Volume LX No. 1

ISSN 1655-1516
June 2023

The Philippine Review of Economics

ARTICLES IN THIS ISSUE

A SYMPOSIUM ON THE CARE ECONOMY

A joint publication of the
University of the Philippines
School of Economics
and the **Philippine Economic Society**

The Philippine Review of Economics

A joint publication of the UP School of Economics (UPSE)
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Publication Information: The PRE (ISSN 1655-1516) is a peer-reviewed journal published every June and December of each year. A searchable database of published articles and their abstracts is available at the PRE website (http://pre.econ.upd.edu.ph).

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Acknowledgements: The PRE gratefully acknowledges the financial support towards its publication provided by the Philippine Center for Economic Development (PCED). The Review nonetheless follows an independent editorial policy. The articles published reflect solely the editorial judgement of the editors and the views of their respective authors.

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The Philippine Review of Economics

Vol. LX No. 1
June 2023

ISSN 1655-1516
DOI: 10.37907/ERP3202J

The Philippine Review of Economics
60(1):19-64. DOI:10.37907/3ERP3202J

Child and elderly care in South Korea: policy analysis with a gendered, care-focused computable general equilibrium model

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The Republic of Korea is characterized by rapid growth of its elderly population, a stagnant working-age population, the world's lowest total fertility rate, and the largest gender wage gap among the OECD countries. The heavy domestic and care work performed by women who receive little or no help from male household members constrains their labor force participation. The government strives to reduce the growing care burden of households, particularly among women, and raise female labor force participation rates as well as fertility rates. We examine the impact of various policy options to attain these objectives using a gendered computable general equilibrium (CGE) model for Korea. It is the first model in the literature using time use data with a focus on care services provided by the market and households. The simulations focus on the impact of policies that expand public care, provide subsidies to care provided by households or the private sector and reduce female wage discrimination. The results indicate that these policies improve the welfare of households with care responsibilities by freeing up time for women to take on jobs that pay better. Their broader economic impact, however, depends on the flexibility of gender roles in the division of labor both in households and in the broader economy.

JEL classification: J13, J14, J16, E16, C68
Keywords: economics of care, gender, social accounting matrix, computable general equilibrium model, Asia, Republic of Korea

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1. Introduction

The Republic of Korea (hereafter Korea) is facing important gender-related policy challenges with major repercussions throughout the economy: rapid growth of the elderly population combined with close to zero growth of the working-age population and low female labor force participation rates. The latter has been attributed to the fact that women provide most of the care in households and to gender inequalities in the labor market. Consequently, policies that support care provision for the young and frail elderly and that promote gender wage equality can enhance the well-being and incomes of households in general, and women in particular. Such policies are also important for broader economic development in the coming decades. Globally, gender equality is at the center of policy debates, pointing to the need for analytical tools that make it possible to think rigorously about gender dimensions of economic policy, including the medium- to long-run consequences and trade-offs of alternative policy options.

To meet this need, this paper presents the first care-focused model in the computable general equilibrium (CGE) literature; for Korea, it is also the first gendered CGE model. For its data, the model draws on an expanded social accounting matrix (SAM) that includes non-GDP household services, disaggregates households based on care needs, and singles out service sectors for child and elderly care. The simulations focus on the impact of policies that expand publicly funded child and elderly care services and reduce female wage discrimination. The results suggest that these policies improve the welfare of households with care responsibilities, but their broader economic impact depends on the flexibility of gender roles, both in the household and the broader economy.

2. Context

The challenges faced by Korea today—including an aging population, long hours of unpaid care work of women, gender disparities, and gender-based discrimination in labor markets—make it an excellent case for an assessment of the economy-wide impact of public policies in the areas of child and elderly care. In this section, we provide the context for the simulation analysis conducted in this study.

2.1. Childcare

Korea has a universal childcare program that covers all children up to seven years old. The main feature of the program is a subsidy allowance for childcare. In 2018, it amounted to a monthly average of KRW 300,000 per child—equivalent to USD 279. Behind this average is a system of benefits that differ depending on the age of the child and on whether care is provided at home or outside the home. Table 1 summarizes the benefits offered in 2018. As a share of GDP, government

spending on childcare support amounted to 0.90 percent, which is split into 0.64 percent in the form of vouchers for use of private or public sector provided care services outside the home, and 0.26 percent in the form of home-based childcare allowances.

TABLE 1. Korean 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 childcare provided by the public sector, which is preferred by most Korean families. This preference is due to the fact that, in government-run care services, the number of children per care worker is typically smaller and working conditions are better, e.g., higher pay and better job security.[1] However, public care was only available for 17 percent of all children in 2019 [Ministry of Health and Welfare 2020]. While the average out-of-pocket monthly care service expense per child was about KRW 200,000 (USD 177 equivalent) in 2017 (Lee [2018]; Yonhap [2018]), the expenses were higher for the 83 percent who were not in public care.

Apart from this main benefit, Korean families enjoy a set of other benefits including coverage of prenatal expenses up to KRW 500,000 (USD 442 equivalent), 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 is mainly provided by women [Korea Employment Insurance Service 2021].

Although the childcare program has expanded since 2004 and has made it less financially burdensome to access childcare, it has not reversed the decline in Korea's total fertility rate (TFR), which is the lowest in the world. This raises questions about the effectiveness of past policies aimed at increasing Korea's TFR.

[1] According to the Korean Ministry of Health and Welfare [2016], in 2015, average monthly public and private childcare staff wages were USD 2,100 and USD 1,630 equivalent, respectively.

2.2. Elderly care

The main government support for elderly care is the Long-Term Care Insurance (LTCI) system. It offers three types of benefits: home-based services, care facilities, and combinations of co-payments and vouchers. During the last decade, the program had expanded rapidly due to the significant increase in the number of elderly (defined here as those aged 65 and above) and in the share of the elderly that receives benefits under the LTCI (Table 2). The number of beneficiaries increased from 145,000 in 2008 (2.9 percent of five million elderly), to 394,000 in 2014 (6.2 percent of 6.3 million elderly) and 569,00 in 2017 (8.0 percent of 7.1 million elderly). In 2014, the cost amounted to 0.24 percent of GDP; by 2017, it had risen to 0.30 percent of GDP. In constant 2010 KRW, the benefits per beneficiary have remained roughly the same but the elderly population growth and an increased share of beneficiaries among the elderly have led to spending increases in excess of GDP growth.

TABLE 2. Korea: Long-Term Care Insurance (LTCI) costs and benefits

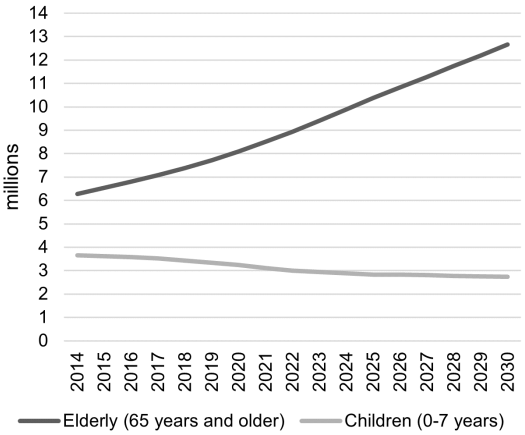
	2014	2017
LTCI cost (bn current won)	3,498	5,148
LTCI cost (% of GDP)	0.235	0.298
Elderly (65 years and older) (mn)	6.347	7.113
Share of elderly benefitting from LTCI	6.200	8.000
LTCI beneficiaries (mn)	0.394	0.569
Average benefit per elderly per month (current won)	47,016	53,625
Average benefit per 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

Source: Peng et al. [2021: 5, 15]; World Bank [2020]; UN [2019].

The LTCI system in Korea is publicly funded but privately delivered. In 2017, there were 20,377 private LTCI providers (5,304 institutions and 15,073 home-based care agencies) and 207 public ones (one 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 Korea's total employment). Private-sector care workers face relatively poor working conditions including long workdays and low wages; in 2019, their average monthly wage was the equivalent of USD 1,300, which is far below the national average wage of USD 3,000 [NHIS 2019].

The ongoing demographic transition poses different challenges for child and elderly care in the next several years. As shown in Figure 1, according to UN population projections for the period 2014-2030, the population of children will decrease while the elderly population will grow rapidly [UN 2019].

FIGURE 1. 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 elderly parents who are living with their children decreased from 38 percent in 2008 to 29 percent in 2016. At the same time, surveys showed that the share of the population who believes that family, government, and society should share the provision of parental support has increased to 45.5 percent, exceeding the population share that cites the family as the main provider, 30.8 percent [Jeon and Kwon 2017]. This indicates a decline in the perceived obligation of children to provide care for their parents in old age.

2.3. Gender wage gap

Persistent gender inequalities in the labor market, e.g., earnings differences, is another constraint to women's labor force participation. In 2019, men in Korea earned on average 32.5 percent more than women, the largest gap among OECD countries with data [OECD 2021]. Lower wages for women are related to the concentration of female employment in occupations and sectors where pay is relatively low, including education and care-related services (e.g., medical, and welfare-related service workers and domestic chores and infant rearing helpers) [Suh 2020]. However, even within sectors, women tend to earn lower wages than men, an outcome that is ascribed to a combination of differences in productivity (which, in turn, may be due to differences in skills, experience,

and education, all related to differences in work tasks) and wage discrimination (i.e., wage differences that are not associated with productivity differences) [Choi 2019]. While wage discrimination seems to be common, it is difficult to produce exact measures since it is hard to measure productivity and quality, especially in services.[2] A few studies provide some evidence. Using the Oaxaca [1973] decomposition method, 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 [2022] estimated that in 2017, unexplained factors accounted for 52.2 percent of the gender wage gap in Korea which, as noted, in 2019 amounted to around 32.5 percent.

