CARE WORK AND THE ECONOMY

Advancing policy solutions with gender-aware macroeconomic models

CHILD AND ELDERLY CARE IN SOUTH KOREA: POLICY ANALYSIS WITH A GENDERED, CARE-FOCUSED COMPUTABLE GENERAL EQUILIBRIUM MODEL

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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

Gender equality is at the center of policy debates throughout the world, pointing to the need for analytical tools that make it possible to consider gender dimensions of economic policy. In the Republic of Korea (hereafter Korea), a high-income and rapidly aging economy, policies related to care provision (for young and elderly) may have a strong impact on household well-being and gender equality, including time use and income-earning opportunities. Such policies may also be of major importance for broader economic developments during coming decades.

The emerging literature of gendered computable general equilibrium (CGE) models offers an approach that permits analysis of gender-related issues, including care policies, in their broader economic context, which is essential whenever policies have significant macroeconomic and sectoral repercussions. In this paper, we apply GEM-Care (the General Equilibrium Model for Care analysis) to address questions related to care and gender policies in Korea.

GEM-Care is a gendered dynamic CGE model designed for country-level policy analysis with a focus on issues relevant to care in a high-income country like Korea. The starting point for the model specification is GEM-Core (Cicowiez and Lofgren 2017), which in its turn draws on Lofgren et al. (2013) and Lofgren et al. (2002). GEM-Core has been extended and adapted to the requirements of care and gender analysis, benefitting from the literature on gendered CGE modeling, pioneered by Fontana and Wood (2000) and surveyed in Fontana (2014). Like GEM-Core and its predecessors, GEM-Care is a multi-purpose template model since, while it includes specific features important to its focus, it can address a wider range of topics that typically are relevant for CGE analysis, including growth, fiscal space, external shocks, poverty, and inequality.[1] The dynamics of the model is recursive: actors are assumed to be myopic, making decisions on the basis of data for the current year, which are influenced by past decisions.

Motivated by our focus on care and gender, the following extensions were brought into GEM-Care: (a) a nested production structure that disaggregates time use by gender and, in addition to GDP production, covers leisure and household services produced for own consumption;[2] (b) a nested structure of household consumption that captures household

[1] Other multi-purpose template models for country analysis include Cicowiez and Lofgren (2017), Decaluwé et al. (2013), Lofgren et al. (2002), and McDonald (2015).

[2] Under the System of National Accounts, production that is part of GDP is referred to as being "within the production boundary". It includes (a) all production actually destined for the market or provided for free by the government or NPISHs (non-profit institutions in the service of households); (b) household production of *goods* that are retained for final consumption within the household (such as production of agricultural goods); and (c) the production of *housing services* for own final consumption by owner occupiers. It does

choices between own production and market supplies to meet its demands for care and other services; (c) interhousehold transfers in the form of unpaid care labor; (d) transfers from government to households in the form of care services; and (c) an extension of the producer first-order conditions for labor hiring that makes it possible to analyze the consequences of wage discrimination (i.e., wage differences that are unrelated to marginal productivity differences).

In outline, the paper is organized as follows. Section 2 summarizes current Korean policies in the areas of child and elderly care and discusses the current gender wage gap in Korea. Section 3 contains a brief literature review on gendered CGE modeling. Section 4 describes the model and its database with a focus on the above-mentioned model extensions. Section 5 covers the base run and a set of scenarios that focus on care and gender policies. Section 6 contains our concluding remarks.

2. CONTEXT

Korea pursues ambitious public policies both in the areas of child and elderly care. With the aim of providing context for the following section on simulation analysis, this section provides brief summaries.

2.1 CHILD CARE

Korea's government has set up a universal child-care program that covers all children up to 7 years old. The main benefit of the program is monetary support for public or private childcare expenses. In 2014, it amounted to an average of 200,000 won per child and month, at the aggregate level corresponding to 0.6 percent of GDP.[3] In 2018, this average benefit was raised 300,000 won. (In current US dollars, this translates into an increase from roughly $190 per child per month in 2014 to $270 in 2018.) Behind these averages is a system with benefits that differ depending on the age of the child and on whether care is provided at home or outside the home. Table 2.1 summarizes the benefits offered in 2018: as a share of GDP, government spending on childcare support amounted to 0.90 percent, split into 0.64 percent on vouchers for care outside the home and 0.26 percent on home care allowances.

not include the production of domestic and personal services for consumption within the same household (such as preparation of meals and care and training of children) (UN 2009:6-7).

[3] In 2014, Korea's GDP was 1,426.7 trillion won. Assuming that all children received the benefit, the cost amounts to 8.743 million won (3.6 million children aged 0-7 *times* 12 months *times* 200,000 won), which is equivalent to around 0.6 percent of GDP.

Table 2.1. Korea: Government spending on childcare (2018)

Vouchers for care outside home			
Child age (years)	won/month	US$/month	GDP share (%)
0-1	825,000	750	0.19
1-2	569,000	517	0.14
2-3	438,000	398	0.12
3-5	220,000	200	0.19
Home care allowances			
Child age (months)	Won	US$	Total GDP share
0-11	200,000	182	0.05
12-23	150,000	136	0.04
24-83	100,000	91	0.17

Source: Ministry of Health and Welfare (2019) and own calculations.

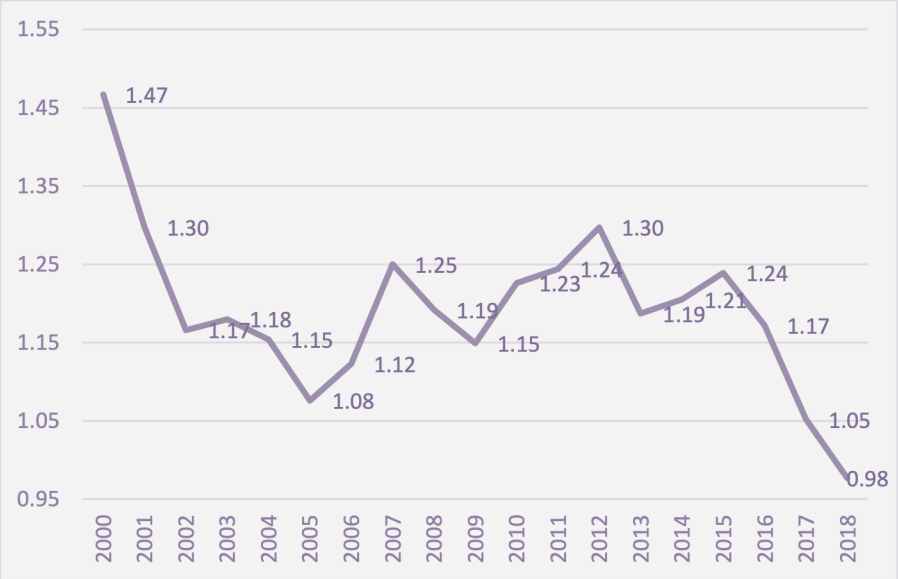
This support is sufficient to pay for public care, the alternative that is preferred by most Korean families, perhaps due to the fact that, in public care, the number of children per caregiver is smaller and working conditions better, including higher pay and better job security.[4] However, in 2019, public care was only available for some 17 percent of all children (Ministry of Health and Welfare 2020). Household expenses for the 90 percent who do not find spots in public care are higher: in 2017, the out-of-pocket monthly payment per child across all Korean households (irrespective of whether they rely on public or private care) was around 200,000 won (Lee 2018, and Yonhap 2018).

Apart from this main benefit, Korean families enjoy a set of other benefits including coverage of prenatal expenses up to 500,000 won, a one-year pension credit per child, a voucher for post-birth care services, and a paid parental leave of up to 12 months per parent per child (to be taken before the child reaches 12 years). The paid leave benefit is not universal as it excludes irregular workers and self-employed. Among leave takers, only 24.5 percent were men in 2020, indicating that childcare mainly is provided by women (Korea Employment Insurance Service 2021).

However, even though this program of childcare has made it less burdensome to give birth and raise children, the program has not reversed the decline in Korea's total fertility rate (TFR), which is the lowest in the world – see Figure 2.1.

[4] According to the Korean Ministry of Health and Welfare (2016), in 2015, average public and private child care staff wages were $2,100 and $1,630, respectively.

Figure 2.1. Korea: Total fertility rate 2000-2018



Source: World Development Indicators (World Bank 2020).

2.2 ELDERLY CARE

The main policy tool for elderly care is the Long-Term Care Insurance (LTCI). It offers three types of benefits: home-based services, aged care facilities, and combinations of copayments and vouchers. During the last decade, the program has expanded rapidly due to increases in the number of elderly (here defined as those aged 65 and above) and in the share of the elderly that receives benefits under the LTCI. As shown in Table 2.2, the number of beneficiaries has increased from 145,000 in 2008 (2.9 percent of 5.0 million elderly), to 394,000 in 2014 (6.2 percent of 6.3 million), and 569,00 in 2017 (8.0 percent of 7.1 million). In 2014, the cost amounted to 3,498 billion won (0.24 percent of GDP); by 2017, it had risen to 5,148 billion won (0.30 percent of GDP). In constant 2010 won, the benefits per beneficiary have remained roughly constant but elderly population growth and an increased share of beneficiaries among the elderly have led to spending increases in excess of GDP growth, thus raising the cost of LTCI expressed as percent of GDP. Compared to child care, the elderly care benefits were higher among those who received them (around 670,000-680,000 2010 won per beneficiary per month) but lower if computed per elderly person in the population (around 50,000 2010 won per elderly per month).

Table 2.2. Korea: Long-Term Care Insurance (LTCI) costs and benefits

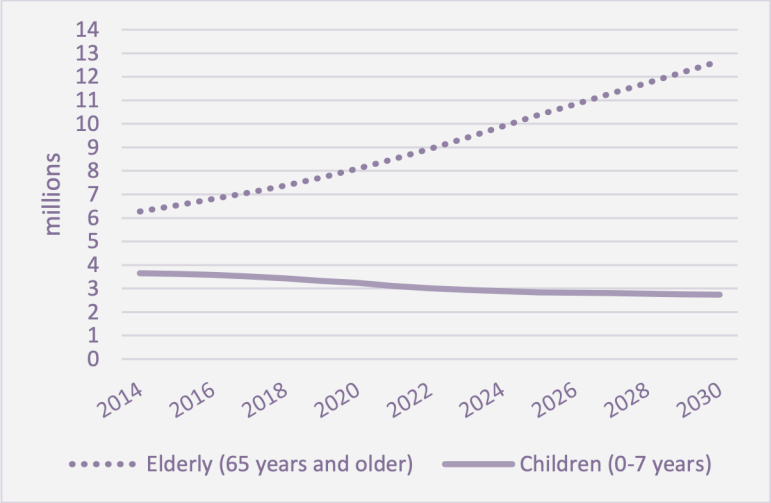
	2008	2009	2014	2015	2016	2017
LTCI cost (bn current won)		1,737	3,498	3,982		5,148
LTCI cost (% of GDP)		0.151	0.235	0.255		0.298
Elderly (65 years and older) (mn)	5.009	5.226	6.347	6.602	6.851	7.113
Share of elderly benefitting from LTCI (%)	2.9		6.2		7.2	8.0
LTCI beneficiaries (mn)	0.145		0.394		0.493	0.569
Average benefit per elderly per month (current won)			47,016			53,625
Average benefit per beneficiary per month (current won)			740,711			753,947
Average benefit per elderly per month (2010 won)			43,111			47,434
Average benefit per beneficiary per month (2010 won)			679,195			666,910
Average benefit per beneficiary per month (current US$)			703			667
Mimeo:						
GDP (bn won)	1,104,492	1,151,708	1,486,079	1,564,124	1,641,786	1,730,399
CPI (2010=100)	94.5	97.1	109.1	109.8	110.9	113.1

Sources: Sources: Peng et al. 2021 (pp. 5 and 15); World Bank (2020); UN (2019).

The LTCI system in Korea is publicly funded but privately delivered. In 2017, among the LTCI providers, 20,377 were private (5,304 institutions and 15,073 home-based care agencies) and 207 public (i.e., around 1 percent of the total); among the private providers, 81 percent were for-profit enterprises (Peng 2021, Table 4a; NHIS 2019). In 2017, the LTCI employed 439,000 paid care workers (around 1.6 percent of total employment). Private-sector care workers face relatively poor working conditions, including long workdays and low wages; in 2009, their average monthly wage was $1,300, which is far below the national average wage of $3,000 (NHIS 2019).

In addition to employing paid care workers, the LTCI scheme allows family members to receive formal training to be caregivers to their elderly at home and be qualified for cash transfers. The share of older persons taken care of by qualified co-resident family members increased from 1.8 percent in 2008 to 23.5% in 2010 (UN ESCAP 2015); if non-resident family members are included, the share reaches 40 percent (UN ESCAP 2015). As the demand for paid family caregiving increased, the LTCI drastically reduced the number of hours and days that family caregivers can be paid. For example, in 2011, the maximum permitted was one hour per day for 20 days per month (regardless of whether family members were co-resident or non-resident) (UN ESCAP 2015).
Due to the demographic context, the challenges for child and elderly care are very different. As shown in Figure 2.2, according to UN population projections, during the period 2014-2030, the population of children will decrease while the elderly population will grow rapidly (UN 2019).

Figure 2.2. Korea: Elderly and child population 2014-2030



Source: UN (2019).

During the last 15 years, family structure and attitudes toward care for older people have changed. The proportion of parents who are living with their children decreased from 38 percent in 2008 to 29 percent in 2016, with surveys indicating that the population share that thinks that family, government, and society should share the provision of parental support (45.5 percent) is larger than the population share that cites family as the main source (30.8 percent) (Jeon and Kwon 2017). Consequently, the role of family obligation associated with caregiving for parents is expected to decline.

2.3 GENDER WAGE GAP

It is important to better understand the mechanisms that generate lower wages for women, the impacts of wage gaps, and how they may be overcome. In 2019, the gender wage gap in Korea was 32.5 percent, the largest among OECD countries with data (OECD 2021). Lower wages are related to the concentration of female employment in occupations and sectors in which wages are relatively low. However, also within sectors, women tend to earn lower wages; this may be due to differences in productivity (which in their turn may be due to differences in experience and education, both related to differences in work tasks) or wage discrimination (wage differences that are not associated with productivity differences) (Choi 2019). While wage discrimination seems to be common, it is difficult to come up with exact measures since it is hard to measure productivity.[5] However, using the decomposition method of Oaxaca (1973), Monk-Turner and Turner (2001) estimated that, due to gender discrimination, men earn from 33.6 percent to 46.9 percent more than women with comparable skills. Using a similar method, Lee (2020) estimated that, in 2017, unexplained factors accounted for 52.2 percent the gender wage gap.

