OPTIONS FOR MODELING THE DISTRIBUTIONAL IMPACT OF CARE POLICIES USING A GENERAL EQUILIBRIUM (CGE) FRAMEWORK

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THE CARE WORK AND THE ECONOMY (CWE-GAM) PROJECT

The Care Work and the Economy (CWE-GAM) Project strives to reduce gender gaps in economic outcomes and enhance gender equality by illuminating and properly valuing the broader economic and social contributions of caregivers and integrating care in macroeconomic policymaking toolkits. We work to provide policymakers, scholars, researchers and advocacy groups with gender-aware data, empirical evidence, and analytical tools needed to promote creative, gender-sensitive macroeconomic and social policy solutions. In this era of demographic shifts and economic change, innovative policy solutions to chronic public underinvestment in care provisioning and infrastructures and the constraints that care work places on women's life and employment choices are needed more than ever. Sustainable development requires gender-sensitive policy tools that integrate emerging understandings of care work and its connection with labor supply, and economic and welfare outcomes.

Find out more about the project at www.careworkeconomy.org.

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1. INTRODUCTION

The importance of public investment in social and physical infrastructure 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 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 reduce and redistribute domestic work and care. Current policy discourses and 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, 2019b). Gender-aware policy tools to better understand and rigorously quantify the effects of alternative approaches to care provision are key to translating such commitments by governments 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 specifically examines the applied computable general equilibrium (CGE) modeling literature. The aim is to identify the key features that a gender-aware CGE model would need, in order to adequately analyze the distributional impact of different forms of providing and financing care. Our focus is on how to design tools to assess the level and composition of public investment that is required to ensure that quality care provision is universally accessible, thus helping to redress gender and other inequalities in an economy. Our main concern is how to reduce inequalities through gender-equalizing fiscal policies, not how to promote GDP growth.

CGE models are representation of the functioning of an entire economy drawing on detailed empirical data (usually organized in the form of a social accounting matrix), and can be fairly disaggregated in terms of economic sectors, factors of production and household categories. Hence, if carefully designed, they can be a good tool to answer questions about gender inequalities related to particular socio-economic structures, multiple interdependencies and first and second round effects of policy interventions. For example, simulations with a gender-aware CGE model would allow the researcher to capture simultaneously both demand-side (direct and indirect employment generation) and supply-

side (alleviation of unpaid work constraints) effects of increased investment in social infrastructure.[1]

Public policies that allocate resources to recognize, reduce and redistribute unpaid domestic work and care can include among others: direct provision of childcare and eldercare services, care-related social protection transfers and benefits (given to workers with care responsibilities or people who need care), and care-relevant infrastructure such as water, sanitation and electricity. The appropriate mix of gender-equalizing care policies in a country will vary depending on economic structure, stages of development and socio-cultural contexts. For instance, physical infrastructure spending on water, roads and electricity is likely to remain an important priority in low-income countries, especially in Sub Saharan Africa, while social infrastructure such as care and health services is likely to be more relevant for ageing, middle-high income economies in both Asia and Latin America.

The ways in which the varied kinds of infrastructure and services are provided and funded, by whom and for whom, determine whether care policies can contribute to gender equality and mitigate other dimensions of inequality (Sepulveda & Donald, 2014). For example, evidence suggests that the impact of social infrastructure expansion, on the quality of services that are provided as well as employment that is generated, is different if the government provides finance but the supply comes from the private sector, rather than if the public sector directly provides these services (Fontana & Elson, 2014). The design of a gender-aware CGE model should include representation of these differences, for example through a detailed specification of both public and private sectors that provide care.

The design of a gender-aware CGE model for fiscal policy analysis should also pay particular attention to the rules of operation of labor markets and the inter-relation between women's access to public services and their bargaining position in paid employment. Many paid care jobs in most countries are taken up by women, but frequently offer poor conditions and low pay (ILO, 2018a). Thus, the labor market features of any model would need to allow for the possibility of gender-based discrimination alongside a representation of the unequal distribution of care work among different groups of women and men.

The design of a gender-aware CGE model for fiscal policy analysis needs to also include an intertemporal dimension. Investments in care, whether made by families, the state or other institutions, produce important benefits for human capacity development[2] and spillover

[1] A number of useful studies on the gender employment effects of social infrastructure have developed in recent years (e.g. Ikkarakan et al., 2015; de Henau at al 2106) but their methodology only permits analysis of short-term demand-side employment effects.

[2] Human capacities development relates to the feminist concept of provisioning of human life; that is, to emphasize things human beings need to survive and flourish and their production in the market and other activities such as unpaid labor at home and volunteer work in communities (Nelson, 1993, 1995). In contrast, the term 'human capital' used in later sections refers to the standard measures of skills and education.

effects to society, which are spread over time and become fully realized only in the long term. Gender differentiated long-term effects are likely to depend on whether the provision of care is adequate and balanced across different genders and institutions, and across care providers and care recipients.

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 poverty (e.g. UN Women, 2019a: Figure 5.3). Moreover, it is widely documented that mothers of young children face an especially severe penalty in accessing quality jobs and earnings (ILO, 2019). Growing evidence shows also the vulnerability of older women who, in many countries, after retirement, need to continue engaging in (precarious) forms of paid work to avoid poverty, and at the same time care for their grandchildren, sometime their older husbands or even their own parents (Horstead & Bluestone, 2018; Samuels et al., 2018; UN Women, 2019: Section 5.7). The lens of a gender-aware CGE model should therefore be sharpened to expose how gender intersects with other sources of disadvantage such as stages in the life cycle, social status, ethnicity, and a lack of income.

CGE models that are explicitly concerned with the gender-differentiated impact of policy have been developed since the late 1990s. However, these models incorporate gender features in limited ways and are mostly used for trade policy analysis, largely in the form of comparative static experiments. The few among these early gender-aware CGE models that have included unpaid (care) sectors alongside paid sectors, in addition to sex disaggregation of factors and households, have succeeded in making women's total economic contribution more visible and drawing attention to the gender implications of interactions between the market and non-market sphere. However, they are too stylized to enable the researcher to trace the full range of gender effects that alternative fiscal policy scenarios may produce. This paper plans to fill this gap and provide suggestions on how to develop a gender-aware CGE framework that directly addresses care and distributional issues.

Our suggestions draw on various streams of the CGE literature that we examine in turn. Section 2 critically reviews those CGE models that have been specifically constructed to undertake gender analysis (from now on CGGEs: computable *gender* general equilibrium models) and summarizes their strengths and limitations. Section 3 explores other kinds of CGE models to identify options for modeling gender-based labor market segmentation and discrimination. Section 4 reviews options for modeling gender dimensions of long-term processes such as investment in human capacities development and ageing. Section 5 concludes.