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.[3] This section briefly surveys the major contributions, taking note of their structure, data needs, and policy coverage. It also situates GEM-Care (General Equilibrium Model for Care Analysis), the model developed for this analysis, in the context of this literature. Additionally, some caveats and unresolved challenges for gender-sensitive CGE modeling are noted.

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 considered part of GDP. The second group goes beyond GDP and extends the model to cover household service production for own consumption, whose labor inputs are also disaggregated by gender. The household services include what is referred to as unpaid care or social reproduction. The second group of models considers the time that is available to different household members more comprehensively, so that time use also includes leisure. The coverage of the databases (importantly, the SAMs) that accompany the models in the two groups reflects the extent to which they are limited to or go beyond the GDP sphere.

Two seminal works serve as pioneers in the integration of gender in CGE models: Arndt and Tarp [2000] for the first group of CGE models and Fontana and Wood [2000] for the second group. The Arndt and Tarp [2000] model introduced a gender-disaggregated labor force in the agricultural sector, making it possible to analyze the gendered impacts of exogenous shocks on labor incomes and employment by gender as well as standard economic indicators, e.g., final demands and value added, both aggregate and disaggregated by sector. Their analysis also

[2] For a survey of issues related to discrimination in labor markets, see Cahuc et al. [2014: 479-550].
[3] For a more detailed review of the literature, see Fontana [2014] and Fontana et al. [2020].

considers the role that risk aversion plays in generating an overallocation of female labor to one of the agricultural sectors (cassava). The database used in the Arndt-Tarp model included gender-disaggregated wages and employment in different agricultural activities.[4]

Fontana and Wood [2000] were the first to develop a gendered CGE model that used an extended SAM by introducing household production. This extension required additional data but has the important advantage of transcending the artificial boundary between time spent on GDP production and the large amount of time spent on production of household services for own consumption as well as on leisure. As a result, it became possible to consider the gendered aspects of changes in market work on time spent in leisure and household work, all of which contribute to household and individual well-being.

The terminology for and extent of disaggregation of household work are varied but reference is often made to this set of activities as social reproduction. These activities can be further disaggregated into sub-groups, including different types of care, cooking, cleaning, washing, and shopping. Both the initial contribution by Fontana and Wood and subsequent contributions have focused on trade-related policy simulations.[5] The application of such an approach to analyzing other policy issues, such as investment in care provisioning in this paper, can enrich macroeconomic modelling and yield new insights while imposing new data requirements.

This study builds on the existing literature on gendered CGE models to address emerging policy debates. East Asia in general and Korea in particular face important gender-related policy challenges in the context of stagnant and even declining growth of the working-age population, low rates of female labor force participation, rapid growth of the elderly population needing care, and persistent gender inequalities both in the household and market spheres. It develops an innovative methodology in integrating the care sector in a gendered CGE model. Using simulation analysis, GEM-Care examines the potential impact of various policy options on wages, household production, welfare, and inequality, including both gender-specific and more aggregate indicators.

Another broad and challenging area revolves around the impact of different types of consumption and investment on the accumulation of human capital, including its gender dimensions. The education analysis in Ruggeri-Laderchi et al. [2010] on Ethiopia touches on this aspect.[6]

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[4] Other models in the first group, with gender disaggregation within the GDP sphere, also include 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.

[5] 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, Ruggeri-Laderchi et al. [2010] on Ethiopia, and Filipski et al. [2011] on the Dominican Republic.

[6] 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.

4. GEM-Care model and database

This section provides an overview of the GEM-Care model and database. Annex A provides additional details of the model, while Lofgren and Cicowiez [2021] provide the mathematical statement of the model.

4.1. Model

The emerging literature of gendered CGE models offers an approach that enables the analysis of gender-related issues, such as unpaid care workload and female labor force participation, in the broader economic context, which is essential for understanding the macroeconomic and sectoral impacts of various policy options. In this paper, we develop GEM-Care to address questions related to care and gender policies using Korea as a case study.

GEM-Care is a gendered dynamic CGE model designed for country-level policy analysis with a focus on issues relevant to care. The starting point for the model specification is GEM-Core, a model developed by Cicowiez and Lofgren [2017] that, in turn, draws on Lofgren et al. [2013] and Lofgren et al. [2002]. Apart from the gender- and care-related aspects, it has features in common with other CGE models: it is a system of non-linear mathematical equations and provides an economywide multi-sectoral representation of the real economy with the bulk of the data derived from a base-year SAM. The equilibrium aspect of the model refers to the fact that, under each solution, agents are assumed to have reached "optimal" decisions, meaning that, subject to budget constraints, producers and consumers maximize profits and utility respectively, while government decisions follow a set of rules (for example, to tax on the basis of policy-determined rates and make sure that spending and receipts, including borrowing, are equal). Similarly, the economy is subject to a budget constraint in its dealings with the rest of the world (represented by the balance of payments). Prices play the key role in market allocations, making sure that, in the context of government policy interventions and international trade, the quantities supplied and demanded (including stock changes) are equal.

As is the case for most CGE models, the dynamics of GEM-Care is recursive: actors are assumed to be myopic, making decisions based on data for the current year, which are influenced by past decisions. It is appropriate for medium- to long-run analysis of shocks that have significant repercussions beyond the sector or household that are affected directly. These repercussions include indirect effects via feedback, which draw upon the model's ability to capture the links between different parts of the economy. For example, CGE models make visible the links between production sectors via intermediate demands, links between household incomes from production, as well as household demands with feedback on production.

GEM-Care draws on the existing literature on gendered CGE modeling but extends it in the area of care. Compared to a standard CGE model, GEM-Care is

distinguished by the following features. First, it has a nested production structure that disaggregates time use by gender and includes leisure and household services produced for own consumption (i.e., cooking, doing laundry, providing care, etc.), in addition to GDP production (which includes paid care activities).[7] Second, it includes a nested structure of household consumption that captures household choices between own production and market supplies to meet its demands for care and other services. Third, it allows for interhousehold transfers in the form of unpaid care labor as well as transfers from government to households in the form of care services. Finally, it extends to the producer first-order conditions for labor hiring to make it possible to analyze the consequences of wage discrimination (i.e., wage differences that are unrelated to marginal productivity differences).

4.2. Database

The disaggregation of GEM-Care as applied to Korea is presented in Table 3 and reflected in the database. The major components of the database are a SAM for 2018, physical data on gendered time use, population data, and a set of elasticities (related to production, trade, and household consumption).[8] For brevity, only data on gendered time use are highlighted in what follows.

TABLE 3. Disaggregation of GEM-Care Korea database (total number of categories in parenthesis)

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 services; administrative and support services; public administration; education; health; other social care; other services; 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

[7] 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 destined for the market or provided for free by the government or by 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 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].

[8] The process followed when building the 2018 SAM is similar to the one followed for constructing the 2014 Korean SAM. This is presented in detail in Lofgren et al. [2020].

TABLE 3. Disaggregation of GEM-Care Korea database (continued)

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.

The SAM is used to define the base values for most 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. Apart from the extensions that cover household (non-GDP) service production, the GEM-Care SAM retains most features of SAMs used with other CGE models.

The data sources used to build the 2018 Korea SAM were: (a) 2018 supply and use tables and integrated economic accounts from the Bank of Korea; (b) the Local Area Labor Force Survey and the Household Income and Expenditure

Survey from Statistics Korea (KOSTAT);[9] (c) the Korean Labor and Income Panel Study, (d) the Korean Longitudinal Survey of Women and Families, (e) the Annual Education Statistics, (f) the Annual Statistics on Child Care Centers, (g) the Farm Household Economy Survey and Household Income and Expenditure Survey;[10] and (h) the Korean Time Use Survey from KOSTAT.[11]

In the current model and its database, GDP care sectors are split by target group (child and elderly) and ownership (private and public). Three representative households are singled out based on their care needs: (a) households with children with head in working age; (b) households without children with head in working age; and (c) households with head above working age. Note that the three-representative households have elderly individuals, with two-thirds of them in the elderly-headed household [Lofgren et al. 2020: 23]. Thus, all three households "consume" GDP and non-GDP elderly care services.

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" only by the household with children aged zero to nine. 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 zero to nine and 65 or more, respectively.

The need for elasticity data depends on the functional forms used in the model. In GEM-Care, household consumption is modeled in two levels with a LES (Linear Expenditure System) at the top and CES (Constant Elasticity of Substitution) functions at the bottom. CES functions are also used to model producer choice between factor inputs and the choice between imports and domestic output in domestic demand. To meet the needs of these functions, we use price elasticities for the LES component and substitution elasticities for the CES component. For the allocation of output between exports and domestic sales, the model uses CET (Constant Elasticity of Transformation) functions, which require elasticities of transformation. 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.

[9] This is used for identifying and classifying labor in GDP activities into different categories.
[10] These datasets are used for identifying and classifying households into relevant categories.
[11] This is used for determining the time allocated to leisure and production of household services for own consumption.