[5] For a survey of issues related to discrimination in labor markets, see Cahuc et al. (2014, pp. 479-550).

3. LITERATURE REVIEW

The small but growing literature on gendered SAM-based CGE models has demonstrated the ability of the CGE approach to generate important insights about gender-differentiated effects of economic policies. This section briefly surveys major contributions, taking note of their structure, data needs, and policy coverage. It also situates the model and analysis of this paper in the context of this literature, discusses some of the features of GEM-Care, and takes note of some of the outstanding challenges for gender-sensitive CGE modeling.[6]
Table 3.1 summarizes the features of key contributions to the literature. The gendered CGE models may be split into two groups. The first introduces a gender disaggregation of labor in the production sphere that, according to the System of National Accounts (SNA), is part of GDP. The second group goes beyond GDP by extending the model to cover household service production for own consumption, also in this sphere with a gender disaggregation of labor. The latter services include what often is referred to as care or social reproduction. Given that the second group of models views the time that is available to different household members more comprehensively, they also tend to cover leisure. The coverage of the databases (most importantly the SAMs) that accompany the models in each of these two groups reflect whether they are limited to or go beyond the GDP sphere.

As shown in Table 3.1, Arndt and Tarp (2000) is the pioneering paper in the first group. Their gender disaggregation of labor, which is limited to agriculture, makes it possible to analyze the impacts of exogenous shocks (in their case affecting productivity and marketing costs) on labor incomes by gender as well as standard non-gendered indicators. Their analysis also considers the role that risk aversion may play in generating an overallocation of female labor to one of the agricultural sectors (cassava). To make it possible to address gender aspects, the database for the Arndt-Tarp model juxtaposes the standard national accounts with additional detail on agriculture.

[6] For a more detailed review of the literature, see Fontana (2014) and Fontana et al. (2020).

Table 3.1. Selected contributions to gendered CGE modeling

	Arndt and Tarp (2000)***	Fontana and Wood (2000)****	Ruggeri Laderchi et al. (2010)
Country	Mozambique	Bangladesh	Ethiopia
Time treatment	Static	Static	Recursive dynamic
Household sectors*	--	Reproduction and leisure	Reproduction and leisure
GDP sectors**	Explicit gender roles in agriculture	Explicit gender distinction in all sectors	Explicit gender distinction in all sectors
Labor	Gender disaggregation of labor factors within agriculture but not for non-agriculture	Gender disaggregation of labor factors in all sectors	Disaggregated by gender and education in all sectors
Households	Rural and urban	Aggregate household	Aggregate household
Policy issues	Changes in agricultural productivity and marketing costs	Changes in food import prices, capital inflows, and manufacturing export incentives (with and without gender targeting)	Expanded public education with alternative scenarios for financing sources, household service productivity, and male-female substitutability in production

*Household service production for own consumption that is not part of GDP. Leisure is also in this category.
**Production that is part of GDP. (For goods, some of these sectors may be produced by households for own consumption.)
***The models in the first group with gender disaggregation within the GDP sphere, also includes Thurlow (2006) on South Africa, Arndt et al. (2006) on Mozambique, Cockburn et al (2009) on multiple countries, and Arndt et al. (2011) on Mozambique.
****Other models in the second group, which also disaggregate households, also include Fontana (2001) on Bangladesh, Fontana (2002) on Zambia, Fofana et al. (2005) on Nepal, Cockburn et al. (2007) on South Africa, Siddiqui (2009) on Pakistan, and Filipski et al. (2011) on the Dominican Republic.

Fontana and Wood (2000) were the first to extend a gendered CGE model to household production, i.e., going beyond GDP production. This adds to data requirements but has the important advantage of transcending the artificial boundary between time spent on GDP production and (often larger amounts of) time spent on production of household services for own consumption and leisure. As a result, it becomes possible to consider the impact (including gender aspects) of changes in market work on time spent on leisure and household work, all of which in different ways contribute to household and individual well-being, including various trade-offs. The terminology for and extent of disaggregation of household work have varied but reference is often made to social reproduction, an activity that may be further disaggregated into activities like different types of care, cooking, cleaning, washing, and shopping. Both the initial contribution by Fontana and Wood and subsequent contributions (see note below Table 3.1) have focused on trade-related policy simulations. This narrow focus suggests that studies on other issues, like care policies in this

paper, could yield new insights at the same time as they may lead to enriched model formulations and impose new data requirements.

In an analysis of Ethiopia, Ruggeri Laderchi et al. (2010) developed a gendered version of MAMS (Maquette for Millennium Development Goal Simulations), a recursive dynamic CGE model designed for medium- and long-run policy analysis that covers indicators related to the Millennium Development Goals (MDGs). The model applies the Fontana and Wood approach to household production and gender. Its innovative aspects lie in its treatment of the educational system: it is split into three levels with endogenous and gendered entry, graduation, dropout, and repetition. Students exiting from the educational system enter the segment of the labor market that corresponds to their educational attainment in shares that reflect data on labor force participation. Those who leave school early wait until they reach labor force age. Model simulations analyzed the impact of rapid expansion in the educated female labor force on wages, employment, and household services and how these impacts are conditioned by labor market segmentation and productivity growth within household services.

Future research will likely generate methodological advances that help analysis based on gendered CGE models contribute to emerging policy debates. One broad area is related to policymaking in the context of changing (often rising) female labor force participation – what impact may different policies have on wages, household production, welfare, and inequality, including both gender-specific and more aggregate indicators? How may these impacts change if wage-discrimination against women diminishes? The analysis in the rest of this paper is an example of this: East Asia in general and Korea in particular face important gender-related policy challenges in the context of little (or no) growth for the working-age population, low rates of female labor force participation, rapid growth in an elderly population that needs care, and gender inequalities both in the household and market spheres.

Another broad and challenging area revolves around the impact of different types of consumption and investment on the accumulation of human capital and growth. The education analysis in the Ethiopia MAMS application touches on this aspect. However, this analysis could be extended to consider the links between, on one hand, growth, and human capital accumulation and, on the other hand, the consumption of prepared food, care, and education services, supplied by the market and households?[7]
Korea was the focal country of a pioneering CGE-based study of income distribution (Adelman and Robinson 1978) and since then CGE techniques have been used to address various issues, in recent applications including innovation, technical progress and their impact on growth and employment (Jung et al. 2016, Jung et al. 2017), world commodity price shocks (Lee and Kim 2018), Korea's emissions trading system (Oh et al. 2015; Choi et al. 2017; Winchester and Reilly 2018), electricity generation and the environment (Lee and

[7] Gibson (2005) effectively makes the point that human capital accumulation is not only the result of formal education but also depends on many other activities, including household and informal sector services.

Kim 2018; Oh et al. 2020), returns to investment in human capital (Yeo et al. 2018), and the distributional impact of progressive income taxes (Seok and You 2018). To the best of our knowledge, no gendered or care-focused model has been developed for Korea before the current one.

4. MODEL STRUCTURE AND DATABASE

In general, CGE models tend to be most appropriate for medium- to long-run analysis of shocks that have significant repercussions beyond the sector or household that is affected most directly (and often end up being affected indirectly, via feedbacks).[8] In this context, one important feature of CGE models is their ability to capture links between different parts of an economy (for example, links between production sectors via intermediate demands, or links between household incomes from production and household demands with a feedback on production). The small but growing literature of gendered CGE models has demonstrated the ability of this approach to generate insights about gender-differentiated effects of economic policies. GEM-Care is distinguished by its treatment and disaggregation of care.

4.1 MODEL STRUCTURE

Figure 4.1 provides an overview of the structure of the payments covered by the static module of GEM-Care while Figures 4.2-4.3 elaborate on the nested structures for production and consumption that are at the core of the treatment of gender, care, and household production. The disaggregation of the database used for this paper is shown in Table 4.1.

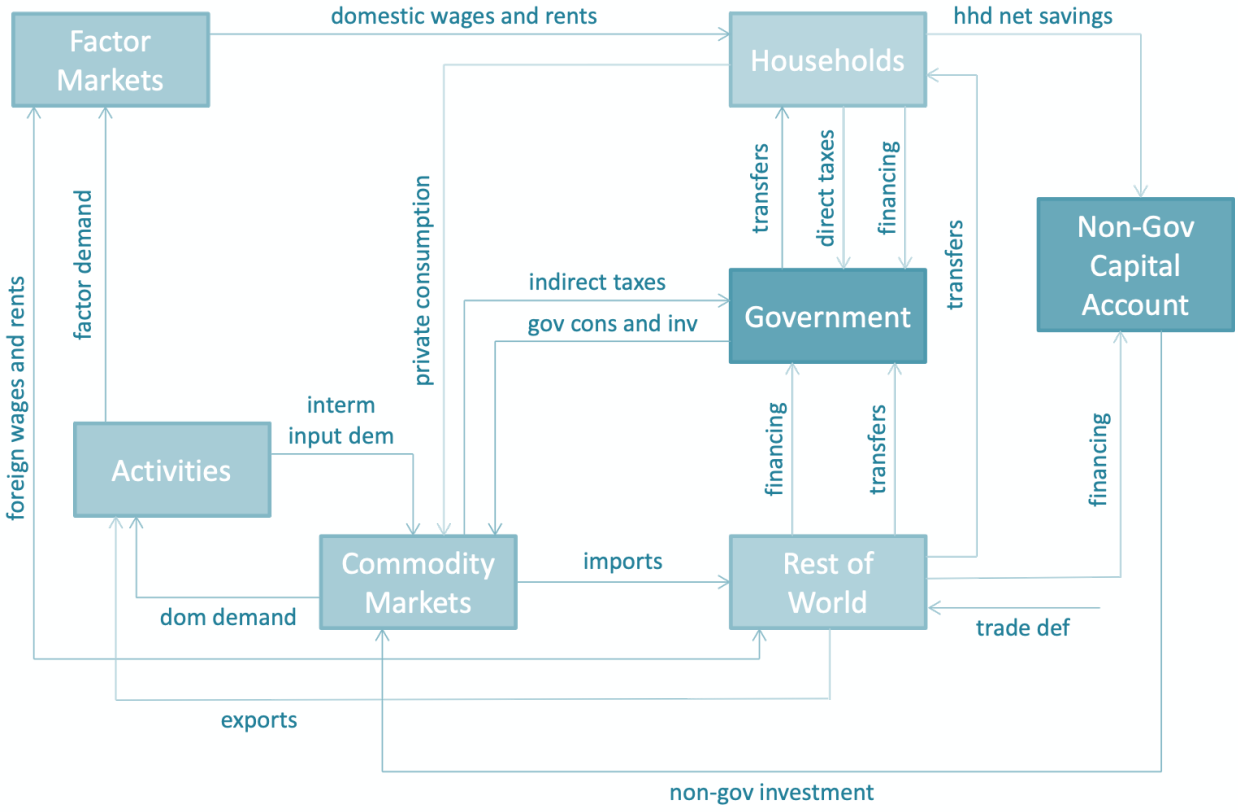
The major building blocks in Figure 4.1 are activities (entities that carry out production), commodities (goods and services produced by activities and/or provided via imports), factors, and institutions (households, enterprises, the [general] government, and the rest of the world). In this figure, the arrows show the direction of payments. The payments to factors (factor services) and commodities are made in exchange for the right to use these factors and commodities. Some of the payments in the figure are only implicit, based on a market-related valuation of goods, services, and leisure that are not traded; such implicit

[8] To exemplify, simulations with CGE models may provide valuable insights on the impact of changes in world energy prices. For an energy net-importing country, a change in the import price has direct effects on sectoral profitability (with large differences between sectors depending on their energy intensity) and on the government budget (due taxes or subsidies on energy products). Beyond these direct effects, indirect effects may include interrelated changes in the real exchange rate; government fiscal policy responses; and prices, production, employment, trade, incomes, and domestic final and intermediate demands at disaggregated and aggregate levels, ultimately changing living standards in a differentiated manner. The details depend on policies and other features of the modeled economy.

payments are particularly important in applications that are extended to cover household services that are not part of GDP.

Most blocks in Figure 4.1 are disaggregated, matching the disaggregation of the SAM that feeds data to the model. More specifically, given that this is an application to gendered care analysis, the factor, activity, and commodity blocks are disaggregated to capture gender and care aspects, and extended to cover both household and GDP production (cf. Table 4.1). Among the factors, this means that the labor components are disaggregated by gender and skill level. It is important to note that the term "labor" here refers to all time use that is covered by (and endogenous in) the model, including time spent on leisure and production within and beyond GDP. This should be seen as applying to the population in working age, covering 24 hours per day net of time that in the context of the application is viewed as non-discretionary and left outside model and database. In our database for Korea, the time needed to satisfy basic needs for survival (like sleeping, eating, and personal hygiene) is non-discretionary along with time spent on education (as educational decisions are not endogenous to the model). Given the relatively detailed treatment of the financing of private investment (compared to most other CGE models), the private (non-government) capital account also has its own box.