2. EXISTING GENDER-AWARE CGE MODELS

The first step toward building a CGE model of a particular country is to construct a social accounting matrix (SAM) containing information about its economic and social structure. There is a long tradition in policy analysis of distributional issues that rely on SAMs as core

databases (Adelman & Robinson, 1978; Leontief, 1986; Lofgren, Robinson, & El-Said, 2003; Round, 2003) for their detailed accounting of the generation and distribution of resources, income and consumption by diverse socio-economic groups and institutions. Provided the relevant accounts are disaggregated to capture key patterns between different categories of women and men, the SAM can therefore be used to highlight the gender structural features of an economy.

The first step toward building a gender-aware CGE model is thus to disaggregate SAM accounts by gender, and this can be done by following two approaches. One approach involves disaggregating standard accounts by sex, for example by distinguishing agricultural production sectors into female-intensive crops and male-intensive crops, which is relevant if the issue of concern is gender relations in rural settings (e.g. Arndt & Tarp, 2000). The other approach involves broadening definitions of what constitutes production or consumption, for example by building new satellite accounts to provide a valuation of unpaid domestic work and care (e.g. Fontana & Wood, 2000)). Ideally both approaches need to be used. The choice of disaggregation is important in determining what aspects of gender inequality and policy interactions can be later simulated in a model. Extending the SAM to account for unpaid work (i.e. time allocated to it across different genders, labor categories and household types) should constitute a salient ingredient when simulating public policies to promote equitable care provision.

The approach chosen to build the SAM will determine the structure of the CGE model. Model equations should be chosen to reflect plausible explanations of the processes causing gender-based inequalities in a particular economy. Existing Computable *Gender* General Equilibrium (C*G*GE) models integrate a gender analytical lens in different ways and varying degrees, with some models only limited to gender disaggregation of standard accounts. In addition to disaggregating by sex labor factors, production sectors and households accounts, a few models (e.g. Cockburn et al., 2007; Fontana, 2004; Fontana & Wood, 2000; Siddiqui, 2009; Terra et al., 2008) include a representation of the non-market sphere alongside the market sphere. Most CGGEs investigate distributional impacts of trade policies, largely in the form of comparative static analysis involving tariff changes, coupled with exchange rate depreciation and endogenous adjustments in domestic tax revenues.[3]

Section 2.1. reviews how various CGGEs disaggregate SAM accounts, and Section 2.2. examines modeling choices, with focus on the labor market and the non-market sphere. Appendix 1 provides the list of CGGEs models reviewed in this paper.

[3] These models are mainly applied to export-oriented low and middle income countries (Cockburn et al., 2007 for South Africa; 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). Very few studies deal specifically with possible gender implications of public investment (e.g. Ruggeri Laderchi et al, 2010 for Ethiopia; Agenor et al, 2011, 2013 for Benin and Brazil).

2.1 GENDER DISAGGREGATION OF SAM ACCOUNTS

Disaggregating SAM accounts by gender should include at a minimum labor factors, production sectors and representative households. Most existing CGGEs disaggregate labor factors not only by gender but also by skill (usually proxied by education levels). Some models also disaggregate labor by other context-relevant categories such as race/ethnicity (in South Africa, Cockburn et al., 2007) or immigration status. For example, in their analysis of the effects of free trade agreements in rural Dominican Republic, Filipski et al. (2011) not only distinguish between Dominican and Haitian immigrant rural women and men, but also by whether they are hired agricultural labor or unpaid subsistence farmers, a categorization with likely gender significance in agriculture-based economies. Distinguishing labor factors by age/stages in the life cycle as well as gender does not appear to feature in any of the existing CGGEs and yet it could be a relevant disaggregation for analyzing care policies. This would be particularly important in the context of ageing economies, where increasing numbers of women are involved in both paid and unpaid care work well beyond retirement age. This type of disaggregation would make visible in the SAM differences in the constraints faced by women with different family circumstances, as well as differences with men in similar life stages[4].

As for market production activities, these are often disaggregated to highlight female-intensive sectors in agriculture (e.g. Arndt and Tarp, 2000 distinguish eight different agricultural activities and find that female labor inputs are heavily concentrated in cassava production, while male labor inputs are more evenly distributed across crops), manufacturing such as garments in Bangladesh, Pakistan and South Africa (Cockburn et al., 2007; M. Fontana, 2001; Siddiqui, 2009), or both (e.g. Zambia and Bangladesh in Fontana, 2007). Few CGGEs provide a detailed gender breakdown of services sectors such as health, education and social services. This omission probably reflects the country and policy focus of most existing C*G*GE analyses, which is goods trade liberalization in low income countries. A disaggregation of activities accounts highlighting services that can either complement or substitute for unpaid care, and are known to be major employers of women (e.g. childcare, health, paid domestic housework) would be a useful ingredient of a care-focused gender-aware SAM.

A good practice in constructing household accounts in SAMs is to choose types of representative household in a way that exposes inequalities in living standards arising from differences in ownership of factors of production (e.g. households whose main source of income is labor vs. households deriving income mostly from capital and other rents) and consumption needs (e.g. households needing to spend a large share of their income on health and social services vs households that do not need to spend much on health). In some of the existing CGGEs, however, disaggregating household accounts 'by gender' takes only the form of distinguishing between female headed and male headed households. This

[4] For discussion on dynamic modeling recommendations related to age-specific productivity and gender distributional effects of fiscal policies over woman's life cycle, see Section 4.

is taken by some authors (e.g. (Arndt, Benfica, & Thurlow, 2011; Filipski et al., 2011) as the main way to capture gender effects in policy impact. Other models are more nuanced and disaggregate households not just by sex of the household head, but also place of residence, employment status of the head, ethnicity and income quintiles (Fontana, 2004; Cockburn et al., 2007; Siddiqui, 2009).

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). However, in most countries, female-headed households as a whole tend to be a rather heterogeneous group, often comprising single mothers as well as widows, a few couples with or without children, and different income levels. Moreover, as pointed out in feminist literature, the exclusive emphasis on households headed by women risks to neglect the plight of those disadvantaged women who live in male headed households, and are usually a larger share of the female population (Chant, 2004).

Distinguishing representative households by number of dependents, care needs (e.g. presence of children below the age of 5, households with only elderly members, and similar), and/or differential access to basic infrastructure (such as electricity or water) is a more helpful approach for exposing gender relevant dimensions than simply differentiating by headship. Many typologies are possible, and the right configuration will depend, as always, on a country specific economic structure and socio-cultural context. For instance, the household typology provided in a microsimulation model used by the United Kingdom Women's Budget Group (Women's Budget Group, 2016) includes the following gendered household categories: working age adults in couples, with or without children; single female and single male adults without children; working age female and male lone parents; retired couples; retired single females and single males. Their findings show that female lone parents and female lone pensioners have been the most negatively affected by austerity policies in the United Kingdom, due to unfavorable changes in the tax and benefit system for the former group, and cuts in health and social care spending for the latter group.