The elasticities used in GEM-Care are shown in Annex B.1. To capture the observed rigidity in 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]; Choi [2019]). The price elasticities of demand are set as follows: -1.0 for GDP goods and services except care; -0.5 for care services, which is a composite of GDP and non-GDP care services; -0.5 for other (i.e., non-care) non-GDP services; and -0.85 for leisure. Given the absence of better data, we test the sensitivity of our results to the values assumed for these key elasticities and to the valuation of unpaid care labor.[12]

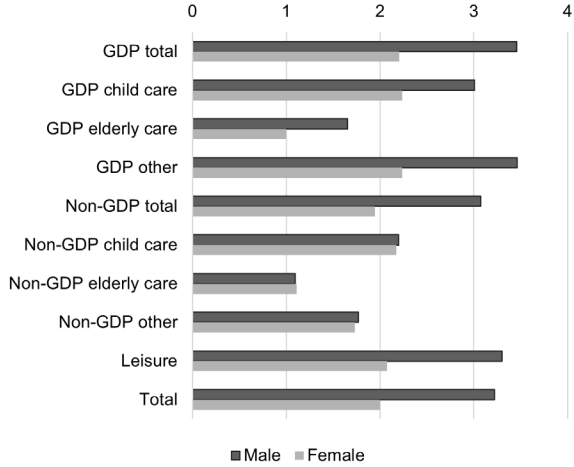
The time use data make it possible to define wages by gender and education level based on labor category and by activity. In an empirical database, payments, wages, and time use for GDP labor are generally observable even though the availability and quality of data can vary greatly across countries. It is, however, more difficult to define the wages and incomes related to non-GDP labor. For household service activities, the wage is defined as the marginal cost of the closest available market equivalent. For leisure, the wage (or price) is informed by the opportunity cost, (i.e., marginal income that is sacrificed since this time is not spent in the highest-wage alternative use). Hence, the valuation of time uses different approaches for estimating the 'wage' equivalent of time spent in different activity types. It should be noted, however, that the reasons for the allocation of time in different activities are not solely based on marginal returns.[13]

Figures 2 and 3 show relative wages and time use by gender. In Figure 2, 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 economy-wide wage gap in Korea. Besides, the SAM assumes that 50 percent of the wage gap is attributed to gender discrimination (see Section 2). Figure 3 shows that women have higher shares in household production (both care and other) and non-household care services than men indicating that the former spend more time in these activities. On the other hand, they have lower shares compared to men in non-care GDP production, while the share for leisure is about the same.

[12] Results of the sensitivity tests are provided in Annex C.

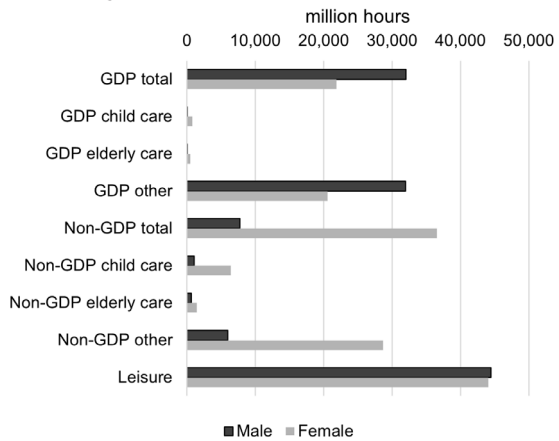
[13] For example, due to variations in the marginal utilities (or disutilities) of different types of time use (independent of what is viewed as being produced), spending time with a child may be very different from harsh physical work. Different time uses may also vary in terms of job security, status,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

FIGURE 2. Relative wages (female wage in GDP elderly care = 1)



Source: GEM-Care Korea database.

FIGURE 3. Base year: Time use for males and females (million hours)



Source: GEM-Care Korea database.

5. Simulation analysis

The simulations conducted in our study analyze 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. The latter is due to policy actions that would make it more attractive for women to work outside the home and easier for families to raise children.

5.1. Scenario definitions

In the analysis, we compare the results for a 2018-2030 base (or business-as-usual) scenario to scenarios in which different shocks are introduced. In all simulations, the model is calibrated to exactly replicate the detailed dataset for 2018. Moreover, for 2019-2021, it imposes what is known about the evolution of relevant government policies (particularly care policies) and growth in GDP at factor cost; the latter is exogenous for the base scenario but not for the other scenarios.[14] The exogenous GDP data are based on IMF [2020], including a projected annual growth rate of 2.6 percent for 2021-2030. The model also rests on several assumptions. First, the base scenario assumes that the 2021 policy regime will remain in place during the period 2022-2030. Moreover, it assumes (a) that the share of the elderly population that benefits from the LTCI is 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, due to the imposition of policy changes. The fiscal space needed to balance government spending and receipts is created via a scaling of the rates for income taxes paid by households and enterprises. The list of different simulations is given in Table 4.

TABLE 4. Scenario definitions

Name	Description
base	business as usual 2018-2030
gspnd-c	in each year 2022-2030, government spending on child care exceeds the base level by 0.15% of base GDP
gspnd-e	same increase in government spending as for spnd-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: Authors' elaboration.

As noted in Section 2, the government has put in place a program of universal childcare support. However, the level of satisfaction among service users is low and the working conditions of nursery teachers are poor [Kim 2017]. Compared to other OECD countries, the children-to-teacher ratio is much higher. For example,

[14] 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 other shocks are introduced, the GDP level (and other results) will deviate from the base.

for children aged three, 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 assumes that more spending is needed to raise the quality of childcare. Specifically, the increase in government spending would be sufficient to cover a doubling of wages of childcare employees as stated in the guidelines provided by the Ministry of Health and Welfare. More precisely, we simulate an increase in the in-kind transfers of childcare services by the government to households with children, at no cost to the household but costing the government around 0.15 percent of GDP.[15] Alternatively, in-kind benefits for childcare 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 in the form of in-kind government transfers of elderly care services to all households with elderly individuals provided at no cost. As a result, in-kind benefits for elderly care increase, compared to the base, 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 ten years earlier. However, the Korean wage gap remains to be 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 16.25 percent in 2029, cutting the 2019 gap by half. If it is the case that roughly half of the wage gap in Korea is due to factors other than discrimination, as shown by Lee [2022], then this policy-induced shock corresponds to the 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 [Suh 2020]. To address this concern, the scenario wcare+ simulates an exogenous increase in the wage of care workers. Specifically, for each occupation category, we reduce the exogenous difference between the wage of care workers and the (endogenous) average wage for all labor in the economy by 50 percent. On average, this leads to a 19.2 percent increase in the wage of care workers compared to the base scenario.

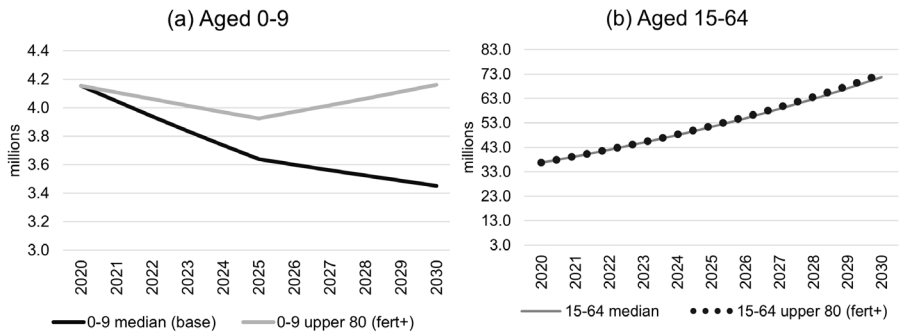
In the base scenario, population projections by age group correspond to the medium fertility variant in the UN World Population Prospects 2019 (see Figure 1).[16] In the fert+ scenario, we increase the fertility rate to the upper 80 percent of the prediction interval [UN 2019]. Figure 4 compares the population projections for the zero to nine and 15-64 age groups for fert+ and the base (and all other) scenarios. In 2030, the number of children aged zero to nine is 20.6 percent higher

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

[16] 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.

in the fert+ scenario than in the base scenario but the impact on the 15-64 age group is minimal. This scenario assumes that government spending per child aged zero to five is kept constant at the base values; a larger child population, as a result, leads to higher government spending on childcare.

FIGURE 4. Population projections for children aged zero to nine and aged 15-64 in scenarios base and fert+ (millions)



Source: Author's elaboration based on UN [2019].

Finally, we simulate a scenario that combines the shocks of all non-base scenarios. In other words, Korea simultaneously raises spending on child and elderly care, 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 during the period 2022-2030.

5.2. Scenario analysis

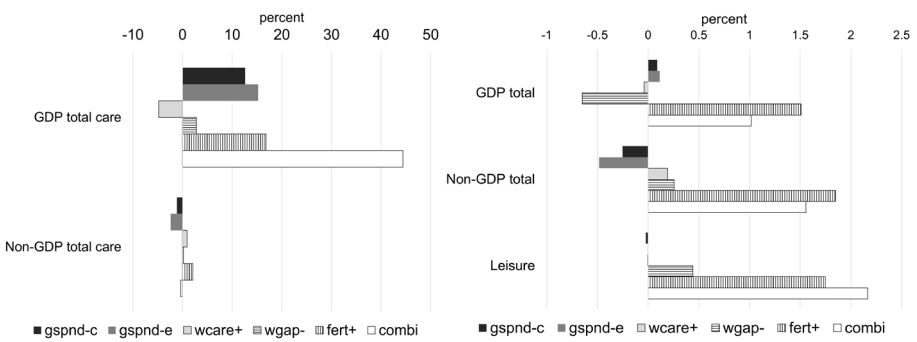
Figures 5-10 show selected simulation results. The result indicators focus on the last simulation year and cover the following indicators: time use shares and values (i.e., wage income or implicit value of time spent on household service production) that are disaggregated by gender and activity; household consumption disaggregated by item consumed; real value added disaggregated by activity; and the government budget. Annex B provides additional simulation results, both for base and non-base scenarios.