Figure 4.1. Overview of GEM-Care



Source: Author's elaboration

Figure 4.2. GEM-Care: Nested production technology

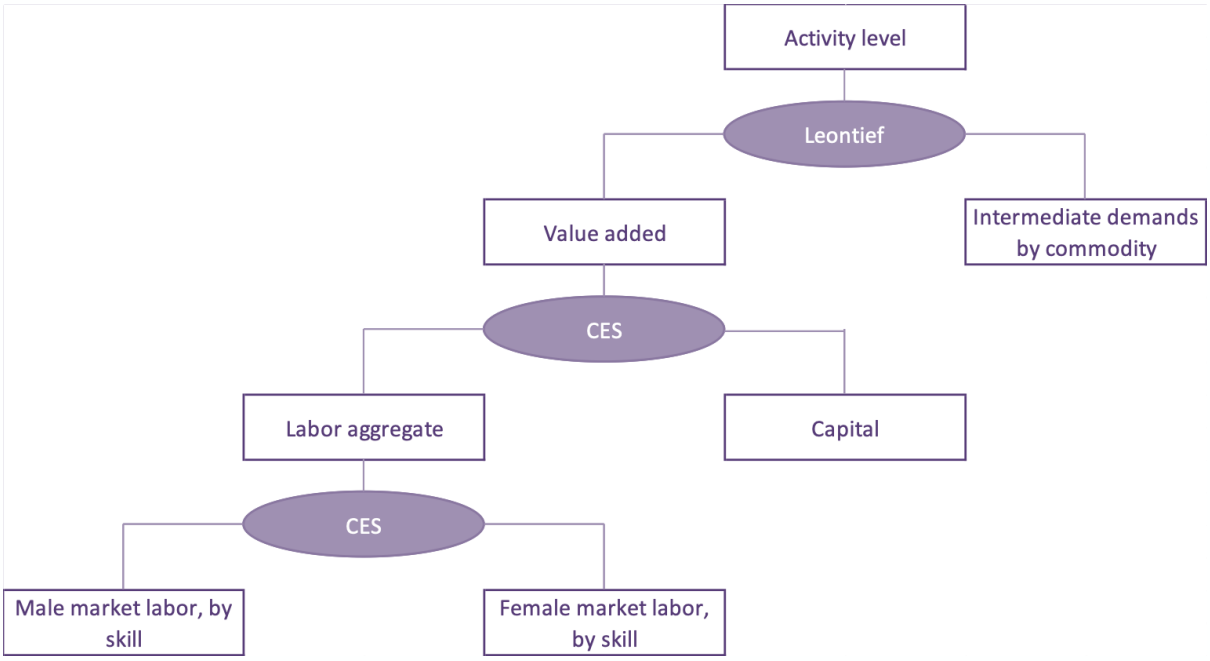


Figure 4.3. GEM-Care: Nested structure of household consumption

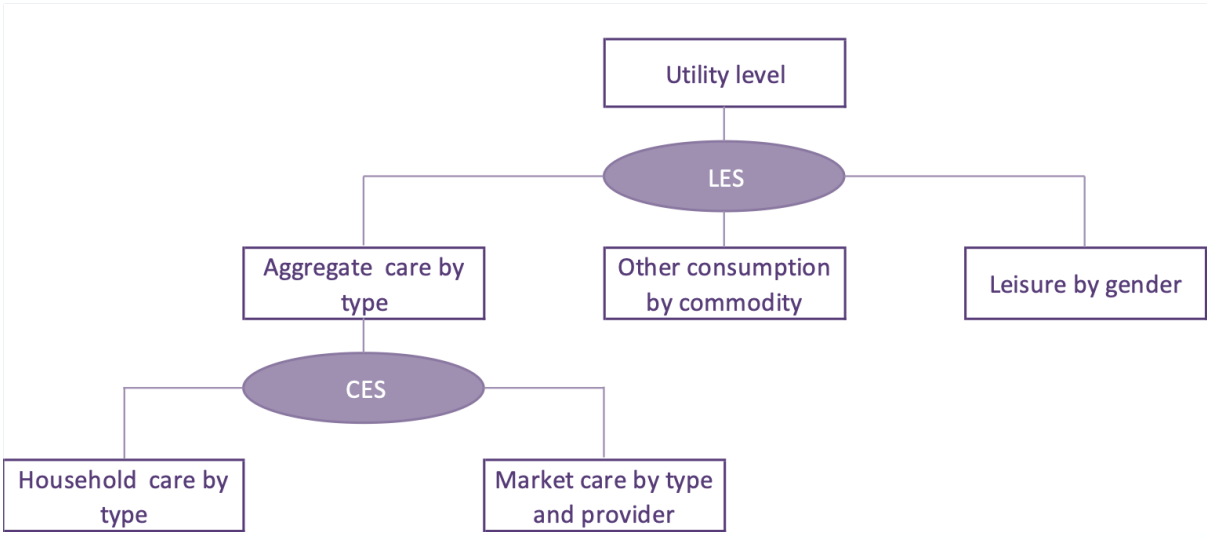


Table 4.1. Disaggregation of GEM-Care Korea database

Sectors (activities and commodities)	*Agriculture and industry (6)*
	agriculture, forestry, fishing; mining; manufacturing; electricity and gas; water supply; construction
	Services, GDP (16)
	trade; transport; hotels and restaurants; information and communication; finance and insurance; real estate; Professional, scientific and technical ser; administrative and support ser; public administration; education; health; other social care; other ser; private care of children; private care of elderly; private service substitutes for household non-care services
	*Services, non-GDP**
	child care; elderly care; non-care
Factors (16)**	Labor, male by skill level (low skill/high skill) (2)
	Labor, female by skill level (low skill/high skill) (2)
	Capital, private
	Capital, government
	Land
	Extractive
Institutions (6)***	*Households (3)*
	working age with children; working age without children; elderly
	Enterprise
	Government
	Rest of the World
Taxes and subsidies (4)	Tax, activities
	Tax, commodities
	Tax, imports
	Tax, income
	Subsidies, commodities
Distribution margins (3)	Trade and transport margins, domestic
	Trade and transport margins, imports
	Trade and transport margins, exports
Investment (3)	Investment, private
	Investment, government
	Investment, change in inventories

*Non-GDP activities and commodities are disaggregated by household.
**For labor, unskilled is completed secondary school or less and skilled is more than completed secondary school.
***The institutional capital accounts are for domestic non-government (aggregate of households and enterprises), government, rest of the world, and the financial institution.
Source: GEM-Care Korea database.

Turning to the different blocks in Figure 4.1 and their links, the activities are split into household and GDP subsets, with the former also including leisure (cf. Table 4.1). Across both subsets, each activity produces a commodity that is treated as having sales in (domestic) commodity markets and/or to the rest of the world (as exports). In empirical databases, government commodities do not tend to have substantial export volumes. In the current database, private care services only have domestic sales while the other private commodity has sales to both destinations, with the split between the two depending on relative sales prices in these two destinations. The activities use their revenues to cover costs of intermediate inputs and to pay wages and rents to the factors that they employ.
Figure 4.2 shows the nested production technology that applies to all activities and is designed to make it possible to capture gendered labor markets. At the top level of the production nest, the activity (the level of which defines the output level) requires aggregate value-added and intermediate demands for different commodities on the basis of Leontief technology (fixed input quantities per unit of activity). On the side of value added, Constant Elasticity of Substitution (CES) functions are used in a nested structure: at the top, the inputs are private capital and aggregate labor and, one level down, the latter is produced by male and female labor. GDP activities employ market labor while household activities employ labor from the household that consumes the output. For a given labor type, here male or female, time uses in GDP and household activities are added and feed into the time constraint for the labor type.

The details of the technology are determined by the database. In the Korea database, only private GDP production has the full set of inputs. For other activities, the production technology is simplified to various degrees. Government GDP activities differ from private activities in that they do not have capital (private or government) in their value-added functions – according to the system of national accounts, government capital does not generate value-added. (However, in the background, the model makes sure that government investment is sufficient to ensure that the government capital stock grows at the same rate as government services.) As opposed to the GDP activities, household activities (services and leisure) are limited to labor inputs – due to a lack of data, intermediate inputs and investments are treated as part of household consumption. While household services employ labor from both genders, the leisure activities, which are gender-specific, only use one labor type, i.e., for leisure activities, Figure 4.2 in effect collapses to one input. In our case, the database not only disaggregates labor by gender but also by skill (see Table 4.1). Thus, additional nests are added to GDP and household service activities while the number of leisure activities increases so that there is one such activity per labor type.

Across all activities, profit maximization drives decisions regarding factor employment -- factors are employed up to the point where the marginal value product equals the wage faced by the activity. Factor employment then determines the activity level and intermediate demands. The exact implications of this varies depending on the structure of input use, the demand structure, and elasticities of substitution between factors. Within private GDP production, the activities may have a relatively high degree of flexibility since

they decide on the output level and factor hiring in light of prices, wages, and rents. For government activities, the flexibility is limited to the combination of labor factors to use since the output level in practice is decided by government policies as long as the government is the predominant demander. Within household services, as a consequence of profit maximization, the labor mix responds to relative wage changes and prices; the latter depends on the price of alternative supply sources. To exemplify, ceteris paribus, higher female wages and lower prices for market care would on the margin shift the labor mix from women to men and reduce the level service output for the household. For leisure activities, since only one input is used, the only decision to make concerns the level, determined by household demand, which is influenced by the price (wage) and the income elasticity.

The factor demands are channeled to factor markets. At the aggregate level, for all factors, the demand curves slope downward, reflecting production activity responses to changes in wages and rents while, within the single time period, the supply is fixed, represented by a vertical supply curve. Flexible wages and rents clear these markets via demand-side adjustments. For labor, this means that there is no explicit reference to unemployment. This follows naturally from the fact that labor here refers to an exogenous quantity of time the allocation of which is endogenous within the model. Time that in other context would have been spent in unemployment (time supplied to GDP work but not employed) is here explicitly allocated to other uses (leisure or work in non-GDP activities).[9]

In GEM-Care, the treatment for wage discrimination against women is based on the canonical approach of Becker (1971). Specifically, he proposed a model of "taste discrimination" according to which an aversion felt by employers, clients, or other workers toward persons belonging to certain groups may constitute a source of discrimination and lead to lower wages for discriminated workers. GEM-Care implements this approach; to the best of our knowledge, this is the first time this is done in a CGE model. This requires a modified treatment of producer hiring decisions and the definition of sectoral factor incomes so that they are based on an erroneous assessment of the marginal productivities for identified labor categories. The essence of the adjustment is that the labor hiring decisions of activities may be influenced by a discrimination rate that, if positive, leads to a perceived marginal cost of hiring a certain labor type that exceeds the wage that actually is paid. The rate is defined by labor type and activity, i.e., for any labor type, it may apply to different degrees to different activities and be totally absent from some. For the producer, this reduces profits. For labor types that face discrimination, the demand curve and wages decline – discrimination functions like a tax. However, as opposed to a labor tax, what may be termed labor discrimination revenue is not passed on to the government but stays inside the activity; this is accomplished by adding this virtual revenue to the income of private capital. (Appendix A presents the firm model that underpins the representation of discrimination in GEM-Care.)

[9] While the aggregate labor (or time) supply is vertical, the supply curve for GDP labor is upward sloping – other things being equal, a higher wage in GDP activities leads to a reallocation of time to these activities.

Among the institutions, the household earns incomes from factors, (net) transfers from the government, and (net) transfers from the rest of the world.[10] After paying direct taxes (determined by policy), the household spends in fixed shares on aggregate commodity consumption (which is defined broadly to include not only GDP commodities but also non-GDP commodities and leisure) and savings. The allocation of consumption across commodities (with aggregation of commodities with both GDP and household supplies) is specified by Linear Expenditure System (LES) demand functions derived from utility maximization. After deducting net financing of the government and of changes in foreign reserves, household savings are used to finance private investment.

The treatment of household services is of particular importance to the current application. Both household production and consumption are treated as part of a general structure that has been enriched to meet the needs of the current analysis. More specifically, each household service is produced by a production activity that uses household labor and supplies its output for use by the household that provides the labor. In terms of Figure 4.1, these services are viewed as being passed on from the household activities to the (domestic) commodity market for private consumption by the labor-providing household. In order to capture household choice between household and market supply sources, the top level with LES household consumption was extended to include a second CES level at the bottom in which the split between demands for services across the two supply sources depends on relative prices. If the only input in the production of a household service is labor (which is the case in the current database and a treatment that is likely to stay in the absence of data on the use of other inputs), the imputed sales revenue is identical to the imputed income earned by household labor.[11] The second extension, already described, is the production side nesting of selected factor demands (here male and female labor), making it possible to capture gender issues in time use across the economy, including household services. The fact that household services and gender issues are part of the general structure has the double virtue of making it possible to enrich the model considerably with only a minor cost in complexity at the same time as the extensions that are introduced also can be employed in other areas.[12] In addition, GEM-Care allows modeling the interhousehold transfers in the form of unpaid care labor. To that end, the model allows using transfers to compensate for the fact that child (elderly) care is only "consumed" by households with children (elderly), even when it is produced by other households.

The government (as an institution, not as a producer of services, which is covered by one or more production activities) gets its receipts from taxes, transfers from abroad, and net financing from households and the rest of the world. It uses these receipts for transfers to

[10] In Figure 4.1, transfers are implicitly netted (since they only go in one direction) and may therefore be negative. In the model and its database, it is possible to include transfers in both directions.
[11] The latter statement is not true if the household service uses intermediate inputs; if so, the labor income falls short of the sales revenue.
[12] A nesting of consumption demands is relevant whenever the analysis is focused on choices between alternative means of satisfying a more general need. (To exemplify, transportation needs may be satisfied using alternative means of transportation.)

households, consumption, and investment (to provide the capital stocks required for government services). To remain within its budget constraint, it either adjusts some part(s) of its spending on the basis of available receipts or mobilizes additional receipts to finance its spending plans. This treatment implies that government capital spending (investment) is funded within the overall government budget. In addition, GEM-Care makes it possible to consider transfers from the government to the households in the form of care services. To that end, the model introduces (a) a phantom tax that permits exogenization of household consumption of care services provided by the government, and (b) a matching transfer from the government to the households that covers the cost of care services provided by the government. Thus, it is possible to consider changes in transfers from the government to the households in the form of care services.

The non-government capital account collects funding to private investment from different sources: household (domestic private) savings net of financing of the government is augmented by financing from the rest of the world (made up of FDI and foreign lending net of interest to the private sector). This funding is passed on to investment demand (i.e., demand for commodities used to construct new capital stock). In the current application, the account is balanced via adjustments on investment spending (and demand) driven by the availability of funding.