The group of CGGEs that extend the SAM account framework to include non-market sectors[5] does so by constructing as many unpaid housework sectors as household types. More precisely, an unpaid housework sector (called 'social reproduction' in Fontana and Wood, 2000) and a leisure (or non-work) sector are constructed for each household type, using available time use data and valuing labor time inputs for each skill and gender category at its average market wage (considered to be the opportunity cost of each worker's time). It is assumed that non-market sectors use neither capital (nor land) nor intermediate inputs. Their output is not traded among households but 'consumed' by the members of the specific household that produces it. Reflecting empirical evidence (consistently found across

[5] This approach was first proposed by Fontana and Wood (2000) and later used in other country applications by various other authors with only minor differences in methodology.

countries), the non-market housework 'sector' overwhelmingly uses female time while 'leisure' is composed of more male time than female time.

2.2 EXPLAINING UNEQUAL GENDER PATTERNS

Gender disaggregation of variables must be accompanied by careful model design to ensure that behavioral specifications adequately reflect the underlying causes of the unequal gender patterns observed. For example, if employment data show that women in a certain country are overrepresented in poorly paid sectors and 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' bargaining power over workers (Grimshaw & Rubery, 2007)? Or is it a lack of public resources to support women in their caring roles? Is it due to women's lower formal education? Or a combination of all these factors? And how does unpaid care work affect other variables in the model, besides acting as a constraint to women's participation in paid market sectors? In many current CGGE models, especially those limited to the market sphere, gender categories tend to be used simply to classify results with the rules of behavior of various agents remaining mostly based on neoclassical principles.

The labor market

In existing CGGEs, gender segmentation in the labor market is usually modeled by using a CES (constant elasticity of substitution) production function that treats female and male labor as imperfect substitutes. To reflect the rigidity of gender roles, Fontana and Wood (2000) set female/male substitution elasticities to lower values than is usual in other CGE models, to –0.5 in market sectors and even lower in non-market sectors –0.25.[6]

Most existing CGGEs that simulate trade policies focus on labor sectoral reallocations 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). Results are driven by the initial sectoral gender composition of labor combined with limited substitutability between female and male labor. No other gender specific labor market feature, or bias, is usually considered.

None of the existing CGGE models includes gender-based constraints to labor mobility across sectors except for Arndt and Tarp (2000). The model of Arndt and Tarp (2000) is original in the way it describes women's crowding in cassava production and simulates technological innovation in Mozambican agriculture. The authors interpret the high concentration of female farmers in cassava as the result of women having primary responsibility for feeding their families and limited access to productive inputs. Because

[6] Some non CGGE models assume limited substitution between categories of workers based on ethnicity, such as Maissonnave et al. (2009)'s for South Africa and Berrittella (2012) analysis for the UK.

they cannot take risks, Mozambican women therefore opt for cassava for its properties as a 'famine reserve crop' and basic food staple in home consumption.

To reflect these dynamics, Arndt and Tarp add an endogenous variable representing a risk premium to the equations for cassava production and set it greater than one in the base case. This premium results in more female labor inputs being allocated to production than profit maximization 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 other market-oriented crops rises and so does the female wage. Although this modeling choice reflects the specific reality of rural Mozambique, Arndt and Tarp's treatment of a gender-specific risk variable could 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[7].

Severini et al. (2018) is to our knowledge one of the few existing CGGE models that adds greater complexity to the specification of the labor market in order to analyze fiscal policies explicitly aimed at boosting female labor force participation in Italy. Unfortunately, however, their model has major limitations. Specifically, markets are assumed to be perfectly competitive except in the case of the labor market, where there is involuntary unemployment due to wage rigidities caused by bargaining between employers and trade unions. This seems an odd modeling choice given that female workers in Italy (and often elsewhere) are usually less unionized than male workers. A comparative static framework is used to simulate 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, male unemployment rates increase, albeit moderately. Given the chosen closure for the government account, this simulation also results in an increased public deficit.

The way the model and simulations are designed seems to (implausibly) suggest that a major cause of low female labor force participation in Italy has to do with limited demand for female labor 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. 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. In sum, this study should be taken as an example of the misleading results that are obtained when key aspects of the gender structure of the economy are omitted or misinterpreted. A model structure including both market and non-market activities as well as a more detailed characterization of the government, and the role

[7] For further discussion on these aspects and alternative approaches to modeling gender-specific mobility, see Section 3.

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.

The unpaid non-market sphere

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 analyze the gender effects of trade policies in Bangladesh and Zambia. Their approach involves estimating a housework 'sector' and a leisure (or non-work) 'sector' are for each household type. The two non-market sectors are modeled differently, in that unpaid housework is treated in the household demand function as a necessity, while 'leisure' is a residual dimension. 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 (which is extended to include not only market goods and services but also unpaid non-market care as well as leisure). In addition, as noted in an earlier section, 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 in the 'production' of unpaid care. 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. Unpaid 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 benefit more than others from it.

An implication of this treatment is that labor supply of both female and male workers becomes endogenous in the model. Importantly, market participation decisions involve a choice not just between paid work and leisure, as conventionally assumed in other models, but between paid work, unpaid care work and leisure. Women are more constrained than men in responding to labor market opportunities because of their gender specific obligation to carry the bulk of unpaid care work.

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 methodology and assumptions remain similar. A valuable contribution of Terra et al (2008) concerns the modeling of (involuntary) unemployment alongside endogenous labor market participation decisions, which vary by skill and gender.

In sum, this integration of unpaid household work and leisure allows emphasis on a range of trade-offs that are neglected in conventional CGE models. In addition, the great level of detail in the disaggregation of factors, sectors and households of some of these CGGE

applications 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 (Fontana, 2001). 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 the family of models developed by (Fontana, 2001, 2007), 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 is desirable.

One of the main limitations of this early CGGE 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. cleaning the house 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 this approach is that unpaid care work is treated 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. 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 distributional 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. For example, recursive dynamic CGE models such as Arndt et al. (2011) and Cockburn et al. (2009) disaggregate a few variables by sex and introduce dynamics by building a sequence of static equilibria in which only physical capital stock is treated as endogenous with minimal updating procedures for exogenous variables. No attempt is made to link changes over time to specific gender dimensions of the economic processes being simulated (e.g. capital accumulation may be affected by changes in the female intensity of paid employment, as suggested by Erturk & Cagatay, 1995). Another limitation of these model applications is that female and male labor supplies are assumed to increase at the exogenous population rate.