The results of the first two simulations, gspnd-c and gspnd-e, in terms of changes in time use shares for men and women are given in Figures 5 and 6. Although the direction of the changes in time use shares (i.e., the share in the total time of each gender) is similar for both groups, the changes are much larger for women since they spend considerably more time in child and elderly care work, both in the household and in the GDP (or paid) care sector. There is a reallocation of time spent from household work to GDP work, especially care work by both women and men. These changes in time use are driven by a switch in demand in response to the increase in transfers from government to households

in the form of paid child and elderly care services that makes the latter more attractive as substitute to household-provided care of children and elderly. For women, this leads to an increase in their time spent in GDP work by 0.6 and 1.1 percent in scenarios gspnd-c and gspnd-e, respectively. In terms of GDP care work, the increases are by 10.5 and 21.4 percent, respectively. 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 (low-wage) labor. For the same increase in government spending, the number of hired care workers is larger under the gspnd-e scenario than under the gspnd-c scenario, e.g., for men, the changes are roughly one-tenth the size. Overall, labor demand increases as a result of the expansion of paid child and/or elderly care services. In addition, wages for women increase since care activities are relatively intensive in female labor, while wages for men decrease. One consequence of the increase in paid work time is a small reduction in leisure time, especially for women.[17]

The changes in the valuation of time spent on GDP and non-GDP (household services and leisure) activities by gender are shown in Figure 7. This corresponds to paid labor income in the case of GDP and implicit wages in the production of household services such as child and elderly care for non-GDP. Given our study focus, we present the results disaggregated by gender. The pattern for labor 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 women (0.2 vs. 0.8 percent increase in the gspnd-c scenario, respectively). This is explained by the fact that child and elderly care are relatively intensive in female labor. For both gender groups, the total value (sum of GDP and non-GDP) also increases by 0.15 and 0.18 in gspnd-c scenario, respectively.

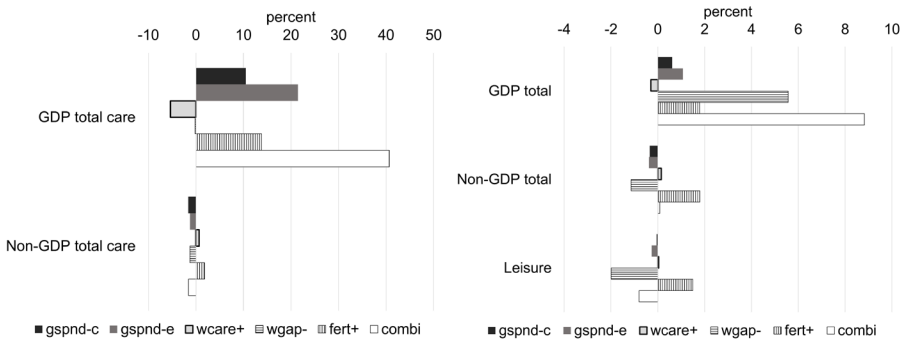
FIGURE 5. Time use – males in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

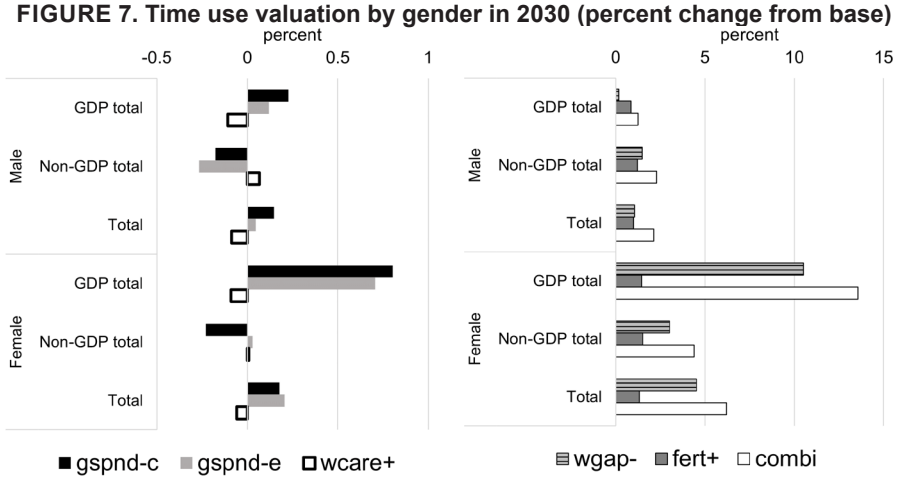
[17] These changes bring attention to the need to carefully consider the determinants of time spent on leisure, which are not only important in their own right but also influence the amount of time that is spent on other activities with impacts on the rest of the economy.

FIGURE 6. Time use – females in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

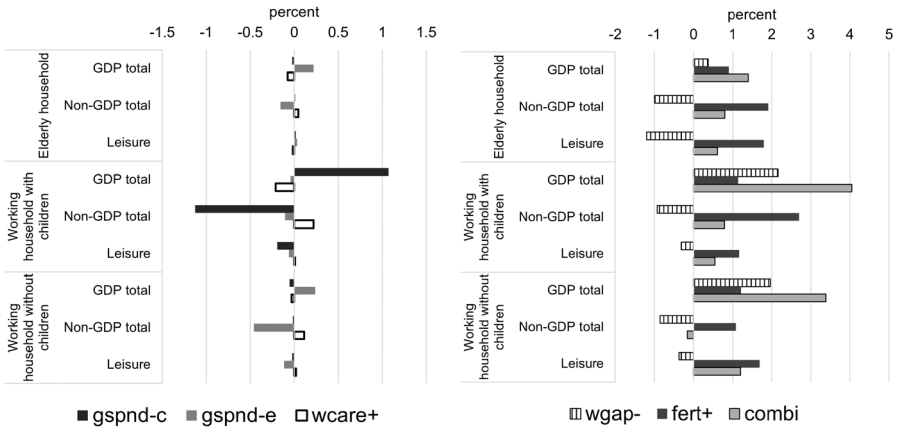
FIGURE 7. Time use valuation by gender in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

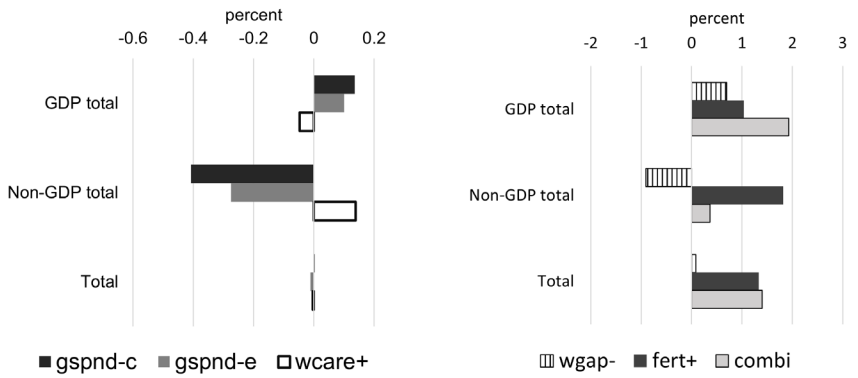
Figure 8 shows the changes in GDP, non-GDP, and leisure real household consumption. It should be noted that not all households benefit from the increase in government spending on child and elderly care. For instance, only the working household with children benefits in the gspnd-c scenario. Specifically, the increase in government spending on childcare leads to increases of 0.16 and 1.07 percent in total and GDP consumption, respectively. In turn, the non-GDP consumption decreases by 1.13 percent as time use is switched away from household service production. For the aggregate of all households, there is a net gain; given this, it may be possible to design redistributive policies such as adjustments in direct taxation for different household categories to ensure that all household groups gain. As shown in Figure 9, the changes in real value added by aggregate sector (0.13 percent increase for GDP and 0.41 decrease for non-GDP) match the preceding patterns of change, with a reallocation of labor time from non-GDP (household production and leisure) activities to GDP production activities.

FIGURE 8. Household consumption including leisure in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

FIGURE 9. Real value-added aggregates in 2030 (percent change from base)

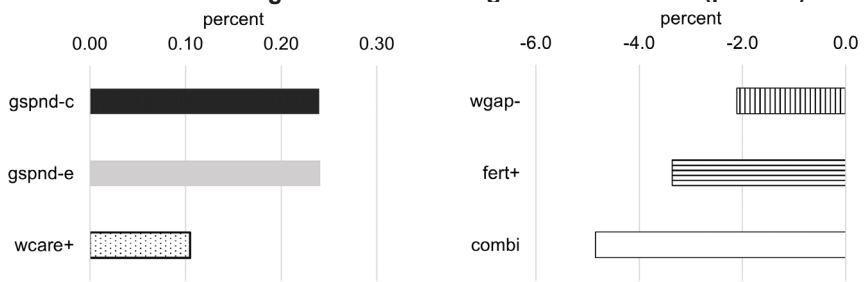


Source: GEM-Care Korea simulation results.

In the gspnd-e scenario, households with elderly persons and households without children gain in terms of their overall consumption. Interestingly, the two working households show a reduction in their transfer of unpaid care labor to the elderly household. Overall, there is a net gain in overall consumption for the household sector on the aggregate.

Finally, Figure 10 shows the change in the average income tax rate relative to the base. The gspnd-c and gspnd-e scenarios require a similar increase in income tax rates in the sense that the increase in government spending on in-kind care transfers is the same in both these scenarios. Specifically, the average income tax rate increases by 0.24 percent in both gspnd-c and gspnd-e scenarios.

FIGURE 10. Change from base average income tax rate (percent)



Source: GEM-Care Korea simulation results.

In the wcare+ scenario, we allow for an exogenous increase in the wage of all four categories of paid (GDP) care workers. Consequently, there is an increase in the supply price of child and elderly care of 7.2 and 11.2 percent, respectively. In Figures 5 and 6, this simulation shows opposite results compared to the first two simulations: time use shifts from GDP activities to household child and elderly care activities. In other words, an increase in wages for private caregivers has the expected effect of decreasing labor supply to GDP economic sectors. The change is larger for women than for men, 0.3 percent vs. 0.02 percent, respectively. Figure 7 shows that GDP income increases for both females and males by 0.09 and 0.11 percent, respectively, while the valuation of non-GDP increases by 0.01 and 0.07 percent, respectively, due to the increase in the supply and demand for unpaid care services. Figures 8 and 9 mimic these results in terms of household consumption and sectoral value-added, respectively.

