about 60 percent of the male labor force and more than 80 percent of the female labor force, but overall female labor force participation rates remain low, at around 50 percent. Unemployment rates are quite low. The labor market is highly segmented, with a heavy concentration of women among ‘irregular workers’, and limited mobility between ‘regular’ and ‘irregular’ segments (or conditions of work) (personal communication Yong Ock, plus other refs). The gender wage gap is the largest among OECD countries and rises with age (OECD Economic Surveys: Korea 2016).

As for the choice of socio-economic groups, grouping representative households by care needs (e.g. households with infants, pensioner households, etc.) would seem a useful way to capture distributional issues related to gender inequalities across different life stages. In South Korea, in particular, it would seem appropriate to single out pensioner households (alongside other household categories e.g. couples with infants), given recent evidence on higher incidence of poverty among households headed by people older than 65, and particularly among older women (ref).

Finally, when there is sufficient evidence of powerful groups dominating specific market transactions because of their wealth and control over large shares of capital (e.g. big corporations with monopsony power), it may be worth considering including these additional socio-economic groups within the SAM structure. This is not frequently done in CGE models, but there are a few interesting examples, such as the CGE analysis of class conflict in Mexico by Gibson, Lustig and Taylor (1986) which include classes which produce labor surplus and classes which extract it, as well as other classes which derive their income from rent from property and are assigned a fixed proportion of total value added in particular sectors.\(^5\)

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\(^5\) More specifically Gibson, Lustig and Taylor’s model includes a complex class structure that reflects the authors’ understanding of the roots of socio-economic inequality in Mexico. Three ‘fundamental classes’ either produce labor surplus (i.e. agricultural workers and urban workers) or extract it (e.g. the urban capitalists). Four additional socio-economic classes do not produce or extract surplus labor but derive their income from rent from land or other property or are assigned a fixed proportion of total value added in particular sectors (e.g. urban marginals receive a fixed proportion of value added in food processing while campesinos are assigned a fixed proportion of value added in agricultural sectors).
b. Rules of operation of the labor market

Disaggregation of sectors and labor categories such as those just suggested above are likely to expose marked gender-based hierarchies of jobs. A number of recent labor market studies certainly seem to confirm this for South Korea (ref 1). Special care should therefore be put into designing the mechanism that most plausibly explains the process by which gender-based segmentation between ‘good’ and ‘bad’ jobs is produced and maintained in an economy. Attention should also be paid to the choice of wage determination mechanisms.

The models reviewed in Section 3 suggest a few possible ways forward. We have reviewed different approaches to reflect a dual economy with informal or subsistence jobs, with wage differentials among formal and informal jobs. In some of these approaches, wage differentials are endogenous, such as the efficiency wage approach. Under this approach, firms are willing to pay wage differentials to keep trained workers or to avoid workers shirking. Implicitly, this assumption implies the higher the wage differential, the higher the investment of firms in workers’ training. This would reflect circumstances in which lower female worker productivity is specifically caused by limited employer investment in women’s skills.

Another way to incorporate formal and informal spheres within the labor market is through a Harris-Todaro approach, as most of models with informality do. This approach also allows accounting for wage differentials, although they become exogenous in the model. Finally, some features of structuralists models can be useful to incorporate not only the inclusion of informal jobs, but also different wage setting mechanisms that depart from the neoclassical tradition.