Ruggeri-Laderchi's model (Ruggeri-Laderchi et al., 2010) is an application of a particular kind of dynamic recursive model called MAMS (Maquette for MDG Simulations, Cicowiez et al., 2013) that examines educational and labor market policies in Ethiopia, and is a more promising approach. The core static model used in this application is theoretically close to the IFPRI 'standard model' (Lofgren et al., 2002), which also provides the foundations for the CGGE model developed by Fontana and Wood (2000). The dynamic component 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 Ethiopia MAMS application 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.

This analysis is insightful but remains at an aggregated level. The additional features of the MAMS approach (relative to the standard IFPRI approach) are not fully exploited from the point of view of gender analysis. For example, the unpaid care sector in the Ethiopia MAMS model is not further disaggregated into separate activities (e.g. water collection, food processing and childcare), and alternative modalities of provision for services such as water services or childcare are not considered. Each of these activities takes a lot of women's time but involves different degrees of drudgery and is carried out using different combinations of infrastructure and labor time. Reducing women's unpaid burden requires a multi-pronged policy response, with each intervention likely to have different macroeconomic implications. For instance, better provision of water services is likely to reduce the most burdensome aspects of women's unpaid work, particularly in regions with weak infrastructure. It is likely to contribute to women's better health and greater time availability, but does not create many paid jobs for them. Increased childcare services are likely to not only alleviate women's care burden but also directly create jobs for them.

Another missed opportunity in Ruggeri-Laderchi et al., 2010 is that they do not link the level and quality of unpaid care work to the skill composition and productivity of the labor force in subsequent periods. This is assumed to be only affected by formal education policies. Thus, the Ethiopia MAMS model, as other existing *CGE* models, constructs unpaid care work as a constraint to women's labor market participation but neglects to consider its long-term contribution to human capacity development via effects on skill formation and the productivity of the labor force[8].

Section 2 highlighted strengths and limitations of existing CGGEs. It identified desirable ingredients as well as aspects that would need refinement in a CGGE model that aims to analyze the full range of gender distributional effects of care-related public policies. Section 3 and Section 4 explore modelling choices that can address some of these issues in further detail, in terms of gendered processes in labor market and dynamic processes of long-run gender effects, respectively.

3. OPTIONS FOR MODELING GENDER-BASED LABOR MARKET SEGMENTATION AND DISCRIMINATION

The CGGE models reviewed in Section 2 incorporate features that to some extent capture different terms of inclusion of women and men in the labor market, most notably in the form of limited labor substitution within production sectors, and endogenous labor supply with different constraints affecting women's and men's participation decisions. However, these labor market specifications need to be refined to enable analysis of policy questions regarding gender equitable care provision. The present section reviews the more general CGE literature to identify innovations in labor market modeling that could be introduced in CGGEs in order to better capture issues such as gender-based labor segmentation, gender bias in job selection and the persistence of gender wage gaps. For the purpose of exploring the potential of alternative modalities of care provision for promoting gender equality, explicitly representing differential access to secure and well-paid jobs by gender, as well as the interaction between market and non-market sector activities, is extremely relevant.

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 (Grimshaw et al., 2017; ILO, 2019). Segmentation by gender is also one of the main causes of gender wage gaps. As presented in (Blau et al., 2014), gender wage gaps have been attributed to various causes by different schools of thought. Becker (1971) conceptualizes discrimination as employer's prejudice (i.e.

[8] Other CGE models that simulate long-term gender effects of infrastructural investment in developing countries involve overlapping generation (OLGs) approaches (Agenor et al, 2011, 2012) and are reviewed in section 4.

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. Other approaches such as labor segmentation and feminist theories (e.g. Grimshaw & Rubery, 2007) emphasize the exploitative aspect of employers' practices who benefit from their power over workers, in terms of higher profits. Finally, institutional theories develop an analysis of the wage gap that gives a more central role to employment segregation. Among them, 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 rest of this section presents model options that reflect these different theoretical explanations. Section 3.1 discusses options for modeling mobility among activities or occupations; while section 3.2. reviews alternative ways of modeling informality. The final sub-section (3.3.) reviews alternative ways to model involuntary unemployment and presents a novel approach to model participation in labor markets at the extensive as well as intensive margin.

3.1 SEGMENTATION AND OCCUPATIONAL SEGREGATION

Segmentation refers to the fact that "different" rules of operations coexist for segments of the labor markets, reflecting diverse labor conditions, promotional opportunities, wages, and market institutions. Segmentation can be based on gender, but also race, age, education, and migrant status.

Workers defined by segments may face different mobility patterns across sectors or firms, which can be explained by the different labor market behavior among men and women, i.e. women usually spend more time in care activities constraining their labor market decisions, and also due to occupational segregation in labor markets by gender, creating limitations to mobility (Pearlman, 2018). Occupational segregation affects women to a larger extent than men, and even more when some women's characteristics are considered, such as age and education. As Guinea-Martin et al. (2018) find in an analysis of the labor force in United Kingdom, three distinctive stages in the woman's life define their occupational segregation: the prime childbearing years, when lower levels of occupational segregation are found but women take to a higher extent part-time jobs, the years when children are school age, when women highly segregated in a narrow set of occupations, and the retirement years, when the authors find that occupational segregation reaches the highest levels. Also in the United Kingdom, Guinea-Martin et al. (2015) analyze to what extent the intersection between

gender and ethnicity explains occupational segregation. Their results find that even when gender explains to a larger extent occupational segregation, ethnicity also contributes to segregation in areas with a higher concentration of minorities. Occupational segregation also affects women in developing countries, as Borrowman and Klasen (2017) find analyzing long-term trends in 69 developing countries. The authors find that in most countries occupational and sectoral segregation increases over time, and is positively related to education, which counters findings in other countries, such as United States (Pearlman, 2018) or Portugal (Crespo et al., 2013).

Most CGE models assume that all types of labor are mobile between sectors, but this assumption should be abandoned in a CGGE model. A useful model feature in Lofgren & Cicowiez (2017) could be usefully incorporated into a CGGE model in order to account for gender-based labor mobility. The authors develop a "proximity framework" that assumes that workers can move from one sector to another, but they become less efficient the further they move from their original sector of expertise. 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.

The authors apply the 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 to labor mobility. 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 the disaggregation of labor.

3.2 MODELING INFORMALITY

Women do not only experience occupational segregation, but, as institutionalist theories argue, they are also segregated to secondary sectors. Dual labor market theory posits the labor market is structured in tiers, each governed by different rules of operations, reflecting the existence of "good" and "bad" jobs in the economy. 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). The formal-informal dichotomy seems particularly relevant to address some of the disadvantages that women face in labor markets. As presented in ILO (2018b), informal employment, composed with

jobs not subject to national labor legislation, income taxation or social protection and employment benefits, affects to a larger extent women than men when low and middle income countries are considered (ILO, 2018a). In some countries, this trend is even starker when the focus is made on the paid care services sectors. In Uruguay, for example, 61% of workers employed in paid care activities, among which 95.9% are women, are not registered workers, compared to 35% of total workers (Aguirre, 2005).