In the first two scenarios described above, the impacts on the time use and labor incomes of men and women were qualitatively similar. However, as shown in Figure 5, compared to the base, elimination of wage discrimination (wgap- scenario) leads to time-use indicators moving in opposite directions for men and women: men decrease their time in GDP work by 0.65 percent and increase their time in non-GDP activities (leisure and production of household services); women increase their GDP time by 5.6 percent and decrease their time in non-GDP activities. Most of the increase in women's employment occurs in non-care GDP sectors such as agriculture and professional services.

The patterns of change in labor valuation (time use values), household consumption, and real value-added follow from the changes in time use. As indicated in Figure 7, female wages in GDP work increase by about 4.3 percent and, as a result, the value of female time in non-GDP activities also goes up, albeit to a lesser degree (by 3.0 percent). Hence, the total value of time for women increases by 4.5 percent. For men, the changes in time use move in the opposite direction. However, because men and women are complements in production, the total labor value of men still increases (by 1.0 percent). A possible consequence of these relative changes in female-male total labor values due to an increase in female market wage incomes is an increase in women's bargaining power and influence over household decisions.

As shown in Figure 8, the reallocation of time use in response to the elimination of wage discrimination leads to a net increase in total real household consumption by 0.2 percent. This gain in aggregate welfare results from an increase in consumption of GDP goods and services that offsets the slight decrease in consumption of household services. Specifically, relative to the base, private GDP and overall (GDP and non-GDP) consumption increase by 1.9 and 0.35 percent, respectively. Similarly, real value added is reallocated from household services and leisure to GDP production (Figure 9).[18] Among the households, real consumption increases for both groups with working-age members whereas the elderly household loses. In the last case, female family caregivers 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 fert+ scenario, we simulate an increase in the fertility rate that, by 2030, lead to increases by 20.6 percent in the population aged zero to nine and 1.7 percent in the labor force age population. The increase in the number of children aged zero to nine adds to the need for GDP and non-GDP childcare. Accordingly, in 2030, the total time spent on both GDP and non-GDP childcare increases by about 4.3 percent. Figures 5 and 6 show that both women and men increase their time devoted to childcare. For instance, women increase their GDP and non-GDP childcare time by 22.1 and 1.8 percent, respectively. Figure 8 shows that household consumption increases in all cases. However, for the working household with children, the increase in GDP consumption is smaller since it must devote additional labor time to childcare. 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 10).

6. Concluding remarks

Korea is facing multiple challenges related to care and gender, perhaps most importantly to meet the care needs of its rapidly growing elderly population, create the conditions that make it easier for its highly educated female population to participate in the labor force, and eliminate gender wage discrimination.

To better understand and address some of these challenges, this paper presents GEM-Care, a pioneering, care-focused, policy-oriented CGE model. It is also the first application of a gendered CGE model for Korea.

[18] 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.

GEM-Care is used to conduct simulations to examine the impact of several policy options on households with care responsibilities: (a) expanded government spending on child and elderly care, (b) reduced female wage discrimination, (c) increased wages for care workers, and (d) an increase in the fertility rate. Given the limited budgetary costs that are involved and the nature of the simulations, these options should be viewed as complementary, in the sense that there is nothing that prevents the government from pursuing interventions on all fronts. Regarding measures that can effectively reduce gendered wage discrimination, the experiences of other OECD countries may provide guidance [Rubery and Koukiadaki 2016].

The simulation results suggest that the policies analyzed in this paper can improve the conditions of households with care responsibilities, most importantly by freeing up time for women to take on jobs that are better paid and commensurate with their education and skills. However, the simulations also point to various trade-offs and suggest the need to consider complementary policy packages. For example, in the absence of increased government support for paid child and elderly care services outside the home, increased female wage work in the wake of reduced wage discrimination can lead to reduced care for children and elderly. While sensitivity analysis indicates that the results presented in the paper are robust to wide variations in elasticities, it is important to note that the size of adjustments depend on the flexibility of gender roles both in the household division of labor and in the broader labor market.[19] In other words, the size of the impacts of reforms that improve the incentives for women's work outside the home depend on the extent to which men take on a larger share of household chores and home-provided care. In addition, the results also depend on the extent to which women who enter the labor market are able to take on relatively high-wage jobs that currently are primarily held by men. If not, these women may end up putting downward pressure on wages in the relatively low-wage jobs that currently are dominated by women. Like the model parameters that capture wage discrimination, the elasticities of substitution between female and male labor in household and care work and market work reflect broader social and economic conditions. Ultimately, to effectively promote gender equality, the care and labor policies examined in this paper would require parallel actions by government and civil society that change the attitudes and laws that govern gender roles.

Acknowledgments: The authors would like to acknowledge the financial support of the William and Flora Hewlett Foundation through the Care Work and the Economy (CWE-GAM) Project, based at American University's Program on Gender Analysis in Economics (PGAE). The authors are thankful to Maria S. Floro and Elizabeth M. King for their comments on a previous version of this paper. The usual disclaimer applies.

[19] Sensitivity analysis results are available in Annex C.

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Annex A. Model structure

This annex provides additional detail on GEM-Care as applied to Korea.[20] Figure A.1 provides an overview of the structure of the payments covered by the static module of GEM-Care while Figures A.2 and A.3 show 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 3 in the main text.

The major building blocks in Figure A.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 payments are particularly important in applications that are extended to cover household services that are not part of GDP.

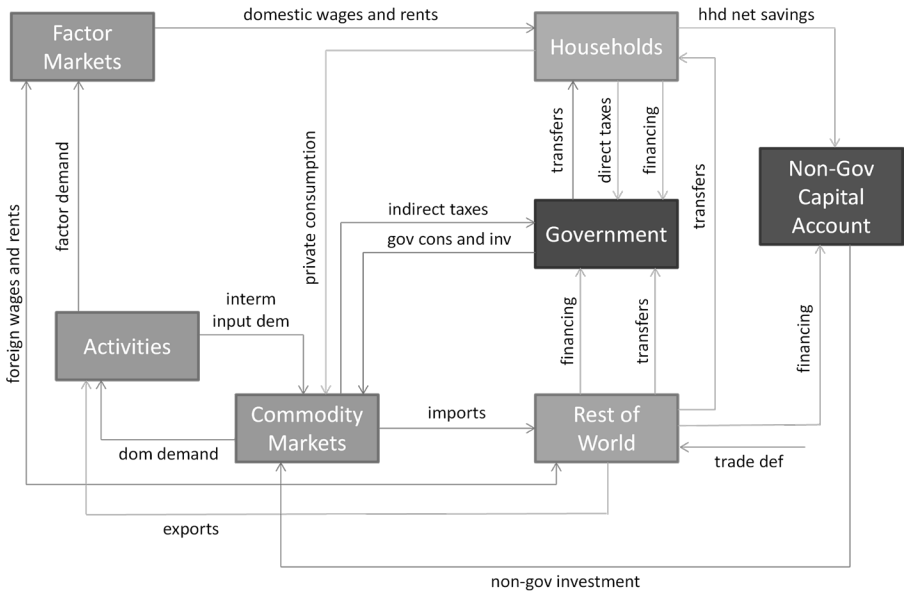
Most blocks in Figure A.1 are disaggregated, matching the disaggregation of the SAM that feeds data to the model. More specifically, given that this is an application to gendered care analysis, the factor, activity, and commodity blocks are disaggregated to capture gender and care aspects, and extended to cover both household and GDP production (cf. Table 3). 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 working age population, 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.

Turning to the different blocks in Figure A.1 and their links, the activities are split into household and GDP subsets, with the former also including leisure (cf. Table 4). 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 tend not 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; the split between the two depends on the relative sales prices in these

[20] For a more detailed model documentation, see Lofgren and Cicowiez [2021].

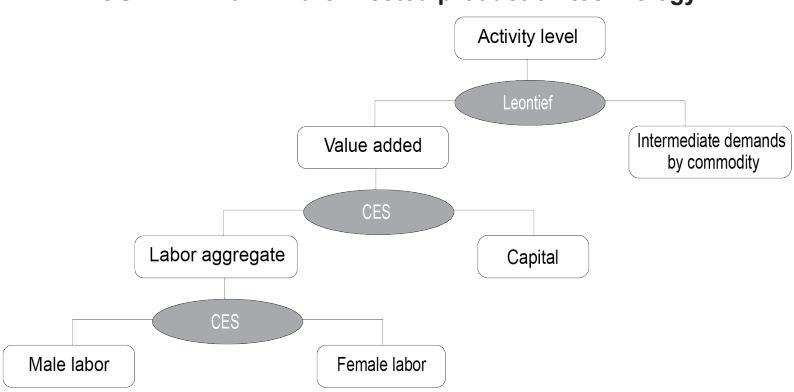
two destinations. The activities use their revenues to cover costs of intermediate inputs and to pay wages and rents to the factors that they employ.

FIGURE A.1. Overview of GEM-Care



Source: Authors' elaboration.

FIGURE A.2. GEM-Care: Nested production technology



Source: Authors' elaboration.

Figure A.2 shows the nested production technology, which applies to all activities (inside or outside GDP), which among other things is designed to make it possible to capture gendered time use. 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 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 use labor from both genders, the leisure activities, which are gender-specific, only use one labor type, i.e., for leisure activities, Figure A.2 in effect collapses to one input. In our case, the database not only disaggregates labor by gender but also by skill (see Table 3). 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 vary 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 agents 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).[21]

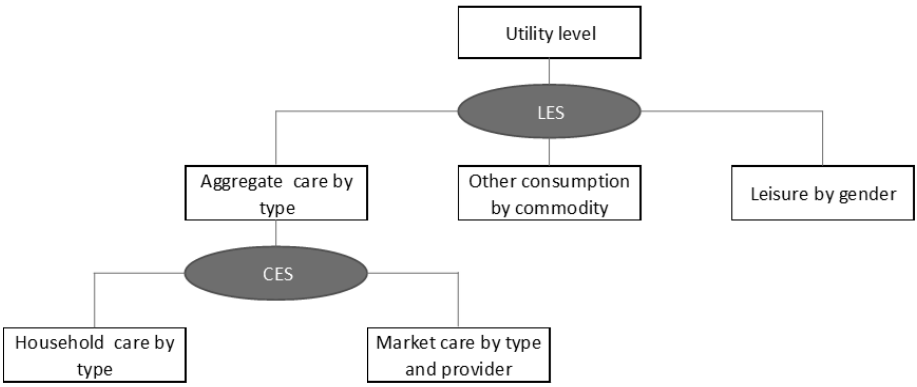
In GEM-Care, the treatment for wage discrimination against women is based on the canonical approach of Becker [1971]. Specifically, he proposed a model of "taste discrimination" according to which an aversion felt by employers, clients, or other workers toward persons belonging to certain groups may constitute a source of discrimination and leads 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. (Lofgren and Cicowiez [2023] presents the firm model that underpins the representation of discrimination in GEM-Care.)