In the commodity markets, flexible prices ensure balance between demands for domestic output from domestic demanders and supplies to the domestic market from domestic suppliers. Foreign trade is potentially relevant both on the demand and supply sides. Part of the demands are for imports, i.e., are not directed to domestic outputs; the ratio between demands for imports and domestic output depends on the ratio between the demander prices for commodities from these two sources – an increase in the import/domestic price ratio lowers the ratio between the demands for imports and domestic output (and vice versa).[13] Similarly, part of the domestic supplies are exported, i.e., do not end up in the domestic market; the domestic producer allocation of output between the domestic market and exports depends on the ratio between the prices offered. For both exports and imports, the application follows the small-country assumption that international prices are exogenous.[14] The balance in the domestic market interacts with the determination of imports and exports – in the case of excess demand in the domestic market, a price increase reduces the quantity demanded (in part via a demand switch to imports) and raises the quantity supplied (in part via a supply switch away from exports).
The complexity of the response mechanisms varies across commodities. In general, in the domestic markets for domestic output, both the demand and supply sides respond to price changes. The market for the government commodity is an exception since here the demand is a policy tool that may not respond to price changes. These mechanisms are also simpler

[13] The demander prices are affected by taxes, subsidies, and transport margins – the latter are not explicit in the current database.
[14] Both for imports and exports, the model offers the option of endogenizing prices (in foreign currency) using constant-elasticity demand and supply functions, respectively.

for commodities that do not have exports and/or imports. For commodities without foreign trade in either direction, only domestic demand and supply responses are relevant. Within this structure, household services (like childcare provided by female family members) are part of private commodity production for the domestic market. Like other private commodities, their prices are flexible, balancing quantities supplied and demanded. To exemplify, other things being equal, the price of household care would increase if female wages outside the home increase (leading to a leftward shift in the supply curve for the service due to a cost increase) and/or if there is an increase in the price of market substitutes to family-provided care (leading to a rightward shift in the demand curve). (The above-mentioned nesting of household consumption demand assures that these responses are present.)

Finally, the rest of the world receives and makes the payments that appear in the balance of payments. As shown in Figure 4.1, imports are represented by payments from commodity markets to the rest of the world while exports appear in the form of payments from the rest of the world to activities. (As noted, commodities differ in terms of whether they are marketed domestically and/or abroad.) Foreign wages and rents are the only non-trade payments to the rest of the world. The non-trade payments received from the rest of the world are net transfers and financing to government and the private sector – each of these payment flows may be negative. Private investment financing from abroad also includes foreign investment other than FDI. The import and export responses to relative price changes, described in the preceding paragraph, underpin the clearing mechanism for the balance of payments: changes in the real exchange rate (the ratio between international and domestic price levels, which may change due to changes in the nominal exchange rate) influence export and import quantities and values. For example, other things being equal, an exchange rate depreciation may eliminate a balance of payments deficit by raising the export quantity and reducing the import quantity (and vice versa for an appreciation).
Over time, production growth is determined by growth in factor employment and changes in total factor productivity (TFP). Growth in capital stocks is endogenous, depending on investment and depreciation. For other factors, the growth in employable stocks is exogenous. For labor and natural resources (with sector-specific factors for natural-resource-based sectors), the projected supplies in each time period are exogenous. For natural resources, they are closely linked to production projections. For labor, the projections reflect the evolution of the population in labor-force age and labor force participation rates. The unemployment rate for labor is endogenous. TFP growth is made up of two components, one that responds positively to growth in government infrastructure capital stocks and one that, unless otherwise noted, is exogenous.

4.2. DATABASE

The disaggregation of the current application, presented in Table 4.1, is reflected in the database. The major components of the database are a social accounting matrix (SAM) for 2018, physical data on gendered time use, population data, and a set of elasticities (related

to production, trade, and household consumption).[15] To save space, only data on gendered time use are highlighted below.

The role of the SAM is to define the base values for the bulk of the model parameters, including those covering production technologies, sources of commodity supplies (domestic output or imports), commodity demands (for household and government consumption, investment, changes in inventories, and exports), transfers between different institutions, and tax rates. In general, most features of a SAM for GEM-Care are familiar from SAMs used for other models. However, a SAM for GEM-Care is usually extended to cover household (non-GDP) service production. In the current application, GDP care sectors are split by target group (child and elderly) and ownership (private and public). In addition, three representative households are singled out based on their care needs: households with children with head in working age; households without children with head in working age; and households with head above working age. Note that the three households have elderly individuals, with two thirds of them in the elderly household (Lofgren et al. 2020, p. 26, Table 4.2). Thus, all three households "consume" GDP and non-GDP elderly care services. In this application, the SAM was also extended to consider (a) transfers from government to households in the form of care services, and (b) interhousehold transfers in the form of unpaid care labor. For (a), a simple incidence analysis was conducted, measuring the extent to which households with children (elderly) benefit from government spending in child (elderly) care. For (b), the interhousehold transfers in the form of unpaid care labor were determined as the difference between the supply and demand of household care services at the household level. For instance, total output of non-GDP childcare services is "consumed" by the only household with children aged 0-9. In other words, the other two households fully transfer their output of non-GDP childcare services. On the other hand, two of the three households are net suppliers of non-GDP elderly care services. In both cases, we assume that child and elderly care needs are proportional to the number of household members aged 0-9 and 65 or more, respectively.

The need for elasticity data depends on the functional forms used – given the use of LES and CES functions, they are mainly made up of expenditure and price elasticities (either of which are imposed, since they are not independent) for the top level of household consumption and elasticities of substitution for decisions related to production, trade, and the bottom level of household consumption. The economics literature provides a starting point for these elasticities, but it is important to test how the responses of the economy to policy changes are conditioned by the elasticities that are used. The elasticities we used are shown in appendix Table B.1. To capture the rigidity of gender roles, particularly within the household, we set the elasticities of substitution between male and female workers at 0.9 and 0.5 in the GDP and non-GDP sectors, respectively (Cho and Lee 2015, and Choi 2019). The price elasticities of demand are set as follows: for GDP goods and services except care, are set at -1.0; for care services, which is a composite of GDP and non-GDP care services,

[15] The process followed when building the 2018 SAM is similar to the one followed for a Korean SAM for 2014, presented in detail in Lofgren et al. (2020).

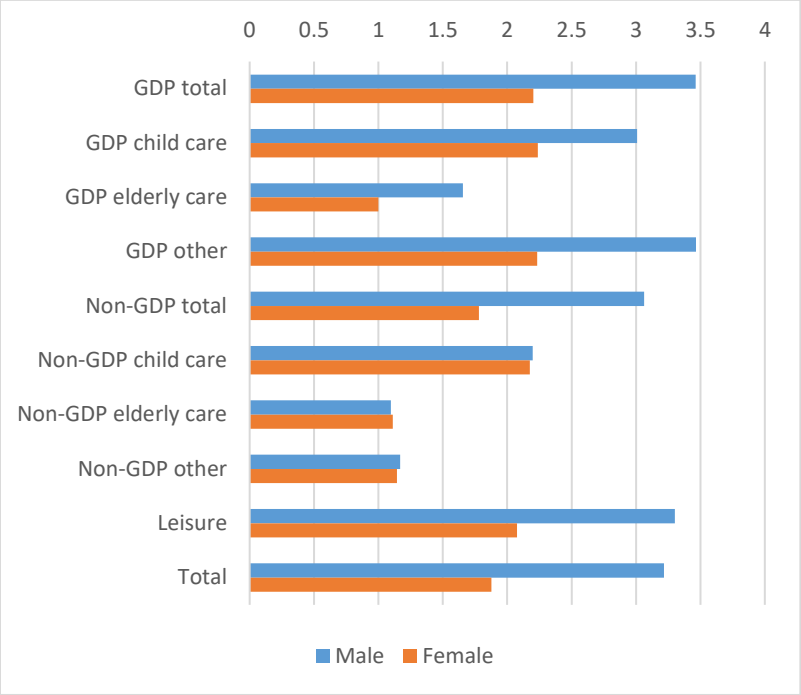
are set at -0.5; for other (i.e., non-care) non-GDP services, are also set at -0.5; and for leisure, are set at -0.85. In any case, and given the absence of better information, in Appendix C we test the sensitivity of our results to the values assumed for these key elasticities and to the valuation of unpaid care labor.

Together with the SAM (which shows payments at the prices of the base-year of the SAM), the time use data make it possible to define wages by labor category (i.e., male and female further split by level of education) and activity. In an empirical database, payments, wages, and time use for GDP labor are observable (even though the availability and quality of data vary greatly across countries). It is more difficult to define the wages and incomes related to non-GDP time use. For leisure, the wage (or price) should be informed by the opportunity cost (i.e., marginal income that is sacrificed due to the fact that this time is not spent in the highest-wage alternative use). For household service activities, the wage may be defined on the basis of the marginal cost of the closest available market equivalent. When such a procedure is followed, the wages for each labor type will vary across different activities, something that the model structure can handle in a straightforward. However, the reasons for why time is spent in different activities with different marginal returns is not made explicit.[16]

Figures 4.4 and 4.5 show relative wages and time use shares by gender. In Figure 4.4, the male and female wages (imputed wage per unit of time) for services provided by the household are at the level of the market wages in these services whereas the wages for leisure were set at the level of non-care GDP wages. For all activities, the gender wage gap by labor category matches the economywide wage gap in Korea. Besides, the SAM assumes that 50 percent of the wage gap is attributed to gender discrimination (see Section 2). Figure 4.5 shows that women have higher shares than men in household production (both care and other) and non-household care services, but they have lower shares than men in non-care GDP production and leisure.

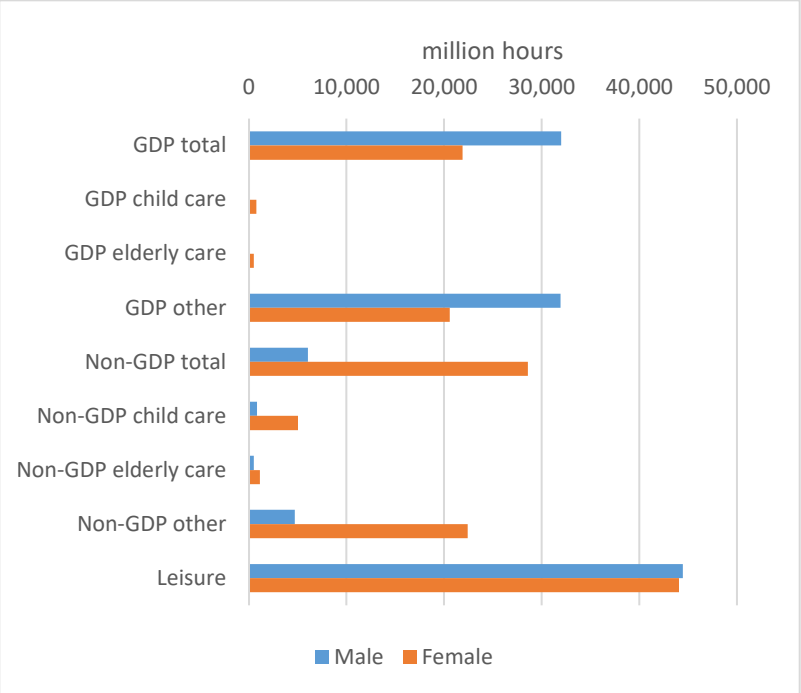
[16] In the background it may, for example, be due to variations in the marginal utilities (or disutilities) of different types of time use (independent of what is viewed as being produced): spending time with a child may be very different from harsh physical work. Different time uses may also vary in terms of job security, status, and risk for injury, something that may end up with workers accepting to allocate time to activities with large differences in marginal value products.

Figure 4.4. Base year: Relative wages (female wage in GDP elderly care = 1)



Source: GEM-Care Korea database.

Figure 4.5. Base year: Time use shares for males and females (%)



Source: GEM-Care Korea database.

5. SIMULATION ANALYSIS

Korea is facing important gender-related policy challenges given demographic trends (rapid growth for the elderly population while the growth for those in working age is close to zero), low rates of female labor force participation, and gender inequalities both in the household and market spheres. The simulations in this section test the impact of expanded public child and elderly care, reduced female wage discrimination, increased wages for care workers, and an increase in the fertility rate, i.e., the consequences of policy actions that would make it more attractive for women to work outside the home and easier for families to raise children.

In the analysis, we compare the results for 2018-2030 for a base (or business-as-usual) scenario to scenarios into which different shocks have been introduced. In all simulations, the model is calibrated to exactly replicate the detailed dataset for 2018 and, for 2019-2021, it imposes what is known about the evolution of relevant government policies (most importantly in the care area) and growth in GDP at factor cost – the latter is exogenous for the base scenario but not for the other scenarios.[17] The exogenous GDP data are based on IMF (2020), including a projected annual growth rate of 2.6 percent for 2021-2030. With regard to policies, the base scenario assumes that the 2021 policy regime will remain in place also during the period 2022-2030. Among other things, it assumes (a) that the share of the elderly population that benefits from the LTCI is kept constant at the 8.0 percent level reached in 2017; and (b) that government spending per child stays constant at the values registered in 2018 (see Section 2). The non-base scenarios start to diverge from the base in 2022, most importantly due to the imposition of policy changes. The fiscal space that is needed to balance government spending and receipts is created via a scaling of the rates for income taxes paid by households and enterprises. The specific features of the different simulations are spelled out in Table 5.1.

[17] Technically, for the *base* scenario, the variable GDP at factor cost is fixed at the projected levels while, at the same time, the model has an endogenous variable that, in each year, scales TFP in selected production activities so that the exogenous GDP level is generated. For the *non-base* scenarios, this setting is reversed: GDP at factor cost is endogenous and the TFP scaling variable exogenous, *fixed at the levels generated by the base scenario*. The point *in italics* is important: this means that the results for the non-base scenarios are no different if the only change is a switch from exogenous to endogenous GDP. However, given that, in fact, other shocks are introduced, the GDP level (and other results) will deviate from the base.

Table 5.1. Simulation definitions

Name	Description
base	business as usual 2018-2030
gspnd-c	in each year 2022-2030, increase in government spending on child care by 0.15% of GDP
gspnd-e	same increase in government spending as for gspnd-c but directed to elderly care
wcare+	50% decrease in the difference between average wage and the wage of care workers during 2022-2030
wgap-	50% gradual decrease in gender wage gap during 2022-2030
fert+	20.6% increase in fertility rate during 2022-2030, from 1.08 to 1.31
combi	combination of all previous scenarios

Source: Author's elaboration

As noted in Section 2, the government has put in place a program of child care support that is universal. However, the level of satisfaction among service users is low and, among the service providers, the working conditions of nursery teachers are poor (Kim 2017). Compared to other OECD countries, the children-to-teacher ratio is considerably higher; for example, for children aged 3, Korea's children-to-teacher ratio is 15:1 compared to 8:1 for the UK. In scenario gspnd-c, we increase government spending on care per child – this applies both to public and private services and reflects the assumption that more spending is needed to raise quality. Specifically, the increase in government spending is sufficient to cover a doubling of wage payments for child care employees of the Ministry of Health and Welfare, a measure that through multiple channels would be expected to improve service quality. To be more precise, we simulate an increase in the in-kind provision of labor services for child care by the government to the working household with children, at no cost to the household but costing the government around 0.3 percent of GDP.[18] Alternatively, in-kind benefits for child care increase by 26.3 percent on average for the period 2022-2030.
In the scenario gspnd-e, we impose the same increase in government spending as in the previous (gspnd-c) scenario, but it is here in the form of in-kind government provision of labor services for elderly care provided at no cost to all households with elderly individuals. As a result, compared to the base, in-kind benefits for elderly care increase by 18.4 percent on average for the period 2022-2030.