The CGE models that incorporate informality provide different options depending on the way they theorize the informal sector. One view considers that informal workers are "excluded" from the formal modern sector. This may be due to the segmentation of labor markets, which prevents working switching from the informal to the formal sector, or as a result of burdensome regulations that leave small firms and entrepreneurs outside the formal sector (Perry et al. 2007). A different view suggests that some workers and firms choose to operate in the informal sector, as a result of a cost- benefit analysis ("exit" hypothesis). According to this view for example, women may "chose" to work in the informal sector as a way to combine paid work and family care responsibilities. As ILO (2018a) shows, workers with care responsibilities are more likely employed in informal arrangements as a work–family reconciliation strategy of last resort. Thus, the incorporation of an informal sector in a CGGE model should take into account 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). This framework has been applied in many CGE models that introduce an informal sector (Flaig et al., 2011; Hernandez, 2012; Marouani & Robalino, 2012, among others), with some variants. Under this approach, formal and informal labor markets are understood as connected through imperfect labor mobility, which is modeled through a "migration cost" that can assume different values for different workers, reflecting for example higher transition costs faced by women in moving to the formal sector.

A different approach to model informality is applied by Estrades & Terra (2011) to analyze the impact of changing payroll tax rates in Uruguay. Following Thierfelder & Shiells (1997), they apply an efficiency wage approach, which implies the existence of an endogenous wage differential among two distinct 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 or due to

monitoring costs.[9] 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. Under this approach, efficiency wages can also be calibrated differently for different segments of workers.

Finally, some structuralist CGE models also assume the existence of a subsistence sector linked to both the exit and exclusion views of informality, and understood as a fundamental part of the capitalist system (Gibson & Kelley, 1994). 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. This approach is applied in Gibson (2005) to simulate a long-term path of transition of a small, open lower middle-income developing country into a globalized economy. 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 presence of an informal sector is key to explain one of the two alternative trajectories in the path of transition the transition to a more globalized economy. Gibson's model is further discussed in Section 4.1 for another aspect related to investment in human capacities in a dynamic framework.

To sum up, there are different ways to incorporate informality in a CGE model, 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. Finally, a more structuralist approach can be implemented in which the different activities in the economy can be part of the formal and the informal sectors. In all the cases, the informal sector should be differently modeled to reflect the higher costs of moving into the formal sector that women often face.

3.3 INVOLUNTARY UNEMPLOYMENT, WAGE SETTING MECHANISMS AND PART-TIME PARTICIPATION

Neoclassical CGE models assume full employment in labor markets, or they treat unemployment as fixed. However, unemployment is a common problem in labor markets in both developed and urban developing economies with higher rates among women, the youth and the elder working age population, as well as ethnic minorities. Incorporating

[9] The formal sector is composed by different activities.

unemployment in CGE models allows the labor market to adjust through employment levels and not just through wages. Neoclassical tradition also assumes wages are determined through the workings of market forces according to the marginal 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.

A widely applied modeling choice 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). Estimations of the wage curve parameter for women show opposite effects: the pure wage effect, usually with higher negative elasticity values that reflect a weaker bargaining power of women; and a discouraged worker effect, with an estimated positive elasticity, as high unemployment levels discourage female workers from entering the labor market (Groot et al., 1992). This last effect has been found mostly in developed countries, such as USA and the UK (Blanchflower & Oswald, 1994), Spain (Sanroma & Ramos, 2003) and the Netherlands (Groot et al., 1992).

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 modeling explicitly the mechanisms that generate unemployment (Persyn et al. (2014)). Also, it allows to define unemployment for some categories of labor but not for all, as in Carneiro & Arbache (2003). This approach has been used to analyze diverse policy questions.

Applying a CGE model to analyze labor market policies in Tunisia, David & 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. This is an assumption that could be incorporated in CGGE with a public sector, as in most countries, the share of women working in the public sector is higher than the share of women working in the private sector (World Bank, 2019). In a CGGE model aimed to simulate an increase in social infrastructure or public services, the presence of a public sector could increase female employment, bringing public wages up, which has upward pressure on private wages, and hence lowering gender wage gap.

A different way to introduce unemployment in labor markets is applied in Severini et al. (2018), linked to wage setting mechanisms. The paper assumes that the presence of trade unions affects the formation of nominal wages in the labor market with segmentation by

gender in Italy, 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. Their approach follows Bohringer et al., (2005), which assumes that bargaining power of firms and union are different by sector. The authors simulate the introduction of subsidies to female employment, which 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 noted, this modeling assumption presents limitations, for example it assumes that women and men present similar unionization and wage negotiating power. The wage curve approach and the wage bargaining approach differ substantially in the power attributed to workers in the wage setting process. In the wage curve approach, workers have a weak bargaining power, whereas in wage bargaining applications, unionized workers have a stronger power to set wages.

In a CGE model aimed at analyzing trade policies in Europe, Boeters & van Leeuwen (2010) also introduce unemployment based on a model of collective wage bargaining between an employers' organization and a representative trade union, in which the parties negotiate a skill-specific wage rate. The model also introduces a novel way to incorporate labor market participation at 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. As women tend to be more engaged in part- time jobs, explicitly modelling number of hours in paid work would be a useful feature of a CGGE model.

Some modifications to Boeters & van Leeuwen (2010) framework could be introduced to account for gender differences in labor markets. In the original model, households maximize a CES utility function with consumption of goods and leisure, which is valued at the marginal wage. In a CGGE, the utility function should also include non-market care. Also, in the original model the decision of the individual 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. In a CGGE model, the nature of the fixed costs could be attributed to gender dynamics within the households, and it would be interesting to run experiments where such costs are distributed differently among men and women within a household.

The authors apply the model to EU countries to evaluate energy policies and warn about the difficulties in the calibration of such a complex model presents. 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 as could be a potentially interesting approach to introduce in a CGGE model.

Section 3 has offered some modelling options that could help in addressing the limitations of existing CGGEs in terms of gendered processes in the labor market. Another important

limitation that needs addressing relates to the fact most existing CGE models are used for comparative static, analysis hence neglecting important interactions between market and non-market sphere over time. Section 4 explores options for modelling dynamic features in a CGGE to highlight the long-run effects of human capacity development and care policies.