Among the institutions, the household earns incomes from factors, (net) transfers from the government, and (net) transfers from the rest of the world.[22] After paying direct taxes on market incomes (facing policy-determined rates), 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 commodities that have both GDP and household supplies replaced by aggregates) is specified by Linear Expenditure System (LES) demand

[21] 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.
[22] In Figure A.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.

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.

FIGURE A.3. GEM-Care: Nested structure of household consumption



Source: Authors' elaboration.

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 A.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. To capture household choice between household and market supply sources, the household consumption structure was extended to have two levels (Figure A.3). At the top, it has an LES function that, in addition to commodities from the market includes aggregates of the services that have both household and market supplies; at the bottom, a CES function was added to split the demands for these aggregates into demands from these two supply sources, which depend on relative prices. On the supply side, 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.[23] 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

[23] The latter statement is not true if the household service uses intermediate inputs; if so, the labor income falls short of the sales revenue.

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.[24] 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 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 foreign direct investment [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 a balance between demands for domestic output from domestic demanders and supplies to the domestic market from domestic suppliers. Imports and exports are present for a commodity if the SAM (base-year) data has a positive value for these flows. Domestic demands are directed to domestic output and imports (if present); 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

[24] 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.)

(and vice versa).[25] Similarly, part of the domestic supplies are exported (if exports are observed in the SAM); 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.[26] 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 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 A.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

[25] The demander prices are affected by taxes, subsidies, and transport margins—the latter are not explicit in the current database.

[26] Both for imports and exports, the model offers the option of endogenizing prices (in foreign currency) using constant-elasticity demand and supply functions, respectively.

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.

Annex B. Additional base-year data and simulation results

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

Sector	Labor	VA	Arming-ton	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.

TABLE B.1. Labor, value-added, trade, and consumption elasticities (continued)

Sector	Labor	VA	Arming-ton	CET	LES-price	Cons-Source
Priv subst for hhd non-care ser	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
Cons-Source=consumption source; household can decide between consuming the same (care) service from different sources (private, government, own-production).

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

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

Sector	VAshr	PRDshr	EMPshr	EXPshr	EXP-OUTshr	IMPshr	IMP-DEMshr
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

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

Sector	Labor, male, high edu	Labor, female, high edu	Labor, male, low edu	Labor, female, low edu	Capital	Land	Extractive resources	Total
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. Time use 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	5.57	0.09	0.12	-0.04	-0.65	1.51	1.02
GDP child care	0.01	17.34	0.07	-3.03	2.95	22.81	41.92
GDP elderly care	0.00	0.00	55.51	-9.53	2.31	0.96	50.93
GDP total care	0.01	12.59	15.24	-4.81	2.77	16.83	44.39
GDP other	5.56	0.06	0.08	-0.03	-0.66	1.48	0.92
Non-GDP total	1.27	-0.25	-0.48	0.19	0.26	1.85	1.56
Non-GDP child care	0.15	-2.00	-0.02	0.38	0.37	2.06	0.93
Non-GDP elderly care	0.11	-0.01	-5.53	1.68	-0.08	2.07	-2.16
Non-GDP total care	0.26	-1.15	-2.37	0.94	0.18	2.06	-0.39
Non-GDP other	1.00	-0.02	0.02	0.00	0.28	1.79	2.07
Leisure	7.47	-0.02	0.00	0.00	0.44	1.75	2.17
Total	14.30	0.00	0.00	0.00	0.00	1.66	1.66
Female							
GDP total	3.42	0.62	1.07	-0.30	5.57	1.78	8.82

TABLE B.4. Time use by gender in 2030 (continued)

	base*	gspnd-c	gspnd-e	wcare+	wgap-	fert+	combi
GDP child care	0.12	17.19	-0.01	-2.90	-0.16	22.12	36.71
GDP elderly care	0.08	0.01	54.94	-9.19	-0.17	0.79	46.85
GDP total care	0.20	10.48	21.44	-5.36	-0.16	13.80	40.67
GDP other	3.22	0.01	-0.17	0.01	5.92	1.05	6.88
Non-GDP total	5.20	-0.34	-0.37	0.15	-1.14	1.80	0.08
Non-GDP child care	0.81	-2.05	-0.11	0.41	-1.21	1.82	-1.02
Non-GDP elderly care	0.22	-0.03	-5.37	1.61	-1.48	1.96	-3.55
Non-GDP total care	1.03	-1.61	-1.24	0.67	-1.27	1.85	-1.57
Non-GDP other	4.17	-0.03	-0.16	0.02	-1.11	1.79	0.49
Leisure	6.58	-0.05	-0.26	0.04	-1.99	1.49	-0.80
Total	15.20	0.00	0.00	0.00	0.00	1.66	1.66

*Hours per day.
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

TABLE B.5. Time use valuation by gender in 2030 (continued)

	base*	gspnd-c	gspnd-e	wcare+	wgap-	fert+	combi
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 KRW 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

TABLE B.6. Household consumption including leisure in 2030 (continued)

	base*	gspnd-c	gspnd-e	wcare+	wgap-	fert+	combi
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 KRW at 2018 prices.
Source: GEM-Care Korea simulation results.

Annex C. Sensitivity analysis

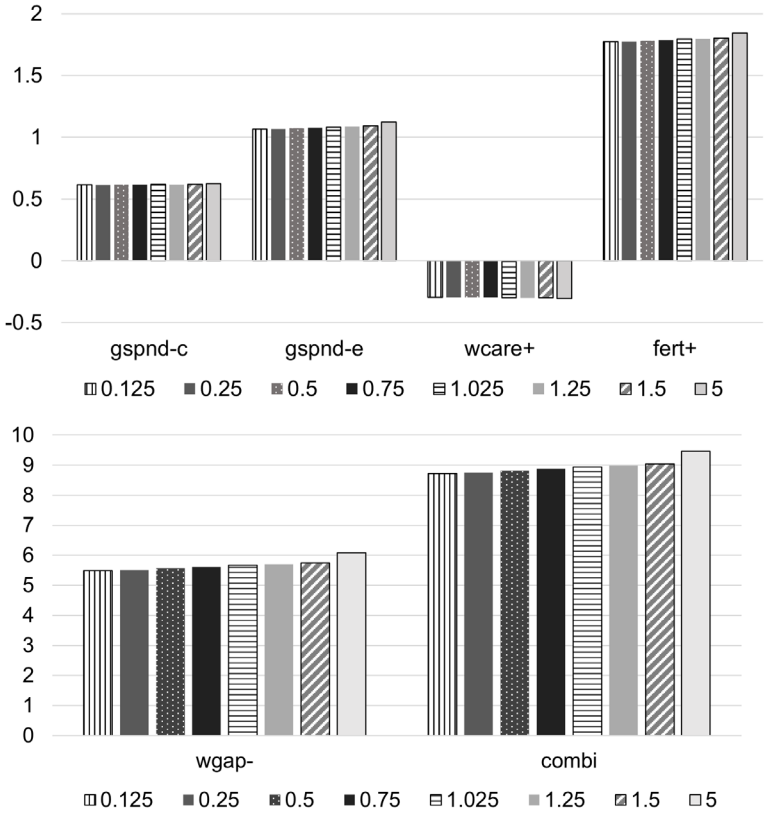
In economic simulation models, results depend on the values of the employed behavior and other parameters such as price and income elasticities. Therefore, it is often informative to analyze the sensitivity of results to selected parameter values. In this annex, we perform two sets of sensitivity analysis relative to our central case discussed in Section 5. Firstly, we test the sensitivity of our results to key elasticities. Secondly, we systematically test the sensitivity of our results to all elasticities simultaneously.

Piecemeal sensitivity analysis with respect to elasticities

In this section, we single out two key elasticities: (a) substitution between male labor and female labor in production functions, both GDP and non-GDP; and (b) substitution between GDP and non-GDP in consumption. The sensitivity analysis shows results when we change one elasticity while all other elasticities are kept unchanged. Figures C.1 and C.2 show the results and the key elasticities we consider in this Annex.

The gspnd-c and gspnd-e scenarios promote the consumption of GDP care services, which are intensive in the use of female labor. Thus, for these two scenarios, higher elasticities of substitution between men and women at home increases female labor supply to GDP activities (Figure C.1); as expected, this increase leads to reduced female wages. On the other hand, when we consider a higher elasticity of substitution between men and women not only in GDP but also in non-GDP activities, it diminishes the increase in female labor supply to GDP activities because of the smaller increase in female wages (Figure C.2).

FIGURE C.1. Sensitivity analysis with respect to elasticity of substitution between male and female workers in non-GDP production: Female GDP employment in 2030 (percent change from base)



Source: GEM-Care Korea simulation results.