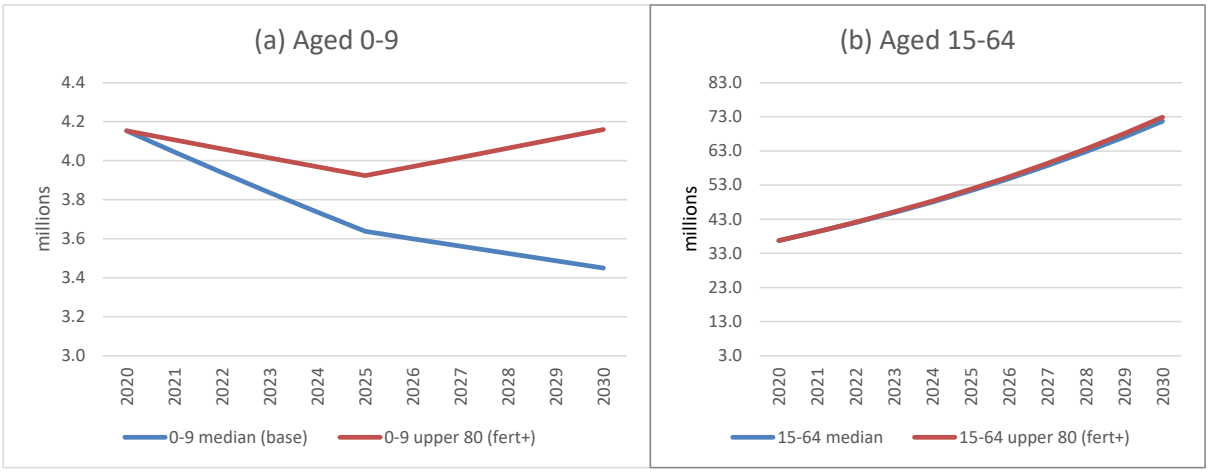
In 2019, the male median wage in Korea was 32.5 percent above the female median wage, a decline from a 39.6 percent gap 10 years earlier. However, in 2019, the Korean wage gap was still the largest among OECD countries, for which the average wage gap was 12.9 percent (OECD 2021). In the scenario wgap-, the wage gap is gradually reduced to reach

[18] In 2019, total spending on child care by the Ministry of Health and Welfare was equivalent to 0.29 percent of GDP with 20.8 percent representing wage payments.

16.25 percent in 2029, i.e., the 2019 gap is cut by half. If the analytical finding that roughly half of the wage gap in Korea is due to factors other than discrimination (Lee 2020), then this shock corresponds to a full elimination of the discriminatory male-female wage gap (see Section 2.3).

In Section 2, the low wage level for child and elderly care workers was also identified as a policy concern (also, see Suh 2020). To address this concern, the scenario wcare+ simulates an exogenous increase in the wage of care workers. Specifically, for each labor category, we reduce by 50 percent the exogenous difference between the wage of care workers and the (endogenous) average wage for all labor in the economy. On average, this leads to a 19.2 percent increase in the wage of care workers compared to the base scenario.
In the base scenario, population projections by age group correspond to the medium fertility variant in the UN World Population Prospects 2019 (see Figure 2.2).[19] In the fert+ scenario, we increase the fertility rate to the upper 80 percent of the prediction interval (UN 2019). Figure 5.1 compares the population projections for the 0-9 and 15-64 age groups for fert+ and the base (and all other) scenarios. In 2030, the number of children aged 0-9 is 20.6 percent higher in the fert+ scenario than in the base scenario but the impact on the 15-64 age group is minimal. Besides, this scenario assumes that government spending per child aged 0-5 is kept constant at the base values; given this, a larger child population leads to higher government spending on childcare.

Figure 5.1. Population projections for children aged 0-9 in scenarios base and fert+ (millions)



Source: Author's elaboration based on UN (2019).

Finally, the combi scenario combines the shocks of all non-base scenarios, i.e., during the period 2022-2030, Korea simultaneously raises spending on child and elderly care,

[19] The medium fertility variant projection corresponds to the median of several distinct trajectories for the different demographic components (UN 2019). In turn, prediction intervals reflect the spread in the distribution of outcomes across the projected trajectories.

eliminates male-female wage discrimination, increases the relative wage of care workers, and raises the fertility rate, with fiscal space provided by higher income taxes.

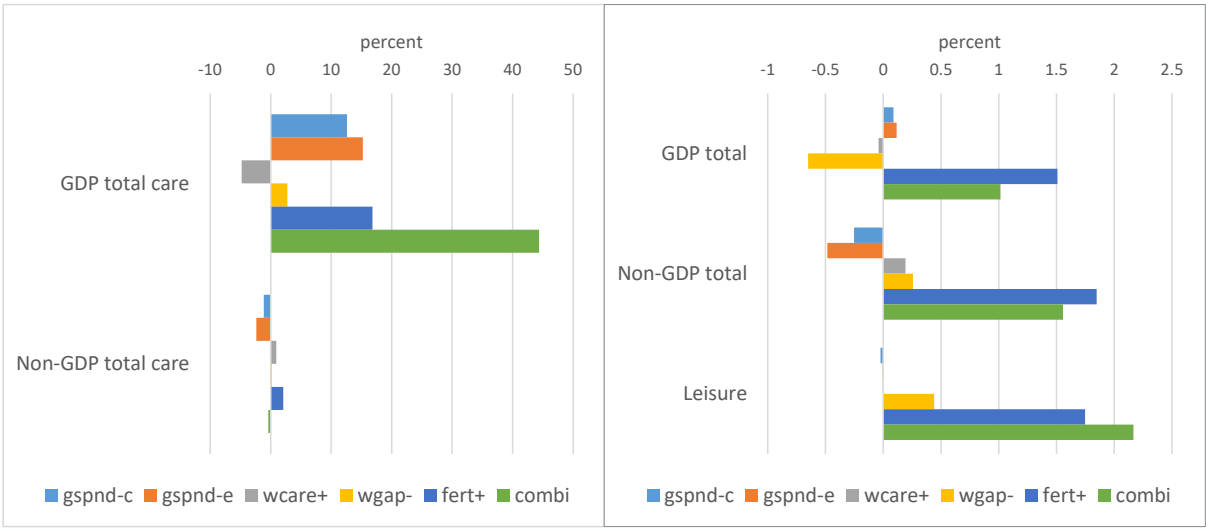
Figures 5.2-5.7 show selected simulation results. The result indicators focus on the last simulation year and cover time use shares and values (i.e., wage income or implicit value of time spend on household service production) disaggregated by gender and activity; household consumption disaggregated by item consumed; real value-added disaggregated by activity; and the government budget. Appendix B provides additional simulation results, both for base and non-base scenarios. (Table B.4 shows time use by gender expressed in daily hours, both for base and non-base scenarios in 2030. Out of 24 hours per day, 14.3 and 15.2 are covered for males and females, respectively, excluding 9.7 and 8.8 hours that are exogenous and used for other purposes.)

Turning to the results, for the first two simulations, gspnd-c and gspnd-e, Figures 5.2 and 5.3 show changes in time use shares for males and females. Qualitatively, the changes are very similar for both groups whereas quantitatively (as shares of the total time of each gender), the changes are much larger for women due to their more important role in child and elderly care work, both in the household and beyond. In fact, Table B.4 in Appendix B shows that, according to base-year data, women (men) only spend 0.89 (0.22) hours per day (i.e., 5.9 and 1.5 percent of their total discretionary time, respectively) on the sum of child and elderly non-GDP care. Qualitatively, both for men and women, time use switches from household to market work, especially care work. These times use changes are driven by demand switches in response to the increase in transfers from government to households in the form of child and elderly care services, both of which make it more attractive to reduce reliance on household-provided services. For women, this leads to increases in their total time in GDP work by 0.6 and 1.1 percent in scenarios gspnd-c and gspnd-e, respectively; in terms of market GDP care work, the increases are by 10.5 and 21.4 percent, respectively.[20] Interestingly, the difference in magnitude reflects the fact that, in the base data set, elderly care pays lower wages for all labor categories. Moreover, elderly care is relatively intensive in the use of unskilled labor which receives lower wages. Thus, for the same increase in government spending, the number of care workers that are hired is larger under the gspnd-e scenario than under the gspnd-c scenario. For men, the changes are roughly one tenth the size. Overall, labor demand increases as a result of the expansion of child and/or elderly care. In addition, given that care activities are relatively female labor-intensive, wages for women increase while wages for men decrease. One consequence of this is small reductions in leisure time, especially for women.[21]

[20] In Appendix B, Table B.4 shows that these changes are equivalent to 0.14 and 0.24 percentage points of the total female discretionary time.

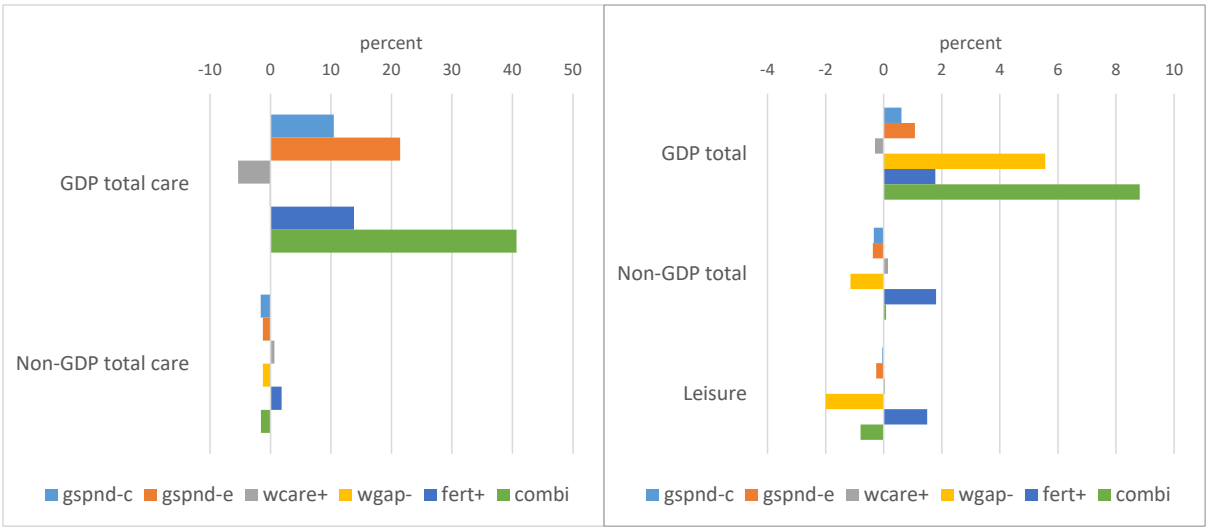
[21] These changes bring attention to the need to carefully consider the determinants of time spent on leisure, which are not only important in their own right but also influence the amount of time that is spent on other activities with impacts on the rest of the economy.

Figure 5.2. Time use – males in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

Figure 5.3. Time use – females in 2030 (percent change from base)

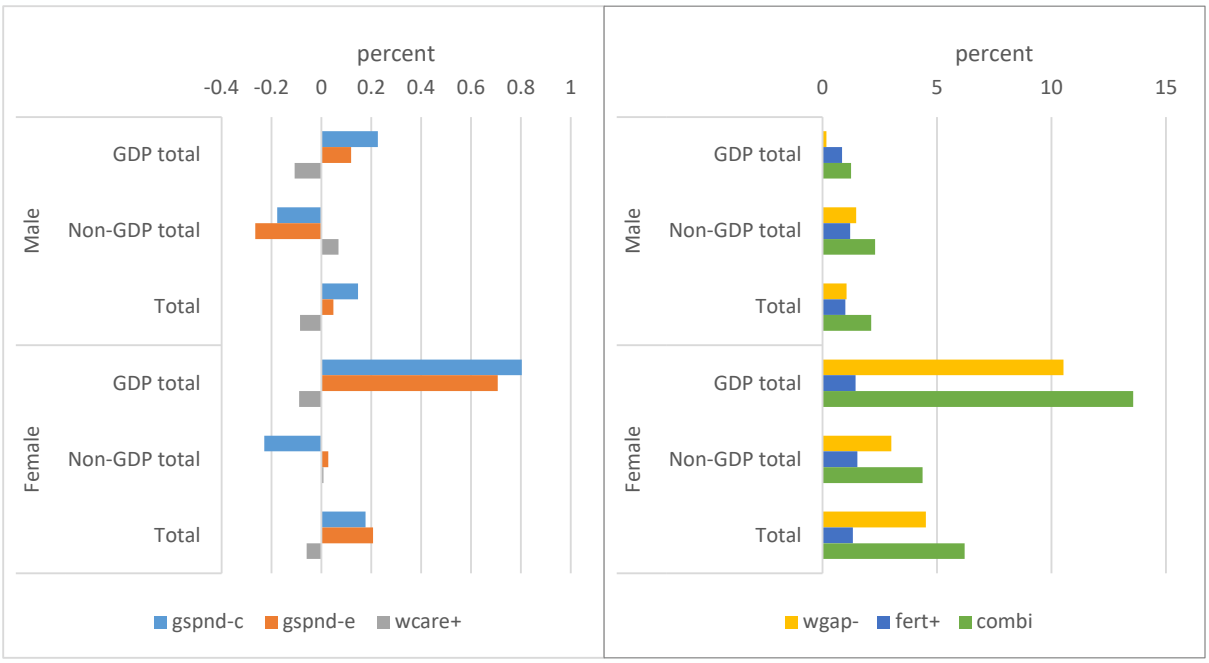


Source: GEM-Care Korea simulation results.