4. OPTIONS FOR MODELING THE LONG-TERM EFFECTS OF CARE POLICIES

Agenor & Canuto, (2013a, 2013b) and Ruggeri-Laderchi et al. (2010)[10] are to our knowledge the only two examples of gender-aware CGE models that include women's unpaid non-market work and link increased public investment and human capital formation as a dynamic process. Agenor's approach is of particular relevance to country settings characterized by a lack of physical infrastructure, such as access to water and electricity, that affect women's unpaid housework. The present section discusses its contribution and limitations, and draws on another dynamic CGE model that offers promising features that could help in capturing the long-term effects of care policies in terms of gender and human capacities.

Dynamic CGGEs can also be integral in analyzing ageing and eldercare policies from a gender perspective. Older women are often in economically vulnerable positions due to gender inequalities faced over their life course. A dynamic, life-cycle framework to study constraints women face throughout their lives can be a helpful set-up to test alternative care-related protection and benefits. In addition, focusing on eldercare specifically acknowledges that women's unpaid care work is not homogenous and depending on who the care recipients are, the care intensity and time demand differ. Eldercare or caring for adults is qualitatively and psychologically more strenuous care work than childcare is[11]. Thus, modeling aging intersected with gender as well as eldercare policies constitute an important component of CGGEs with dynamic processes.

Section 4.1 discusses dynamic modeling choices related to human capacities development and long-term gender effects of care policies. Section 4.2 reviews promising features to study care-related protection and benefits, and eldercare policies.

4.1 INVESTMENT IN HUMAN CAPACITIES

The family of existing CGGE models developed by Agenor & Canuto (2013a, 2013b and 2012) to study investment in physical infrastructure in countries as diverse as Benin and

[10] Ruggeri-Larderchi (2010) was reviewed in Section 2.2 as part of the existing CGGEs.

[11] For higher elasticity of time for caring for adults, see Mommaerts (2018), Skira (2015), and Van Houtven, Coe, & Skira (2013). For depressive symptoms and negative health effects, see Do (2008), Do et al., (2013), Jeon & Kwon (2017), Malhotra et al., (2012), and Skira (2015).

Brazil has potential for linking unpaid work and its long-run effects in the economy. Using overlapping generations (OLG)[12] framework, Agenor et al's approach distinguishes raising children and unpaid housework in women's non-market work and model interaction of these two components with the market and government sphere in the following way.

Women's care time for their children contribute to their better health and human capital accumulation in the long run. In addition, if women care for and 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 assumes that women's bargaining power depends on the relative levels of human capital of husband and wife. There is also a policy dimension to the dynamic process due to the fact that home production combines women's time allocated to an activity (for instance food preparation) with infrastructure services (for instance electricity and labor-saving cooking devices). This feature allows the authors to link improvements in physical infrastructure that reduces the drudgery of housework to long-term health and productivity.

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, modeling 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 is "gender-neutral" is somewhat problematic.

Agenor's approach is an application of care-related infrastructure that helps reduce unpaid domestic work, which allows women (but not men) to invest more time in child rearing boosting future health and productivity outcomes in the long-run. From a feminist perspective, modelers are encouraged to shift away from assuming women's full "specialization" in domestic work and child rearing within the family. This is particularly relevant to modeling social infrastructure such as investment in health, education or care services. Care policies not only reduce women's unpaid work but also redistributes unpaid care work within families and onto adequate market and state options. Dynamic models

[12] OLG models include adult cohorts who make production and consumption decisions over different lifetimes that are both intra and inter-temporally optimal. This contrasts with recursive dynamic models with myopic agents making decisions based on only past and the current period. See Dixon & Parmenter (1996) for further differentiations.

that allow this redistribution aspect of unpaid work provide a better set up to test alternative care policies.

Another study, which does not have gender analysis, but is innovative in its way of modelling human capital formation is Gibson (2005) introduced in Section 3.1. Here we focus on Gibson's dynamic framework and his treatment of households with heterogeneous socioeconomic characteristics[13]. Human capital accumulation in Gibson's model is governed by an equation similar to the standard physical capital accumulation, but is assumed to vary by each type of household and can be affected by public policies. Families in the higher socioeconomic status face a liquidity-constrained trade-off between educating their children and current consumptions needs. On the other hand, families without liquid assets respond to negative income shocks by withdrawing their children from school. The labor market implications are twofold. First, total labor supply increases via an expansion in the relative unskilled labor, which will be mainly absorbed by the informal sector that the model explicitly captures in the non-traded goods sector. Second, the labor market dynamics is such that informal sector absorbs surplus during recessionary periods and supplies labor in periods of expansion. During economic downturns, the informal sector swells due to the crowding of unemployed skilled labor and due to an expansion in unskilled labor from households endogenously reducing their human capital accumulation. However, households' decision making in forming human capital are 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 for households. This is likely to encourage households' decision to acquire human capital in the face of negative income shocks, both at the intensive and the extensive margins.

Gibson's informal sector framework could be applied to the modeling of unpaid care sector over business cycles in the following way. Liquidity-constrained families face the trade-off between providing childcare at home and utilizing care services from outside options such as market or public services. In the face of negative shocks, families without liquid assets opt fully for unpaid care arrangement, which leads to an increase in unpaid care time for families and lost opportunities for human capital accumulation such as training and learning-by-doing effects for those who withdraw from the labor market. Given social norms and gender inequalities in the labor market, women are likely to be affected by the negative income shock and upward pressure on unpaid care work. The labor market implications are as follows. Unpaid care sector absorbs labor supply during economic downturns due to household's utility maximization process to reduce or opt out of utilizing outside care options and instead increase unpaid care work. During expansion, labor market rigidities are relaxed and paid care services are relatively cheaper, which encourages families to enter or increase their participation in the labor force[14].

[13] Household is disaggregated by place of residence (rural/urban) and employment status (informal/ formal).

[14] This is supported by recent studies on the cyclicity of unpaid care. For example, Mommaerts & Truskinovsky (2019) has found, in the U.S. context, that unpaid care from working age adult children are

As with Gibson's education policy framework, care policies can also endogenously affect household's decision in this process. Gibson simulates a policy trajectory such that the government prioritizes domestic investment and directs fiscal policy towards maintaining family income such that they still accumulate adequate human capital. This policy path, in comparison to the other trajectory of fiscal discipline, leads to higher human capital formation and lower inequality measures in the medium-to-long run. Likewise, adequate investment in care and human capacities can enable families, and particularly women, to make strategic decisions about their participation in the market in the face of income shocks. Given adequate public investment, families' decisions to utilize care provision is not compromising the level of human capacities and well-being of future generations in the long term. This is also a welcome feature as public investment in care feeds into future productive capacities, in addition to mitigating women's constraint to entering the labor market.