FIGURE C.2. Sensitivity analysis with respect to elasticity of substitution between male and female workers in GDP and non-GDP production: Female GDP employment in 2030 (percent change from base)

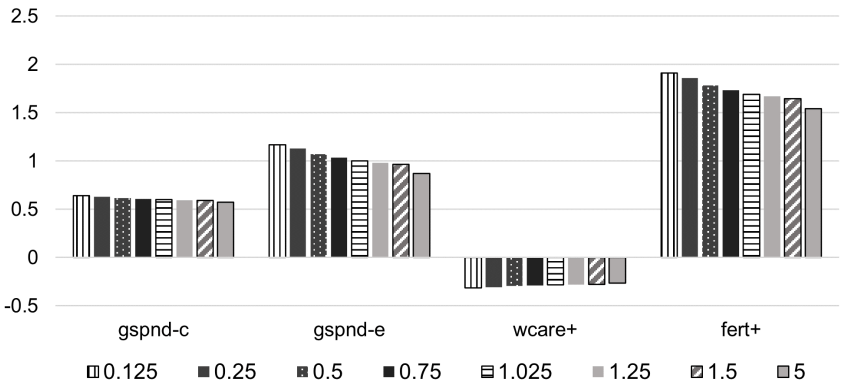
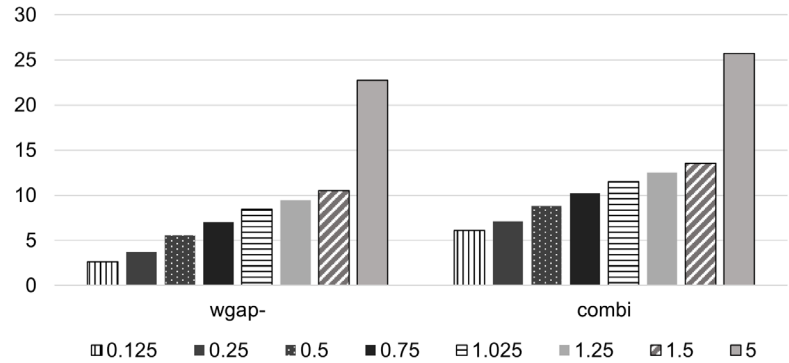


FIGURE C.2. Sensitivity analysis (continued)



Source: GEM-Care Korea simulation results.

In the wgap- scenario (i.e., reduced wage discrimination), our central case leads to an increase of 5.6 percent in female GDP work time (see Figure 6 in Section 5). Figure C.2 shows that, for the lowest elasticities tested, the increase is merely 2.6 percent and, for the highest elasticities tested, it is 22.7 percent.

Systematic sensitivity analysis with respect to elasticities

In this section, we analyze the sensitivity with regard to all model elasticities of simulated results for two major indicators: male and female GDP incomes, and time use changes (GDP, non-GDP, and leisure). To do so, we implement a variant of the method originally proposed by Harrison and Vinod [1992].

We assume that each model elasticity is uniformly distributed around the central value used to obtain the results presented in the main text. The range of variation allowed for each elasticity is +/- 75 percent; i.e., we consider a fairly wide range of variation for each model elasticity. The model is solved iteratively with different sets of elasticities. The resulting distribution of results is used to build confidence intervals for selected model results. The steps for the systematic sensitivity analysis are as follows:

1. The distribution (i.e., lower and upper bound) is computed for each model parameter that will be modified: elasticities of substitution between male and female labor both for GDP and non-GDP activities, elasticities of substitution between GDP and non-GDP care services, elasticities of substitution between primary factor of production, trade-related elasticities, and price elasticities for household demands.
2. The model is solved repeatedly, each time with a different set of elasticities following a Monte Carlo type procedure: First, the value for all model elasticities is randomly selected. Second, the model is calibrated using the selected elasticities. Third, the same counterfactual scenarios as previously described are conducted.

These three steps are repeated 1000 times, with sampling with replacement for the value assigned to the elasticities.

Table C.1 shows the percentage change in private consumption estimated (i) under the central elasticities, and (ii) as the average of the 1000 observations generated by the sensitivity analysis. For the second case, the upper and lower bounds under the normality assumption were also computed. All runs from the Monte Carlo experiment receive the same weight. As can be seen, the results reported in Figures 6 and 7 in the main text are within the confidence intervals reported in Table C.1 and Table C.2, respectively. For example, Table C.2 indicates that, if government spending on child care is expanded as in scenario gspnd-c, it is almost fully certain that the GDP income for female workers will increase between 0.33 and 1.39 percent. (In Table C.2, see the results for in the intersection between the row for Female, GDP Total, and the columns lower and upper bounds for gspnd-c.)

In other words, results given in Table C.1 and Table C.2 suggest that qualitatively, i.e., in terms of the direction of the changes for the key indicators that are shown, the results are robust to relatively large changes in the elasticities. However, as expected higher elasticity values lead to larger changes.

TABLE C.1. Systematic sensitivity analysis: 95 percent confidence interval under normality assumption for time use by gender in 2030 (percent change from base)

Male	gspnd-c				gspnd-e				wcare+			
	Mean	Std Dev	Lo bnd	Up bnd	Mean	Std Dev	Lo bnd	Up bnd	Mean	Std Dev	Lo bnd	Up bnd
GDP total	0.09	0.03	0.03	0.15	0.11	0.02	0.07	0.15	-0.04	0.01	-0.06	-0.01
GDP child care	17.98	5.11	7.96	28.00	0.08	0.06	-0.04	0.20	-2.88	1.00	-4.84	-0.92
GDP elderly care	0.01	0.05	-0.10	0.11	57.49	14.10	29.86	85.12	-9.19	2.62	-14.34	-4.05
GDP total care	12.99	3.59	5.96	20.02	15.83	3.64	8.69	22.96	-4.63	1.08	-6.75	-2.50
GDP other	0.06	0.02	0.01	0.11	0.08	0.02	0.04	0.12	-0.03	0.01	-0.05	-0.01
Non-GDP total	-0.23	0.09	-0.40	-0.05	-0.42	0.24	-0.90	0.05	0.19	0.09	0.02	0.36
Non-GDP child care	-1.82	0.89	-3.57	-0.06	-0.01	0.04	-0.10	0.07	0.38	0.26	-0.13	0.89
Non-GDP elderly care	-0.01	0.03	-0.06	0.04	-4.87	2.93	-10.62	0.87	1.70	0.97	-0.21	3.60
Non-GDP total care	-1.03	0.48	-1.97	-0.09	-2.07	1.24	-4.49	0.36	0.93	0.44	0.07	1.80
Non-GDP other	-0.02	0.03	-0.08	0.04	0.01	0.07	-0.12	0.14	0.00	0.01	-0.02	0.01
Leisure	-0.03	0.03	-0.08	0.02	-0.01	0.04	-0.09	0.07	0.00	0.01	-0.02	0.01
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Male	**wgap-**				**fert+**				**combi**			
GDP total	-0.65	0.24	-1.11	-0.18	1.52	0.27	0.98	2.06	1.03	0.39	0.26	1.80
GDP child care	3.13	1.18	0.82	5.43	22.24	2.62	17.11	27.38	42.51	8.24	26.37	58.65
GDP elderly care	2.36	0.65	1.07	3.64	0.99	0.41	0.19	1.79	53.26	15.92	22.05	84.46
GDP total care	2.91	0.87	1.20	4.62	16.37	1.82	12.81	19.93	45.32	7.45	30.73	59.92
GDP other	-0.65	0.24	-1.12	-0.19	1.49	0.27	0.95	2.03	0.94	0.39	0.17	1.70
Non-GDP total	0.28	0.31	-0.33	0.89	1.90	0.30	1.31	2.50	1.71	0.52	0.70	2.73
Non-GDP child care	0.44	0.60	-0.75	1.62	2.50	1.47	-0.39	5.39	1.57	1.75	-1.86	4.99
Non-GDP elderly care	-0.03	0.41	-0.82	0.77	2.09	0.30	1.49	2.68	-1.43	2.39	-6.11	3.26
Non-GDP total care	0.24	0.37	-0.49	0.96	2.30	0.87	0.60	4.00	0.29	1.40	-2.45	3.02
Non-GDP other	0.30	0.38	-0.44	1.04	1.81	0.34	1.15	2.46	2.09	0.55	1.01	3.18
Leisure	0.44	0.16	0.12	0.76	1.73	0.23	1.28	2.18	2.13	0.30	1.54	2.71
Total	0.00	0.00	0.00	0.00	1.66	0.00	1.66	1.66	1.66	0.00	1.66	1.66

TABLE C.1. Systematic sensitivity analysis (continued)