The changes in the valuation of time by gender, split into GDP and non-GDP (household services and leisure) are shown in Figure 5.4. (Table B.5 in Appendix B shows the same values in tabular form.) For GDP, this corresponds to paid labor income whereas, for non-GDP, it corresponds to changes in its valuation (which is based on implicit wages in the production of household services such as child and elderly care). Within each of the four

labor categories (i.e., two gender groups and two skill levels), the relative unit wages change in the same proportion across all activities as each labor category group is part of a unified time use (or labor) market (i.e., within each labor category, the relative wages across activities are fixed). However, to save space, we only present results disaggregated by gender. The pattern for income change is similar to the pattern for time use change. For the first two simulations, both male and female labor gain in GDP incomes, with the strongest gains for females. Again, this is explained by the fact that child and elderly care are relatively intensive in their use of high- and low-skilled female labor, respectively. For both gender groups, the total (sum of GDP and non-GDP) valuation also increases. For the sum of both men and women, the pattern is similar, simply a weighted average of the two.

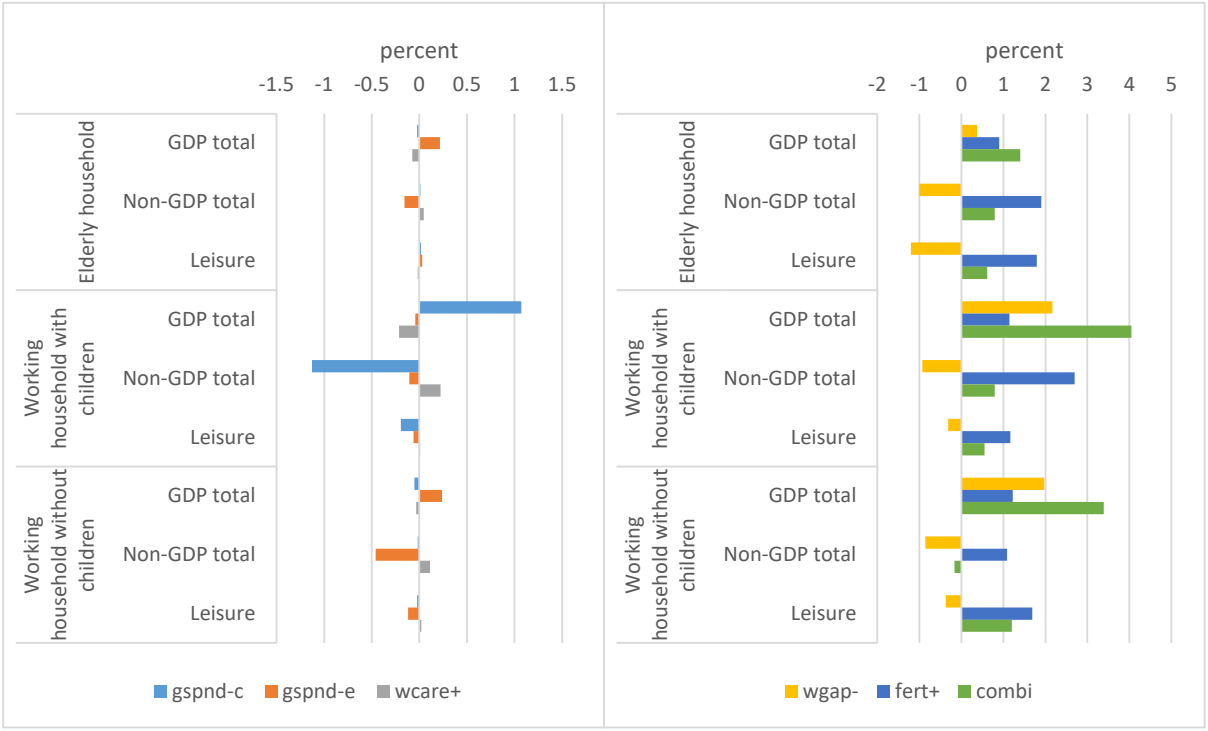
Figure 5.4. Time use valuation by gender in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

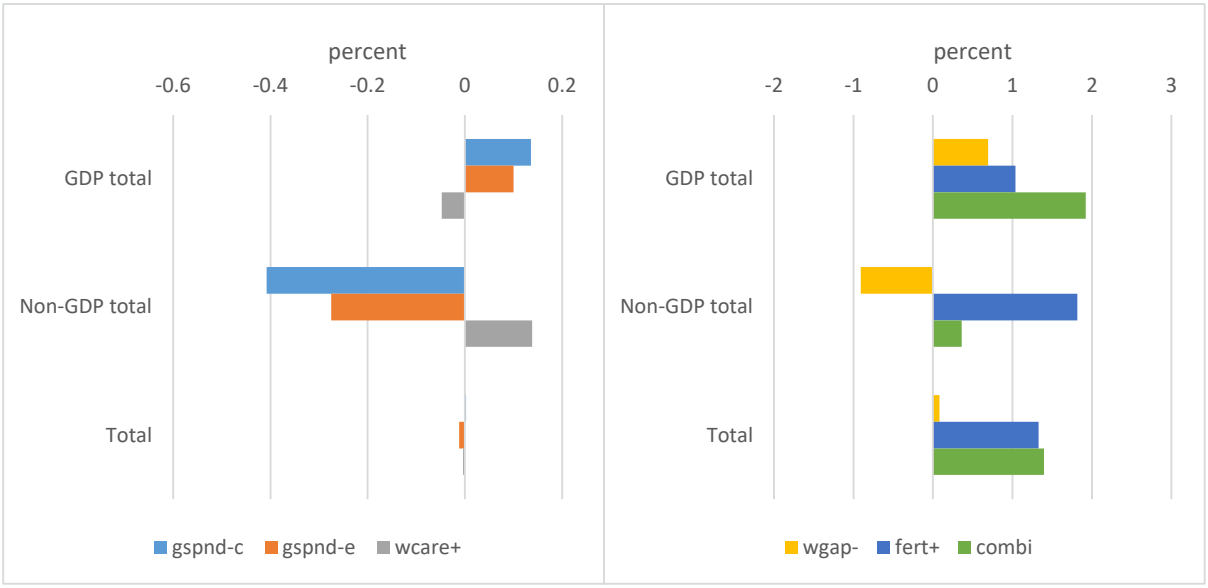
Figure 5.5 shows the changes in real household consumption, here split into GDP, non-GDP, and leisure. The increase in government spending on child and elderly care leads to increases in GDP and total consumption whereas the non-GDP part decreases as time use is switched away from the home. Naturally, not all households benefit from the increase in government spending on child and elderly care. For instance, only the working household with children benefits in the gspnd-c scenario. As shown in Figure 5.6, the changes in real value-added by aggregate sector matches the preceding patterns of change, with a switch from non-GDP to GDP production.

Figure 5.5. Household consumption including leisure in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

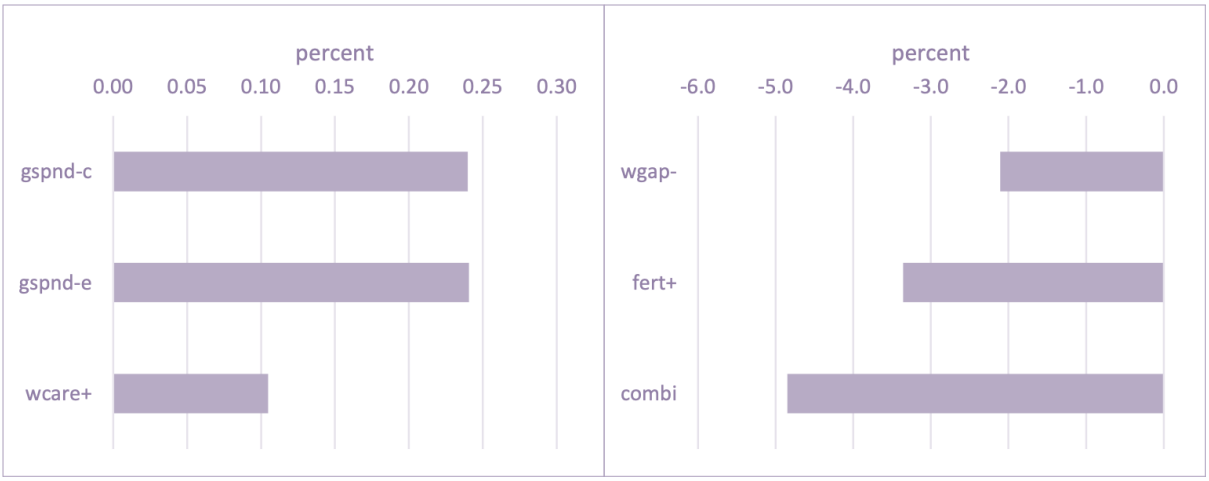
Figure 5.6. Real value-added aggregates in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

Finally, Figure 5.7 shows the change in the average income tax rate relative to the base. As expected, the first two scenarios (i.e., gspnd-c and gspnd-e) require a similar increase in income tax rates – the increase in government spending on care in-kind transfers is the same in both these scenarios. Specifically, the average income tax rate increases by 0.24 percent in both scenarios gspnd-c and gspnd-e.

Figure 5.7. Change from base average income tax rate (percent)



Source: GEM-Care Korea simulation results.

In the first two scenarios, the impacts on the men and women were qualitatively similar. On the other hand, they move in opposite directions when wage discrimination against women is eliminated relative to the base (scenario wgap-). Figure 5.2 shows that men decrease their time in market work by 0.65 percent and increase their time at home, where it is used for both leisure and the production of various household services. For women, the average wage increases by 4.9 percent in 2030, something that leads to an increase in their GDP time by 5.6% and reduction in their time in leisure and non-GDP production.[22] Most of the increase in women's employment occurs in non-care GDP sectors such as agriculture and professional services.

The patterns of change for time use values, household consumption, and real value-added follow naturally from the changes in time use. As indicated in Figure 5.4, female pay from GDP work increases and, thanks to a wage increase (a higher unit value across the economy), the value of female time in non-GDP activities also goes up, albeit to a lesser degree. Naturally, there is a gain for the total time value for women. For men, the changes in time use move in the opposite direction. The increase in female market wage incomes may increase their bargaining power and influence over household decisions.
The reallocation of time use in response to a mitigation of distortionary wage discrimination leads to an increase in total real household consumption in the context of smaller

[22] In Appendix C, Figure C.2 shows that, for the lowest elasticities tested, the increase in GDP time is merely 2.6 percent and, for the highest elasticities tested, it is 22.7 percent.

consumption inside the household and higher consumption out of GDP production (Figure 5.5) – i.e., a gain according to a standard economic measure of aggregate welfare. Specifically, private GDP and overall (GDP and non-GDP) consumption increase by 1.9 and 0.35 percent relative to the base, respectively. Similarly, real value added is reallocated from household services and leisure to GDP production (Figure 5.6).[23]

In the wcare+ scenario, we exogenously increase the wage of all four categories of (GDP) care workers. Consequently, there is an increase in the supply price of child and elderly care services. In Figures 5.2 and 5.3, this simulation shows qualitatively opposite results compared to the first two simulations: time use shifts from GDP activities to household child and elderly care. In other words, we see that increasing wages for private caregivers has the undesired but expected effect of decreasing labor supply to GDP sectors. Again, given their initial pattern of time use, the change is larger for women than for men. Figure 5.4 shows that GDP income increases for both for females and males while the valuation of non-GDP increases due to the increase in the supply/demand of unpaid care services. Figure 5.5 and 5.6 mimic these results in terms of household consumption and sectoral value-added, respectively.

In scenario fert+, we simulate an increase in the fertility rate that would increase the populations aged 0-9 and in labor force age by 20.6 and 1.7 percent, respectively. Naturally, the increase in the number of children aged 0-9 increases the need for the provision of GDP and non-GDP child care services. Accordingly, in 2030, the total time spent on child care has increased by about 4.3 percent for both GDP and non-GDP child care. Figures 5.2 and 5.3 show that both women and men increase their time devoted to child care activities. For instance, women increase their GDP and non-GDP child care time by 22.1 and 1.8 percent, respectively. Figure 5.5 shows that household consumption increases in all cases. However, the increase is smaller for GDP consumption of the working household with children since it has to devote additional household time to child care. The overall positive impact is explained by the increase in labor supply due to the increase in the population aged 15-64 (i.e., in the labor force age). In fact, this scenario shows a decrease in the income tax rates driven by the increase in GDP labor (and non-labor) incomes (see Figure 5.7).

[23] Interestingly, the reduced gender wage gap has a negative impact on investment growth. In our simulation, this is because less female wage discrimination reduces capital rents and the incomes of enterprises, which are the institutions with the highest savings rate. Consequently, the initial positive impact on GDP may decline over time as the decrease in investment (and capital stocks) has a negative impact on growth. Complementary policies that encourage savings by both household and enterprises could reduce or eliminate this effect. It should also be noted that it is difficult to predict how a change like reduced female wage discrimination would impact savings rates.

6. DISCUSSION

Table 5.2 summarizes the simulation results. Given the limited budgetary costs that are involved and the nature of the simulations, they should be viewed as complementary, i.e., nothing prevents the government from considering appropriate interventions along all fronts.[24]

In sum, an increase in the government spending on child care per capita has a positive impact (scenario gspnd-c) on female wage work and wage incomes while reducing time spent on non-wage work and, marginally, on leisure. The impact on male time use is qualitatively similar but smaller in magnitude. In terms of real household consumption (also influenced by higher taxes), those with children gain while the other two household groups lose. For the aggregate of all households, there is a net gain; given this redistributional policies (for example adjustments in direct taxation for different household categories) could be designed to make sure that all household groups gain.

In the next scenario, gspnd-e, the same increase in government spending as in the gspnd-c scenario but directed to elderly care is used to cover the cost of additional services to elderly households. In terms of direction of change, this intervention also frees up time for wage work, raising wage incomes for both males and females. Moreover, given that the elderly care sector primarily employs low skilled female labor, the time use effects of this intervention are particularly strong, at the aggregate level leading to increased female work accompanied by less female leisure. Among the households, the elderly household and working household without children gains. Interestingly, the two working households show a gain because their transfer of unpaid care labor to the elderly household is reduced. For the aggregate of all households, there is a net gain, i.e., in principle it would be possible to finetune the policy so that all household groups gain.