The imperfect labor mobility framework developed by Lofgren and Cicowiez could be useful to show how workers move imperfectly among sectors depending on their characteristics. Women may face higher barriers to mobility, and in this sense, we find that this framework could be adopted to represent this constraint. Also interesting to incorporate into a CGGE framework is the labor supply modelization proposed by Boeters and van Leeuwen, because it model changes in labor supply at the extensive and intensive margin. Women not only present lower participation rates in labor markets, but also work fewer hours in order to carry out non-labor activities such as care activities. A CGGE would benefit by incorporating this double feature of labor supply, also accounting for care activities and other non-remunerating activities. Finally, the way Marouani and Robalino model labor market dynamics in Morocco, paying attention to the interaction between education choices, the pension system and the labor market mechanisms, which include a dual labor market representation with an informal sector has too potential for gender analysis.

c. Interaction between the market and the non-market

It is important to move beyond modelling unpaid care work simply as a constraint to women’s labor market participation, and emphasize its role for human capacity development. It is also important to spell out the key gender interactions likely to be associated with public investment in social infrastructure (or lack of it). For example, static CGEs would tend to record increased public provision of child care simply as an item of government expenditure. However, increased public provision of childcare is also an important form of investment that
can yield positive outcomes in the future, in terms of reduced gender gaps in paid and unpaid work as well as general well-being.

A dynamic model is thus better at capturing the full range of gender-based interactions between market and non-market activities, in particular if the dynamic component can be used to endogenously update human capacities development by making it a function of care provision (including both unpaid care and public investment) in earlier periods. This component could resemble somewhat what Gibson (2005) proposes in his model of human capital accumulation in a globalizing economy, but would have the important addition of a gender lens.

A model of the recursive dynamic kind would seem preferable than an overlapping generational model. Both model types are data demanding and make strong assumptions, but OLGs seem to make even more stringent assumptions regarding how people make decisions, and their foresight. The only OLG model we found that is explicitly applied to gender analysis simulates the gender impact of physical infrastructure investment such as water and electricity in low-income countries (Agenor et al 2011). Other OLGs for high income countries focus on retirement behavior, pension designs and fiscal costs of ageing, but without consideration of gender distributional effects. One concern about both the low-income and high-income OLG examples we reviewed, regards the unchallenged assumption that women will act as safety net of last resort in providing unpaid care unlimitedly, to either future (e.g. educating their children) or past generations (e.g taking care of frail elderly).

Another aspect of the interaction between market and non-market work that merits refinement relates to the way ‘leisure’ is assumed to interact with decisions to work in either market activities or unpaid care in earlier models. Borrowing from earlier literature (for example, the idea of an efficiency factor negatively correlated to the hours of awake time women must devote to production in Darity 2000), it would seem appropriate to consider adding a constraint to the model similar to a sort of binding constraint whereby total amount of work (both market and non-market work) above a certain threshold is modelled to negatively affect well-being and productivity.

d. Closure rules

The choice of macro-closures is likely to significantly influence simulation results and is often subject of controversy among different schools of CGE modelers. Given the emphasis of our proposed policy analysis on public spending for gender equality, and the concerns often expressed by policy makers about fiscal constraints when demands for higher public investment are raised, the choice of mechanisms for clearing the government budget must be an important part of the simulations. A useful feature of MAMS is that it is programmed to easily allow the modeler to choose among a large number of alternatives scenarios for government budget clearing and financing (and other closures). For example, in Ruggeri Laderchi et al. two alternative ways to finance increasing government expenditure in education are simulated: an increase in domestic taxes (direct and indirect) and higher foreign grants. It is usually advisable to experiment with alternative closure rules rather than set for a specific combination.

6 Other government closure rules included in MAMS are financing through domestic debt, through foreign debt, reduction of current public expenditure, or a combination of financement sources.
e. **Indicators for analysing results**

Changes in various aspects of gender inequality resulting from policy simulations would be best captured by a range of indicators, not by a single indicator. These could include: the gender wage gap (economy-wide and by labour categories); labour and capital shares in total value added as well as female share in total money income; paid/unpaid work ratios for different labour categories and across different household types.

A first set of simulations could involve expansion of care services under different modalities: expansion of direct public sector care provision vs. government’s subsidies for care services and see what happens to: women's level of employment and wages, the economy-wide gender wage gap, the level and distribution of unpaid care work and the well-being of different households with different care needs and different level of income.
References


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