To sum, modeling investment in human capacities is better captured via a dynamic process that is governed by family's decision making in human capacity development. Both within and between household inequalities have important insights. Modeling women's but also men's unpaid care work is integral in capturing unequal care responsibilities within the household and how that may be redistributed after a policy shock. Household heterogeneity, as illustrated by Gibson's model, captures between household inequalities in terms of socioeconomic characteristics or care needs[15]. Using a representative household instead thus leads to biased policy recommendations that could further exacerbate inequalities between households over the long-run. Lastly, investment in human capacities impact future productivity and labor force via two main channels: quality care provision leading to better productive capacities of future labor force; and reducing women's constraints to participate in the market and possibly improving women's bargaining position at home and in the market over time. Dynamic models that allow for both channels capture more in-depth gender dimensions of investment in human capacities.

4.2. AGEING, CARE-RELATED SOCIAL PROTECTION AND LONG-TERM CARE POLICIES

Unequal care responsibilities and unequal market opportunities affect woman throughout her life. These gender inequalities compound over women's lifespan and are likely to put older women in economically vulnerable positions. Legendre (2009) illustrates the importance of intersecting inequality dimensions such as age, gender and class using OLG framework applied to France. Across workers and retirees, the author models eight heterogeneous social groups – four professional or social groups, disaggregated by gender.

countercyclical and this can be mitigated or exacerbated by public-private options for care services for families.

[15] Section 2.1. extensively reviews different disaggregation of households for the purpose of modeling care policies.

Legendre tests 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 of ageing. Among retired men and women, their findings provide evidence that older women are in a particularly disadvantaged position in terms of income in a general equilibrium framework.

Legendre's results reflect the fact that women's lower access to decent paid jobs over the life cycle and their higher chance of being low-paid or engaging in unpaid care work lead to low lifetime savings and wealth accumulation (Samuels et al., 2018). In addition to income insecurity, older women often still face various family care responsibilities towards their spouses, ageing parents or grandchildren. Therefore, care-related social protection and benefits can be an important component of care policies for older women.

Diaz-Saavedra (2017)), though it does not focus on gender, develops OLG model with heterogeneous agents disaggregated by age, education, employment status. Moreover, agents additionally face stochastic shocks of earnings, wealth and pension rights in each period. They argue that policy analysis needs to account for not only individuals' response to tax and transfer changes but also the effects of such changes on the constraints individual face throughout their life course. For example, tax and transfers[16] encouraging older workers to delay retirement may incentivize older workers to prolong their worktime but those programs can also change workers' behaviors earlier in their life cycle. Workers may reduce their work hours or opt for part time jobs when young, in an anticipation of delayed retirement and its associated benefits. In fact, they find that incentives to delay retirement lead to lower output per head due to individuals smoothing their aggregate work hours and consumption over their life cycles.

Diaz-Saveedra's life-cycle framework, when disaggregated by gender, can be insightful in considering care-related social protection and benefits. For example, pension credits for women during their time at home providing unpaid care as opposed to simply providing cash benefits to unpaid caregivers[17]. Many of these alternatives are not tested in a general equilibrium framework. Thus, gender-aware CGE models have potential for testing and comparing the distortionary effects of alternative care-related benefits on labor supply, retirement decisions and welfare.

Long-term care policies are another pressing issue related to ageing. Despite demographic ageing and rising demand for eldercare, many countries are still not adequately prepared

[16] They tested three different reforms: 1) eliminates all labor income taxes for workers after the first retirement age, 60; 2) eliminates the implicit tax of working beyond retirement age; and 3) collecting pension while still working

[17] For example, Uruguay offers pension childcare credits to women where Germany and South Korea provide cash transfers to family caregivers as part of their long-term care scheme.

(Scheil-Adlung, 2015). Modeling eldercare separate from childcare is a step towards understanding the full dimension of unpaid care burden and informs more comprehensive approach to care policies. Adding detailed and realistic accounts of existing eldercare policies and care structure in a chosen country can bring more meaningful results under alternative scenarios.

Kato (2018), for example, studies the Japanese long-term care insurance scheme within a dynamic OLG framework. The representative household faces lifetime uncertainty in each period and maximizes over consumption and leisure in an overlapping generations framework. Their treatment of long-term care and government accounts are detailed but mostly operate through various tax rates, contribution and receipts of pension and long-term care in the household's budget constraint. The incorporation of the long-term insurance scheme allows agents to contribute to the scheme depending on their age[18] and other detailed schemes are present in terms of pension and child allowances. Within the representative household, there are four types of workers: regular workers and non-regular workers[19], disaggregated by gender.

Kato's model focuses on financing long-term care scheme and not on the provision of care. This explains why the author modeled unpaid time spent on child rearing and eldercare to be exogenously given to the household. Both financing and provision are important for gender distributional effects of eldercare policies. However, focusing on financing without adequate treatment of how households make decisions in care arrangements misses an important dimension of inequalities in the household and across different households. For example, non-regular female worker is more likely to provide unpaid care as opposed to the other three labor types. Exogenous time spent on unpaid care assigned to the household neglects this heterogeneity.

Tabata (2005) considers "household health production"[20] within an OLG framework where old-age health level of agents is determined by both their own input and the young agents' input[21]. In this way, the author attempts to include the role of family, and especially children though not gendered, in determining the health level of aged parents. Long-term care policy lowers the health care cost to children when they make decision to contribute to the old-age health level of their parents. Tabata's model assumes altruistic preferences of young agents towards their parents and does not consider bequest motives of children providing

[18] Note that an individual starts to contribute to the LTCI once she becomes age 40 in Japan. Between age 40 and 64, the amount of their contributions depends on their earnings. Once an individual becomes age 65, then she still contributes but only a fixed amount that is reflective of the current scheme (Kita, 2018; p.3)

[19] Non-regular workers include part-time, dispatched, or fixed term workers.

[20] See Grossman (1972) for the concept of "household health production" often used to describe the agent's health investment behavior.

[21] Note that inputs in Tabata's model is monetary inputs in the health production. However, this lends possibility of adjusting it for time transfer.

eldercare. Assuming altruistic agents without considering bequests has its limitations but are assumed widely in the OLG literature[22]. Tabata's model allows for transfer of care between young and old households. This is helpful as adult children caregivers are less likely to live with their parents or family relatives are usually under a different household than the elderly household who receive care.

In sum, OLG is a useful framework for studying ageing and gender as it allows for how agents distort their behavior based on their future expected gains or benefits. Exploring care-related protection and benefits using this framework can be particularly helpful in understanding its different long-term gender effects. OLG is also more widely used in eldercare policies though recursive dynamic models can also be adjusted as such. For example, disaggregating households by care needs and allowing for inter-household transfer of care can be equally insightful. However, not many recursive dynamic CGEs appear to have studied the topic. Lastly, regardless of study's focus on financing or provision of eldercare, unpaid caregivers' endogenous decision making is an integral component from a gender perspective.