The scenario wgap- simulates reduced wage discrimination against women. In response to changed incentives, women spend more time in wage work and less time in work at home and, especially, in leisure, in the process raising their own wage income. As a consequence, the net effect on women's well-being is ambiguous. For men, the effects go in the opposite direction; the main effect is a switch from wage work to leisure. Thus, given that household GDP consumption increases, this suggests that the welfare of men improves. However, on the other hand, the share of monetary income controlled by men declines, something that may reduce their influence over the composition of the household consumption basket. Among the households, real consumption increases for both groups with working-age members whereas the elderly household loses. In the last case, female family care givers

[24] Note that in Table 5.1, when describing the non-base scenarios, we referred to base GDP shares when defining the non-base scenario. On the other hand, Table 5.2 reports government spending as a GDP share of the respective simulations, not the base. As a result, the GDP shares in Tables 5.1 and 5.2 are slightly different.

reduce their supply of non-GDP care services. In other words, the opportunity cost of providing non-GDP elderly care has gone up for the female members of the family.
In the scenario wcare+, we increased the wages of (GDP) care workers. Thus, contrary to the first two policies, this intervention encourages family members (especially women) to withdraw from wage work to provide for children and elderly family members, leading to lost opportunities to earn wage income. In terms of household well-being, the result is that household consumption increases for the working household without children. On the other hand, the other two household groups lose because of the increase in the cost of paid care labor.

In the scenario fert+, using alternative population projections elaborated by the UN, we simulated an increase in the fertility rate by 20.6 percent, from 1.08 to 1.31. Besides, also the population in the labor force age increases by 1.7 percent in 2030. Consequently, there is an overall gain with positive effects for all three households. As expected, the working household with children shows a decline in GDP consumption and an increase in non-GDP consumption.

Table 5.2. Selected results from simulations (absolute and percent changes from base case levels)

	base	qual-c		gspnd-e		wgap-		wcare+		fert+		combi	
	level*	Δ level**	level***	Δ level	% Δ level	Δ level	% Δ level	Δ level	% Δ level	Δ level	% Δ level	Δ level	% Δ level
Government spending on child and elderly care (trillion 2018 wons)	24.7	0.9	3.78	0.7	2.78	0.1	0.42	0.8	3.13	1.6	6.56	4.1	16.70
Government spending on child and elderly care (% GDP share)	1.0	0.0	3.59	0.0	2.71	0.0	0.53	0.0	2.77	0.1	5.52	0.1	15.03
Wage income (GDP work) (trillion 2018 wons)													
Male	880.4	2.0	0.23	1.1	0.12	-0.9	-0.11	1.5	0.18	7.5	0.85	10.9	1.24
Female	385.8	3.1	0.80	2.7	0.71	-0.3	-0.09	40.6	10.53	5.6	1.44	52.3	13.56
Time use (million hours)													
GDP work - Male	29,257.1	26.0	0.09	33.7	0.12	-11.6	-0.04	-190.1	-0.65	-44.5	-0.15	-186.5	-0.64
GDP work - Female	20,540.6	126.5	0.62	220.4	1.07	-60.8	-0.30	1,143.8	5.57	23.9	0.12	1,445.3	7.04
Non-GDP work - Male	6,647.0	-16.8	-0.25	-32.1	-0.48	12.8	0.19	17.0	0.26	12.0	0.18	-7.0	-0.11
Non-GDP work - Female	31,289.2	-107.1	-0.34	-117.0	-0.37	46.4	0.15	-357.4	-1.14	42.1	0.13	-486.6	-1.56
Leisure - Male	39,226.0	-9.1	-0.02	-1.6	0.00	-1.2	0.00	173.0	0.44	32.5	0.08	193.5	0.49
Leisure - Female	39,583.9	-19.4	-0.05	-103.4	-0.26	14.4	0.04	-786.4	-1.99	-66.0	-0.17	-958.7	-2.42
Consumption (trillion 2018 wons)													
Elderly household													
GDP	102.7	0.0	-0.02	0.2	0.22	-0.1	-0.07	0.4	0.37	0.9	0.90	1.4	1.40
Non-GDP	96.1	0.0	0.01	-0.1	-0.16	0.0	0.05	-1.0	-1.00	1.8	1.91	0.8	0.80
Total	494.5	0.0	0.01	0.1	0.02	-0.1	-0.02	-3.9	-0.79	8.2	1.65	4.3	0.86
Working household with children													
GDP	308.3	3.3	1.07	-0.1	-0.04	-0.7	-0.21	6.7	2.17	3.5	1.15	12.5	4.05
Non-GDP	178.0	-2.0	-1.13	-0.2	-0.10	0.4	0.22	-1.7	-0.93	4.8	2.69	1.4	0.80
Total	1,039.5	1.7	0.16	-0.7	-0.06	-0.5	-0.05	2.3	0.22	21.2	2.04	23.4	2.25
Working household without children													
GDP	840.3	-0.4	-0.05	2.0	0.24	-0.3	-0.03	16.6	1.97	10.3	1.22	28.5	3.39
Non-GDP	225.8	0.0	-0.02	-1.0	-0.46	0.3	0.11	-1.9	-0.86	2.5	1.09	-0.4	-0.16
Total	2,336.1	-0.8	-0.03	0.6	0.03	0.0	0.00	8.9	0.38	32.7	1.40	41.7	1.78

*Base, level for period 2030 (trillion 2018 wons or million hours).
**Change in level from base.

***Percent change in level from base.
Source: GEM-Care Korea simulation results.

6. CONCLUDING REMARKS

Korea is facing multiple challenges related to care and gender, including the need to meet the care needs of its rapidly growing elderly population, pave the way for stronger participation of the country's highly educated female population in the labor force, and eliminate the wage discrimination from which female workers suffer.
With the aim of better understanding some of these challenges, this paper draws on simulations with a model that, in multiple respects, is pioneering globally, it is the first care-focused CGE model; for Korea, it is also the first gendered CGE model; and, drawing on Becker (1971), it introduces a new approach to embedding gender-based wage discrimination in a CGE setting.

The simulations address the impact of expanded government spending on child and elderly care, reduced female wage discrimination, increased wages for care workers, and an increase in the fertility rate. However, given the limited budgetary costs that are involved and the nature of the simulations, they should be viewed as complementary, i.e., nothing prevents the government from pursuing interventions along all fronts. With regard to measures that may or may not be effective in reducing gendered wage discrimination, the experiences of other OECD countries may provide guidance (Rubery and Koukiadaki 2016). The results for the simulations suggest that the simulated policies improve the conditions of households with care responsibilities, most importantly by freeing up time for women to make use of their education in jobs that raise their wage incomes. However, the simulations also point to various trade-offs and suggest the need to consider packages of policies. For example, in the absence of increased government support for child and elderly care from outside the home, increased female wage work in the wake of reduced wage discrimination could lead to reduced care for children and elderly. While sensitivity analysis (see Appendix C) indicates that, in qualitative terms, the results presented in the paper are robust to wide variations in elasticities, it is important to note that the size of adjustments would depend on the flexibility of gender roles both in the household division of labor and in the broader labor market: To what extent would men take on a larger share of home-provided care if women spend more time in the labor market? To what extent would the growing numbers of women in the labor market take on jobs that so far primarily have been held by men instead of putting downward pressure on wages in segments of the labor market that currently are dominated by women? Like model parameters that capture wage discrimination, elasticities of substitution between the two genders in household and market work reflect broader social and economic conditions that, in order to change in favor of gender equality, would require parallel actions by government and civil society that change the attitudes and laws that govern gender roles.

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APPENDIX A: MODELING GENDER-BASED WAGE DISCRIMINATION

Introduction

Many CGE models have labor disaggregated by gender (along with other dimensions) with wage differences between men and women that otherwise belong to the same labor categories. By construction, the models assume that the wage differences are matched by identical differences in marginal productivity, i.e., that they are not due to discrimination but instead caused by lower marginal productivities that, in the market place, result in lower wages.

We here present the model of a profit-maximization firm with wage discrimination that is embedded in GEM-Care. The model improves on the prevalent CGE formulation by introducing a distinction between wage differences that are due to discrimination and those that are due to productivity differences. Discrimination (positive or negative) is manifested in that employers do not pay a category of workers their marginal value product (MVP), i.e. the product of the output price and the marginal product, the latter defined by the production function. Gaps like these, between the MVP and the wage, could also result from taxes or subsidies on wage payments specific to a subset of the worker categories; the difference is that payments due to taxes and subsidies are linked to the government budget, not recycled inside the firm, as is the case for our discrimination treatment when it is embedded in a CGE context.

Gender discrimination as here defined could result if an employer erroneously assumes that, because someone is male (female), the person is more (less) productive and therefore is paid more (less). The same formulation is general in the sense that it may be applied in settings where a person's work performance is mis assessed due to characteristics like ethnic group, religion, or some physical attribute. The model does not explain the reasons for wage discrimination. It only tries to better understand the consequences of such discrimination for indicators like wages, employment, profits, and incomes of different categories of households and workers. In a multi-sector setting, discrimination patterns could be sector-specific.

In this appendix, we first present a model of a profit-maximizing firm with discrimination using the above-described approach. After this, we propose a measure of gendered wage discrimination and show the results from some simulations.

Model of a profit-maximizing firm

The firm is assumed to maximize profits in a static setting. For simplicity, a Cobb-Douglas function is used. The basic optimization problem of the firm (without wage discrimination): maximize

$$\pi = p \cdot Q - (wk \cdot QK + wm \cdot QM + wf \cdot QF)$$

subject to

$$Q = a \cdot QK^{shk} \cdot QM^{shm} \cdot QF^{shf}$$

where π = profits; p = output price; Q = output quantity; wk, wm, wf = wages (rents) for capital, male labor, female labor; QK, QM, QF = hiring levels for capital, male labor, female labor; shk, shm, shf = value shares (output elasticities) for capital, male labor, female labor; and a = efficiency parameter

The notation uses upper case for variables and lower case for parameters. In this exposition, we use a Cobb-Douglas production function for algebraic simplicity; in GEM-Care, the production function is nested and based on CES functions. The firm optimization problem could also be expressed in general functional form.

The Lagrangian function for the above problem:

$$Z = p \cdot Q - (wk \cdot QK + wm \cdot QM + wf \cdot QF) + \lambda\left(a \cdot QK^{shk} \cdot QM^{shm} \cdot QF^{shf} - Q\right)$$

where λ = the shadow price of output.
The first-order conditions (FOCs):

$$\frac{dZ}{dQ} = p - \lambda = 0$$
$$\frac{dZ}{dQK} = -wk + \lambda \cdot a \cdot shk \cdot QK^{shk-1} \cdot QM^{shm} \cdot QF^{shf} = 0$$
$$\frac{dZ}{dQM} = -wm + \lambda \cdot a \cdot shm \cdot qk^{shk} \cdot QM^{shm-1} \cdot QF^{shf} = 0$$
$$\frac{dZ}{dQF} = -wf + \lambda \cdot a \cdot shf \cdot qk^{shk} \cdot QM^{shm} \cdot QF^{shf-1} = 0$$
$$\frac{dZ}{d\lambda} = a \cdot qk^{shk} \cdot QM^{shm} \cdot QF^{shf} - Q = 0$$

The equations of the firm model, which in GAMS is solved as a system of simultaneous equations, is derived from the FOCs but adjusted (a) to account for potential discrimination between males and females (positive and/or negative); and (b) to reflect the short-run nature of the problem, capital employment is fixed and the capital rent rendered flexible. The equations are expressed as follows:

(1) $p \cdot a \cdot shk \cdot qk^{shk-1} \cdot QM^{shm} \cdot QF^{shf} = WK$
(2) $p \cdot a \cdot shm \cdot qk^{shk} \cdot QM^{shm-1} \cdot QF^{shf}/(1 + dm) = wm$
(3) $p \cdot a \cdot shf \cdot qk^{shk} \cdot QM^{shm} \cdot QF^{shf-1}/(1 + df) = wf$
(4) $Q = a \cdot qk^{shk} \cdot QM^{shm} \cdot QF^{shf}$

The only new notation is the two discrimination factors, dm and df, which show the degrees of male and female wage discrimination, respectively; for both, values above zero indicate negative discrimination and below zero the opposite. In addition, compared to the above FOCs, p has been substituted for λ and the use of lower and upper cases for capital quantity and rent have been reversed to reflect the above-mentioned assumption change.

A measure of wage discrimination

Using this model formulation, it is possible to define pure wage discrimination, i.e. firm-level wage gaps not matched by worker characteristics that influence productivity (like differences in education and experience). As indicated by the above model, at profit maximum

$$\mathrm{mvpm}/(1+\mathrm{dm}) = \mathrm{wm};\ \text{and}$$
$$\mathrm{mvpf}/(1+\mathrm{df}) = \mathrm{wf};$$

where mvpm and mwpf are the male and female MVPs (the numerators of the left-hand sides of equations 2 and 3, i.e. the products of output price and marginal products)
Given this, the degree of wage discrimination against females may be defined as follows, for illustration assuming that df = 0.1, dm = -0.1, wm = 1.5, and wf = 1:

$$\mathrm{wdiscr} = \frac{\mathrm{mvpf}/\mathrm{wf}}{\mathrm{mvpm}/\mathrm{wm}} - 1 = \frac{1+\mathrm{df}}{1+\mathrm{dm}} - 1 = \frac{1.1}{0.9} - 1 = 0.22$$

The interpretation is that, relative to actual male and female MVPs, women are underpaid by 22%. This is here due to the combined effect of an underpayment to women and an overpayment to men but it could also stem from only one of these two sources. In effect, empirical data on wage discrimination would not be able to distinguish between the two sources of wage discrimination unless data on both wages and MVPs are available.