Female	gspnd-c				gspnd-e				wcare+			
	Mean	Std Dev	Lo bnd	Up bnd	Mean	Std Dev	Lo bnd	Up bnd	Mean	Std Dev	Lo bnd	Up bnd
GDP total	0.62	0.13	0.36	0.88	1.09	0.20	0.70	1.49	-0.29	0.07	-0.43	-0.14
GDP child care	17.81	5.00	8.02	27.60	-0.01	0.02	-0.04	0.02	-2.76	0.98	-4.67	-0.85
GDP elderly care	0.01	0.01	-0.02	0.03	56.81	13.76	29.84	83.77	-8.87	2.30	-13.39	-4.36
GDP total care	10.80	2.90	5.11	16.49	22.12	4.95	12.42	31.83	-5.16	1.12	-7.37	-2.96
GDP other	0.00	0.06	-0.12	0.11	-0.19	0.10	-0.40	0.01	0.01	0.01	-0.02	0.04
Non-GDP total	-0.32	0.09	-0.51	-0.14	-0.36	0.09	-0.53	-0.19	0.15	0.05	0.04	0.25
Non-GDP child care	-1.87	0.87	-3.57	-0.18	-0.12	0.05	-0.21	-0.02	0.40	0.26	-0.10	0.91
Non-GDP elderly care	-0.04	0.05	-0.15	0.06	-4.75	2.67	-9.99	0.49	1.63	0.90	-0.14	3.39
Non-GDP total care	-1.47	0.65	-2.74	-0.19	-1.11	0.55	-2.19	-0.02	0.66	0.28	0.11	1.22
Non-GDP other	-0.05	0.06	-0.16	0.07	-0.18	0.08	-0.34	-0.01	0.02	0.01	0.00	0.04
Leisure	-0.07	0.08	-0.22	0.08	-0.29	0.12	-0.53	-0.04	0.03	0.01	0.01	0.06
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Female	**wgap-**				**fert+**				**combi**			
GDP total	5.42	0.54	4.37	6.47	1.74	0.26	1.22	2.26	8.66	0.64	7.39	9.92
GDP child care	-0.10	0.32	-0.72	0.52	21.49	2.37	16.84	26.14	36.96	7.09	23.06	50.87
GDP elderly care	-0.18	0.27	-0.72	0.35	0.80	0.29	0.24	1.36	48.85	15.07	19.31	78.38
GDP total care	-0.13	0.22	-0.55	0.30	13.38	1.33	10.76	15.99	41.45	7.29	27.16	55.74
GDP other	5.76	0.57	4.64	6.88	1.03	0.28	0.48	1.58	6.65	0.61	5.45	7.86
Non-GDP total	-1.14	0.25	-1.62	-0.66	1.85	0.30	1.26	2.43	0.16	0.39	-0.61	0.92
Non-GDP child care	-1.19	0.39	-1.96	-0.43	2.23	1.41	-0.53	4.99	-0.49	1.60	-3.62	2.64
Non-GDP elderly care	-1.50	0.42	-2.32	-0.67	1.95	0.34	1.28	2.63	-2.97	2.11	-7.11	1.17
Non-GDP total care	-1.26	0.33	-1.91	-0.61	2.16	1.11	-0.02	4.33	-1.02	1.31	-3.59	1.54
Non-GDP other	-1.11	0.28	-1.66	-0.56	1.78	0.34	1.11	2.46	0.46	0.46	-0.45	1.37
Leisure	-1.92	0.30	-2.51	-1.34	1.48	0.26	0.97	1.99	-0.79	0.42	-1.61	0.04
Total	0.00	0.00	0.00	0.00	1.66	0.00	1.66	1.66	1.66	0.00	1.66	1.66

Source: Authors' calculations.

TABLE C.2. Systematic sensitivity analysis: 95 percent confidence interval under normality assumption for time use valuation by gender in 2030 (percent change from base)

Male	gspnd-c				gspnd-e				wcare+			
	Mean	Std Dev	Lo bnd	Up bnd	Mean	Std Dev	Lo bnd	Up bnd	Mean	Std Dev	Lo bnd	Up bnd
GDP total	0.26	0.12	0.02	0.50	0.12	0.03	0.06	0.18	-0.10	0.01	-0.12	-0.09
GDP child care	18.18	5.21	7.97	28.38	0.13	0.07	-0.01	0.27	0.15	1.05	-1.91	2.20
GDP elderly care	0.18	0.15	-0.11	0.47	57.57	14.14	29.85	85.29	2.08	3.26	-4.31	8.47
GDP total care	15.00	4.22	6.73	23.27	10.11	2.29	5.62	14.60	0.48	1.09	-1.66	2.62
GDP other	0.24	0.12	0.00	0.47	0.10	0.03	0.05	0.16	-0.11	0.01	-0.12	-0.09
Non-GDP total	-0.11	0.19	-0.49	0.26	-0.22	0.17	-0.56	0.12	0.07	0.07	-0.06	0.20
Non-GDP child care	-1.66	0.96	-3.54	0.23	0.04	0.05	-0.06	0.14	0.30	0.26	-0.22	0.82
Non-GDP elderly care	0.16	0.10	-0.03	0.34	-4.82	2.94	-10.58	0.94	1.61	0.97	-0.29	3.51
Non-GDP total care	-1.15	0.69	-2.51	0.21	-1.27	0.81	-2.86	0.31	0.65	0.33	0.00	1.30
Non-GDP other	0.15	0.09	-0.03	0.32	0.05	0.06	-0.07	0.17	-0.08	0.01	-0.10	-0.06
Leisure	0.14	0.08	-0.02	0.29	0.02	0.03	-0.04	0.08	-0.08	0.01	-0.10	-0.06
Total	0.18	0.10	-0.02	0.37	0.05	0.02	0.01	0.09	-0.08	0.01	-0.10	-0.07
Male	**wgap-**				**fert+**				**combi**			
GDP total	0.10	0.41	-0.70	0.90	0.83	0.17	0.49	1.17	1.17	0.52	0.14	2.19
GDP child care	4.11	1.14	1.88	6.34	21.42	2.54	16.43	26.40	46.28	8.26	30.08	62.47
GDP elderly care	3.50	0.65	2.23	4.76	0.31	0.35	-0.38	0.99	64.78	16.59	32.26	97.29
GDP total care	4.00	0.95	2.15	5.85	17.71	2.03	13.74	21.68	49.40	7.52	34.66	64.15
GDP other	0.09	0.41	-0.71	0.90	0.80	0.17	0.46	1.14	1.09	0.52	0.07	2.10
Non-GDP total	1.42	0.37	0.69	2.14	1.24	0.34	0.56	1.91	2.35	0.63	1.11	3.59
Non-GDP child care	1.46	0.66	0.16	2.76	1.80	1.46	-1.07	4.66	1.98	1.88	-1.70	5.66
Non-GDP elderly care	1.11	0.44	0.26	1.97	1.40	0.33	0.75	2.05	-0.88	2.42	-5.63	3.87
Non-GDP total care	1.36	0.50	0.39	2.34	1.67	1.08	-0.45	3.79	1.20	1.53	-1.79	4.20
Non-GDP other	1.43	0.42	0.60	2.26	1.13	0.35	0.44	1.82	2.66	0.63	1.42	3.89
Leisure	1.59	0.25	1.10	2.08	1.05	0.49	0.10	2.01	2.69	0.62	1.48	3.90
Total	0.96	0.25	0.47	1.46	0.97	0.27	0.44	1.50	2.04	0.45	1.16	2.93

TABLE C.2. Systematic sensitivity analysis (continued)

	gspnd-c				gspnd-e				wcare+			
Female	**Mean**	**Std Dev**	**Lo bnd**	**Up bnd**	**Mean**	**Std Dev**	**Lo bnd**	**Up bnd**	**Mean**	**Std Dev**	**Lo bnd**	**Up bnd**
GDP total	0.86	0.27	0.33	1.39	0.74	0.15	0.44	1.03	-0.08	0.05	-0.18	0.02
GDP child care	18.21	5.22	7.98	28.45	0.14	0.07	0.00	0.28	0.14	1.01	-1.83	2.11
GDP elderly care	0.19	0.15	-0.10	0.47	57.55	14.05	30.03	85.08	2.07	2.82	-3.45	7.59
GDP total care	13.99	3.93	6.30	21.69	13.40	2.98	7.55	19.25	0.59	1.06	-1.49	2.66
GDP other	0.24	0.12	0.00	0.47	0.13	0.03	0.07	0.19	-0.11	0.01	-0.12	-0.09
Non-GDP total	-0.15	0.24	-0.63	0.33	0.07	0.12	-0.17	0.31	0.01	0.06	-0.11	0.12
Non-GDP child care	-1.59	1.00	-3.55	0.38	0.12	0.07	-0.02	0.25	0.28	0.27	-0.24	0.81
Non-GDP elderly care	0.18	0.12	-0.04	0.41	-4.40	2.75	-9.80	1.00	1.50	0.90	-0.26	3.25
Non-GDP total care	-1.36	0.87	-3.07	0.35	-0.44	0.39	-1.20	0.32	0.43	0.27	-0.09	0.95
Non-GDP other	0.17	0.11	-0.04	0.38	0.20	0.08	0.06	0.35	-0.11	0.01	-0.13	-0.08
Leisure	0.12	0.07	-0.02	0.26	0.06	0.08	-0.09	0.21	-0.09	0.01	-0.11	-0.06
Total	0.22	0.15	-0.07	0.51	0.23	0.08	0.08	0.38	-0.06	0.02	-0.09	-0.03
Female	**wgap-**				**fert+**				**combi**			
GDP total	10.40	0.88	8.67	12.12	1.41	0.21	0.99	1.83	13.48	1.02	11.49	15.47
GDP child care	4.44	0.58	3.31	5.57	21.47	2.53	16.51	26.43	46.83	7.80	31.55	62.11
GDP elderly care	3.84	0.38	3.10	4.57	0.35	0.34	-0.32	1.02	65.37	16.50	33.03	97.70
GDP total care	4.30	0.48	3.36	5.24	16.55	1.87	12.87	20.22	51.01	7.26	36.77	65.25
GDP other	10.69	0.91	8.90	12.47	0.69	0.19	0.33	1.05	11.70	0.95	9.83	13.56
Non-GDP total	3.03	0.33	2.38	3.68	1.58	0.49	0.63	2.53	4.55	0.68	3.20	5.89
Non-GDP child care	3.16	0.45	2.28	4.04	2.09	1.51	-0.86	5.05	4.14	1.85	0.51	7.77
Non-GDP elderly care	2.64	0.42	1.82	3.45	1.65	0.38	0.91	2.39	1.23	2.27	-3.22	5.68
Non-GDP total care	3.09	0.40	2.30	3.88	2.03	1.33	-0.58	4.63	3.77	1.66	0.52	7.02
Non-GDP other	3.01	0.37	2.29	3.74	1.48	0.49	0.51	2.44	4.77	0.67	3.45	6.09
Leisure	2.29	0.46	1.39	3.19	1.10	0.67	-0.21	2.41	3.47	0.86	1.78	5.16
Total	4.52	0.42	3.70	5.34	1.32	0.39	0.56	2.08	6.27	0.64	5.01	7.52

Source: Authors' calculations.