5. CONCLUSIONS

This paper aimed to identify the key features that a gender-aware CGE model would need to include, in order to adequately analyze the distributional impact of different forms of providing and financing care. The paper argued that existing approaches used in CGE models for integrating gender are limited in scope and would need refinement. To this end, it suggested a number of avenues for improvement.

First, special attention should be paid to the way production activities, labor factors and representative households are disaggregated in the construction of a SAM, and to ensure that the mechanisms underlying unequal gender patterns are then adequately captured in the design of the corresponding model. For example, in the context of middle/high income countries with economic structures dominated by services and ageing populations, it would seem relevant to provide a fine level of disaggregation for services sectors and to single out services that disproportionately employ women and are care-related, in particular. In the context of low-income economies reliant on natural resources, a more detailed characterization of gender distributions in agriculture, as well as accounting for gaps in physical infrastructure that can reduce the drudgery of unpaid work, may be more relevant. In all contexts, it is important to highlight possible differences in the structure of publicly provided services relative to privately provided ones since empirical evidence suggests lower quality of employment for women in privately run care sectors.

[22] In exception, Barczyk & Kredler (2018) develops an OLG with a game theoretical exchange between parents and children where both altruism and bequest motives are considered in making care arrangements. However, their computational framework is not within the scope of this paper.

Second, labor factors should be disaggregated not only by gender but also by skill, age, place of residence, immigration status and other relevant categories when appropriate, to capture intersectionality. Literature reviewed in this paper made it clear that mothers of young children and women after retirement are two groups which face particular challenges related to care provision in most countries. The rural-urban divide can be another important source of inequality between women, and men, of different socio-economic characteristics. This should be exposed in model design.

The gender disaggregation of sectors and labor categories in the SAM of any CGE model must be carried out in such a way as to bring to light gender-based hierarchies of jobs. This disaggregation must be accompanied by a careful modeling of labor market mechanisms likely to reproduce gender inequalities, such as occupational segregation or wage discrimination. In the context of economies with marked dual labour markets for care, special attention should be put into designing mechanisms that best explain the process by which gender-based stratification between 'good' and 'bad' jobs is reproduced and maintained.

Third, providing a more nuanced representation of the non-market care sector and its interaction with market sectors must be high priority. It would be useful to differentiate non-market care work into different separate activities. These activities could be modeled as each using different production technologies and each having some degree of substitutability with specific public or private services (e.g. cleaning the house with domestic paid services; nursing elderly parents with public/private social care services, or similar). Moreover, it would be important to move beyond modeling unpaid care work simply as a constraint to women's labor market participation and emphasize its role for human capacity development and the sustainability of the economic system in the long term. A dynamic CGE model is likely to be better at capturing the full range of gender-based interactions between market and non-market activities. One promising approach could involve using the dynamic component to endogenously update human capacities development as a function of care provision (including both unpaid care and public investment) in earlier periods.

Dynamic CGGEs could make the additional contribution of enhancing our understanding of women's constraints over the life-cycle and illuminating how care-related social protection and care provision affect these constraints throughout different stage of life. For example, eldercare policies need to be distinguished from childcare policies and have different implications for different groups of women (and men) in both the household and market. The modelling of care policies should include these different facets of gender distributional long-term effects.

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APPENDIX 1. COMPUTABLE *GENDER* GENERAL EQUILIBRIUM APPLICATIONS BY COUNTRY, POLICY ISSUE AND GENDER FEATURE

Country	Policy Issue	Gender features	Key references
Bangladesh	Trade related simulations	Disaggregation of standard SAM accounts ▪ Labor by gender and education ▪ Households by residence, income, land ownership, gender of the head Non-market sectors included Experiments with alternative gender-related elasticities	Fontana, M., & Wood, A. (2000) Fontana, M. (2001)
Dominican Republic	Trade related simulations	Disaggregation of standard SAM accounts ONLY ▪ Labor by gender, immigration and employment status ▪ Households only by gender of the head	Filipski, M., Taylor, E., & Msangi, S. (2011)
Ethiopia	Educational and labor market simulations	Disaggregation of standard SAM accounts ▪ Labor by gender and education ▪ One single household Non-market sectors included Experiment with alternative gender-related elasticities	Ruggeri-Laderchi, C., Lofgren, H.,& Abdula R. (2010)
Iran	Changes in agricultural productivity	Disaggregation of standard SAM accounts ONLY ▪ Labor by gender and skill	Al-Haboby, A., Breisinger, C. Debowicz, D., El-Hakim, A. H., Ferguson,

		▪ Households by income, residence and gender of the head	J., Telleria, R., & Rheenen, T. V. (2016).
Italy	Labor market tax incentives	Disaggregation of standard SAM accounts ONLY ▪ Labor by gender and employment status ▪ Households only by gender of the head Female unemployment modelled as result of unions power	Severini, F., Felici, F., Ferracuti, N., Pretaroli, R., & Socci, C. (2018)
Mozambique	Agriculture technology Marketing margins Changes in crop mix	Disaggregation of standard SAM accounts ONLY ▪ Labor by gender and education ▪ Households by residence and gender of the head Arnd&Tarp 2000 include a gender specific risk aversion parameter	Arndt, C., & Tarp, F. (2000) Arndt, C., Benfica, R., & Thurlow, J. (2011)
Pakistan	Trade related simulations	Disaggregation of standard SAM accounts ▪ Labor by gender and education ▪ Households by residence, gender of the head, education and employment status Non-market sectors included Separate household module to calculate impact on individual consumption and infant mortality	Siddiqui, R. (2009)
South Africa	Trade related simulations	Disaggregation of standard SAM accounts • Labor by gender and education (also includes child labor)	Cockburn, J., Fofana, I., Decaluwe, B., Mabugu, R., & Chitiga, M. (2007)

		• Households by residence, race and gender of the head Non-market sectors included	
Tanzania	Trade related simulation with imperfect competition in selected production sectors	Disaggregation of standard SAM accounts ONLY ▪ Labor by gender and skill ▪ One single household	Latorre, M. (2016).
Uruguay	Trade related simulations	Disaggregation of standard SAM accounts ▪ Labor by gender and skill ▪ Households by income Unemployment modelled differently for different labor categories Non-market sectors included	Terra, M. I., Bucheli, M., & Estrades, C. (2008)
Zambia	Trade related simulations with focus on mining and agriculture	Disaggregation of standard SAM accounts ▪ Labor by gender and education ▪ Households by residence, income, land ownership, gender of the head Non-market sectors included Experiments with alternative gender-related	Fontana (2002)