APPENDIX B: ADDITIONAL BASE-YEAR DATA AND SIMULATION RESULTS

Table B.1: Labor, value-added, trade, and consumption elasticities

Sector	Labor	VA	Armington	CET	LES-price	Cons-Source
Agriculture	0.90	0.25	2.00	2.00	-1.00	n.a.
Mining	0.90	0.20	2.00	2.00	-1.00	n.a.
Manufacturing	0.90	0.95	1.50	1.50	-1.00	n.a.
Electricity and gas	0.90	0.95	0.80	0.80	-1.00	n.a.
Water	0.90	0.95	0.80	0.80	-1.00	n.a.
Construction	0.90	0.95	0.80	0.80	-1.00	n.a.
Trade	0.90	0.95	0.80	0.80	-1.00	n.a.
Transport	0.90	0.95	0.80	0.80	-1.00	n.a.
Hotels and restaurants	0.90	0.95	0.80	0.80	-1.00	n.a.
Information and comm	0.90	0.95	0.80	0.80	-1.00	n.a.
Finance and insurance	0.90	0.95	0.80	0.80	-1.00	n.a.
Real estate	0.90	0.95	0.80	0.80	-1.00	n.a.
Prof, scientific and tech ser	0.90	0.95	0.80	0.80	-1.00	n.a.
Administ and support ser	0.90	0.95	0.80	0.80	-1.00	n.a.
Public administration	0.90	0.95	0.80	0.80	-1.00	n.a.
Education	0.90	0.95	0.80	0.80	-1.00	n.a.
Health	0.90	0.95	0.80	0.80	-1.00	n.a.
Other social care	0.90	n.a.	n.a.	n.a.	-0.85	n.a.
Other private services	0.90	n.a.	n.a.	n.a.	-0.85	n.a.
Priv subst for hhd non-care	0.90	n.a.	n.a.	n.a.	-0.85	n.a.
Priv care of elderly	0.90	n.a.	n.a.	n.a.	-0.85	n.a.
Priv care of children	0.90	n.a.	n.a.	n.a.	-0.85	n.a.
Child care, non-GDP	0.50	n.a.	n.a.	n.a.	n.a.	n.a.
Elderly care, non-GDP	0.50	n.a.	n.a.	n.a.	n.a.	n.a.
Non-care, non-GDP	0.50	n.a.	n.a.	n.a.	n.a.	n.a.
Composite, child care	n.a.	n.a.	n.a.	n.a.	-0.50	1.50
Composite, elderly care	n.a.	n.a.	n.a.	n.a.	-0.50	1.50
Composite, non-care	n.a.	n.a.	n.a.	n.a.	-0.50	1.50
Leisure, male	n.a.	n.a.	n.a.	n.a.	-0.85	n.a.
Leisure, female	n.a.	n.a.	n.a.	n.a.	-0.85	n.a.

Note:

VA = CES value-added function
Armington = CES aggregation function for domestic demand (elasticities of substitution between imports and domestic output);
CET = Constant Elasticity of Transformation function for domestic output (elasticities of transformation between exports and domestic supply)
LES-price = Linear Expenditure system (elasticities of household consumption with respect to own-price) for the household

Table B.2. Korea: sectoral structure and export and import intensities in 2018 (percent)

Sector	VAshr	PRDshr	EMPshr	EXPshr	EXP-OUTshr	IMPshr	IMP-DEMshr
Agriculture	1.91	1.49	1.74	0.09	1.12	1.81	16.58
Mining	0.12	0.11	0.09	0.02	3.05	19.82	97.06
Manufacturing	29.05	43.14	21.21	87.65	36.11	64.42	28.43
Electricity and gas	1.34	2.30	0.58	0.01	0.06	0.02	0.13
Water	0.75	0.56	0.67	0.06	1.99	0.00	0.10
Construction	5.92	6.05	9.23	0.02	0.07	0.00	0.00
Trade	7.82	6.39	9.78	0.48	1.34	0.43	1.28
Transport	3.35	3.66	4.08	4.45	21.60	2.94	16.24
Hotels and restaurants	2.86	3.69	4.67	1.33	6.39	2.49	12.02
Information and comm	4.57	3.51	3.45	1.22	6.19	1.05	5.52
Finance and insurance	5.91	4.23	4.60	0.56	2.34	0.41	1.83
Real estate	7.67	4.87	1.91	0.04	0.14	0.19	0.74
Prof, scientific and tech ser	6.23	5.18	8.35	2.12	7.28	3.01	10.62
Administ and support ser	3.55	2.17	3.99	1.65	13.56	2.17	18.04
Public administration	6.58	3.60	7.54	0.00	0.02	0.08	0.44
Education	4.09	2.39	6.65	0.02	0.18	0.29	2.22
Health	3.66	2.94	4.79	0.05	0.32	0.05	0.30
Other social care	0.75	0.50	1.37	0.00	0.07	0.01	0.24
Other private services	2.57	2.42	3.51	0.20	1.46	0.82	6.09
Priv subst for hhd non-care ser	0.13	0.05	0.25	0.00	0.00	0.00	0.00
Priv care of elderly	0.91	0.56	1.17	0.00	0.00	0.00	0.00
Priv care of children	0.26	0.16	0.37	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	17.77	100.00	18.10

Note:
VAshr = value-added share (%)

PRDshr = production share (%)
EMPshr = share in total employment (%)
EXPshr = sector share in total exports (%)
EXP-OUTshr = exports as share in sector output (%)
IMPshr = sector share in total imports (%)
IMP-DEMshr = imports as share of domestic demand (%)
Source: GEM-Care Korea database.

Table B.3. Korea: sectoral factor intensity in 2018 (percent)

Sector	Labor, male, high edu	Labor, female, high edu	Labor, male, low edu	Labor, female, low edu	Capital	Land	Extractive resources	Total
Agriculture	10.88	0.81	18.97	15.04	12.97	41.34	0.00	100.00
Mining	7.17	1.02	25.02	5.76	50.48	0.00	10.56	100.00
Manufacturing	17.41	2.65	15.16	4.85	59.93	0.00	0.00	100.00
Electricity and gas	18.29	2.06	3.30	0.70	75.65	0.00	0.00	100.00
Water	22.42	2.96	19.22	2.29	53.11	0.00	0.00	100.00
Construction	33.89	3.22	48.52	2.54	11.83	0.00	0.00	100.00
Trade	28.04	11.03	16.13	11.34	33.46	0.00	0.00	100.00
Transport	24.02	4.67	34.10	3.63	33.59	0.00	0.00	100.00
Hotels and restaurants	14.07	8.39	20.36	42.82	14.37	0.00	0.00	100.00
Information and comm	30.72	6.90	2.93	1.15	58.29	0.00	0.00	100.00
Finance and insurance	23.57	8.88	4.41	5.14	58.00	0.00	0.00	100.00
Real estate	4.30	1.19	4.40	1.95	88.16	0.00	0.00	100.00
Prof, scientific and tech ser	53.99	12.63	3.53	1.78	28.06	0.00	0.00	100.00
Administ and support ser	17.05	6.03	23.43	14.96	38.52	0.00	0.00	100.00
Public administration	34.83	12.24	12.43	3.84	36.65	0.00	0.00	100.00
Education	38.09	46.30	3.30	5.38	6.92	0.00	0.00	100.00
Health	20.84	35.90	2.04	10.10	31.12	0.00	0.00	100.00
Other social care	18.49	32.30	4.80	43.77	0.64	0.00	0.00	100.00
Other private services	25.20	13.80	18.32	14.08	28.60	0.00	0.00	100.00
Priv subst for hhd non-care ser	0.00	7.22	0.65	92.13	0.00	0.00	0.00	100.00
Priv care of elderly	5.55	59.14	0.25	6.07	29.00	0.00	0.00	100.00
Priv care of children	2.03	9.11	2.13	57.73	29.00	0.00	0.00	100.00
Total	0.00	16.05	0.00	83.95	0.00	0.00	0.00	100.00

Source: GEM-Care Korea database.

Table B.4. Base time use and changes from base by simulation in 2030 (hours/day)

	base	gspnd-c	gspnd-e	wcare+	wgap-	fert+	combi
Male time							
GDP total	5.569	0.005	0.006	-0.002	-0.036	-0.008	-0.036
GDP child care	0.009	0.002	0.000	0.000	0.000	0.002	0.003
GDP elderly care	0.003	0.000	0.002	0.000	0.000	0.000	0.002
GDP other	5.557	0.003	0.005	-0.002	-0.037	-0.010	-0.041
Non-GDP total	1.265	-0.003	-0.006	0.002	0.003	0.002	-0.001
Non-GDP child care	0.152	-0.003	0.000	0.001	0.001	0.001	-0.001
Non-GDP elderly care	0.113	0.000	-0.006	0.002	0.000	0.000	-0.004
Non-GDP other	1.000	0.000	0.000	0.000	0.003	0.001	0.004
Leisure	7.466	-0.002	0.000	0.000	0.033	0.006	0.037
Total	14.300	0.000	0.000	0.000	0.000	0.000	0.000
Female time							
GDP total	3.415	0.021	0.037	-0.010	0.190	0.004	0.240
GDP child care	0.120	0.021	0.000	-0.003	0.000	0.024	0.041
GDP elderly care	0.077	0.000	0.042	-0.007	0.000	-0.001	0.034
GDP other	3.219	0.000	-0.005	0.000	0.191	-0.019	0.165
Non-GDP total	5.203	-0.018	-0.019	0.008	-0.059	0.007	-0.081
Non-GDP child care	0.809	-0.017	-0.001	0.003	-0.010	0.001	-0.021
Non-GDP elderly care	0.222	0.000	-0.012	0.004	-0.003	0.001	-0.011
Non-GDP other	4.172	-0.001	-0.007	0.001	-0.046	0.005	-0.048
Leisure	6.582	-0.003	-0.017	0.002	-0.131	-0.011	-0.159
Total	15.200	0.000	0.000	0.000	0.000	0.000	0.000

Source: GEM-Care Korea simulation results.

Table B.5. Time use valuation by gender in 2030 (level for base and percent change from base for non-base)

	base*	gspnd-c	gspnd-e	wcare+	wgap-	fert+	combi
Male							
GDP total	880.4	0.23	0.12	-0.11	0.18	0.85	1.24
GDP child care	1.2	17.50	0.11	-0.01	4.02	22.00	45.77
GDP elderly care	0.3	0.14	55.55	1.60	3.53	0.31	62.21
GDP other	878.9	0.20	0.10	-0.11	0.17	0.82	1.16
Non-GDP total	102.7	-0.18	-0.26	0.07	1.47	1.20	2.30
Non-GDP child care	15.4	-1.87	0.02	0.30	1.47	1.39	1.43
Non-GDP elderly care	5.7	0.13	-5.49	1.59	1.15	1.42	-1.53
Non-GDP other	81.6	0.12	0.05	-0.08	1.50	1.15	2.73
Leisure	1,140.4	0.11	0.02	-0.08	1.67	1.09	2.80
Total	2,123.4	0.15	0.05	-0.09	1.04	1.00	2.13
Female							
GDP total	385.8	0.80	0.71	-0.09	10.53	1.44	13.56
GDP child care	13.4	17.52	0.12	-0.01	4.37	22.08	46.40
GDP elderly care	4.0	0.14	55.60	1.62	3.82	0.34	62.78
GDP other	368.3	0.20	0.13	-0.11	10.83	0.70	11.83
Non-GDP total	475.8	-0.23	0.03	0.01	3.01	1.52	4.37
Non-GDP child care	89.6	-1.82	0.10	0.28	3.13	1.67	3.49
Non-GDP elderly care	12.8	0.15	-5.05	1.48	2.63	1.65	0.54
Non-GDP other	373.5	0.14	0.19	-0.11	2.99	1.48	4.72
Leisure	701.5	0.11	0.05	-0.09	2.23	1.11	3.41
Total	1,563.1	0.18	0.21	-0.06	4.52	1.32	6.21

*Trillion wons at 2018 prices.
Source: GEM-Care Korea simulation results.

Table B.6. Household consumption including leisure in 2030 (level for base and per cent change from base for non-base)

	base*	gspnd-c	gspnd-e	wcare+	wgap-	fert+	combi
Elderly household							
GDP total	102.7	-0.02	0.22	-0.07	0.37	0.90	1.40
GDP child care	0.0	0.00	0.00	0.00	0.00	0.00	0.00
GDP elderly care	0.7	0.01	23.04	-8.55	0.02	1.44	14.90
GDP other	101.9	-0.02	0.05	-0.01	0.38	0.90	1.30
Non-GDP total	96.1	0.01	-0.16	0.05	-1.00	1.91	0.80
Non-GDP child care	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Non-GDP elderly care	8.0	0.00	-1.23	0.54	-1.15	1.88	0.06
Non-GDP other	88.1	0.01	-0.06	0.00	-0.98	1.91	0.86
Leisure	198.5	0.02	0.03	-0.02	-1.20	1.80	0.61
Total	494.5	0.01	0.02	-0.02	-0.79	1.65	0.86
Working household with children							
GDP total	308.3	1.07	-0.04	-0.21	2.17	1.15	4.05
GDP child care	29.7	13.2	0.0	-2.2	0.1	16.1	27.2
GDP elderly care	0.2	-0.05	47.90	-8.27	0.47	1.75	41.43
GDP other	278.3	-0.22	-0.08	0.01	2.38	-0.45	1.55
Non-GDP total	178.0	-1.13	-0.10	0.22	-0.93	2.69	0.80
Non-GDP child care	92.2	-2.0	-0.1	0.4	-1.0	1.8	-0.8
Non-GDP elderly care	2.5	-0.14	-1.71	0.44	-0.73	3.45	1.19
Non-GDP other	83.3	-0.14	-0.08	0.01	-0.86	3.62	2.51
Leisure	344.5	-0.19	-0.06	0.01	-0.31	1.17	0.55
Total	1,039.5	0.16	-0.06	-0.05	0.22	2.04	2.25
Working household without children							
GDP total	840.3	-0.05	0.24	-0.03	1.97	1.22	3.39
GDP child care	0.0	0.00	0.00	0.00	0.00	0.00	0.00
GDP elderly care	7.5	-0.01	41.48	-6.64	0.02	0.54	35.89
GDP other	832.8	-0.05	-0.13	0.03	1.99	1.23	3.10
Non-GDP total	225.8	-0.02	-0.46	0.11	-0.86	1.09	-0.16
Non-GDP child care	0.0	0.00	0.00	0.00	0.00	0.00	0.00
Non-GDP elderly care	5.5	-0.03	-13.12	3.75	-1.11	1.49	-9.76
Non-GDP other	220.4	-0.02	-0.15	0.02	-0.85	1.08	0.08
Leisure	1,036.3	-0.02	-0.12	0.02	-0.37	1.69	1.20
Total	2,336.1	-0.03	0.03	0.00	0.38	1.40	1.78

*Trillion wons at 2018 prices.
Source: GEM-Care Korea simulation results.