The Provision of Elderly Care and the Macroeconomy

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Abstract

Population aging in developed and developing economies is leading to an increase in the number of people in need of care, which poses a challenge to the social arrangements of care and has important aggregate economic implications. This paper proposes a theoretical framework to evaluate the economic effects of increasing elderly care needs and the different policies associated to them, including the prevalence of unpaid care work. We model the demand of care as being complementary to elders' consumption. We argue that this complementarity increases over time, as retired households become older, making the demand for care more inelastic. We analyze how increasing care needs affect key economic aggregates, such as savings, labor market participation and the gendered provision of paid and unpaid care. Finally, we use the model to study the effects of the secular increase in women's labor supply that took place between the 60s and the 90s on the provision of care, and evaluate alternative social arrangements, e.g. market-based vs publicly provided care, that so far have only partially replaced the unpaid care traditionally provided by women.

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1 Introduction

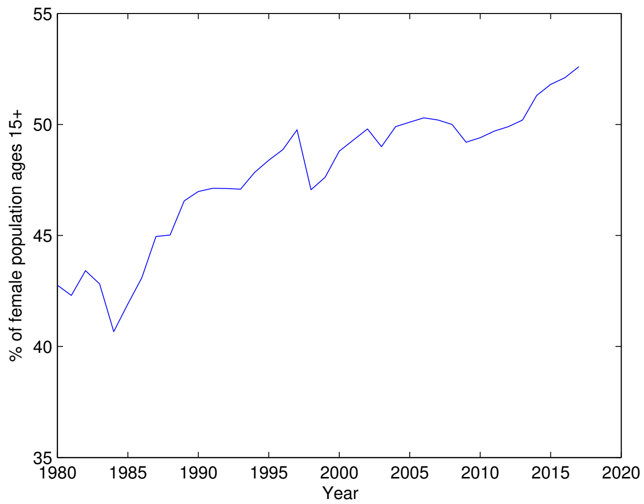
A first order challenge for contemporary societies is to find ways to deal with a growing number of the population in need of care. The dramatic increase in life expectancy in most developed and developing countries over the last few decades has led to renewed discussions around elderly care policy options, and the debates are expected to intensify as the ratio of elderly to working-age adults continues to rise. According to United Nations, the share of people aged 60 years or over is growing faster than all younger age groups. In fact, older segments of the world population are expected to double by 2050 and to more than triple by 2100.

At the same time, the decline in fertility and the increase in female labor participation rates have led to additional concerns about the adequate provision of elderly care. As of 2015, 46% of the world's population lives in countries with below replacement level (or 2.1 births per woman on average) fertility rate, while another 46% lives in intermediate fertility (between 2.1 and 5 births per woman on average) countries. Moreover, the increase in women's labor supply during the last decades has put additional pressure on traditional care arrangements.

In addition to these demographic shifts and labor market trends, contemporary societies are also characterized by two distributional patterns. The first has to do with growing wealth inequality. The gap between rich and poor households has increased in almost every region of the world over the last four decades, giving rise to heightened pressure for innovative policies that deal with the different causes and effects of this phenomenon. Second, gender inequality continues to manifest itself in many different spheres, including within households. Despite recent progress in addressing gender gaps, more needs to be done for governments to attain gender equality and empowering women. Salient to these efforts is the task of reducing the unpaid care burden of women while ensuring equitable access to quality care. Yet, the use of gender lens in general equilibrium macromodels on eldercare is scant.

Our paper has three objectives. First, we propose a new way of modelling the demand for eldercare, which is particularly suitable for life-cycle models. We model elderly care as enabling services that shift up the elderly's derivation of utility from regular consumption goods, instead of treating care services as another consumption good. While the concept is similar to the health-state dependent utility used in some recent literature, our model allows for the marginal utility of consumption to decrease with age. Second, we extend the standard overlapping generations model with production (Diamond, 1965) to incorporate the elder's need for long-term care (LTC) and the provision of gender-based unpaid and paid care. We show that, in the context of the traditional OLG framework, care needs contribute to capital overaccumulation and dynamic inefficiency, and that the degree of such inefficiency depends on the elderly care arrangement. Third, we use the model to evaluate the effects of the secular increase in women's labor supply that took place between the 60s and the 90s on the provision of unpaid care, and study the aggregate effects of alternative care arrangements, including market-based and publicly provided solutions. In a extended version of the model, we will examine the wealth inequality dimension.[1]

Figure 1: Female Labor Force Participation



Source: ILOSTAT database

The model will be calibrated for South Korea. South Korea has one of the fastest ageing rates and is experiencing an imminent elder care crisis. Despite rooted sexism and a huge gender pay gap (the average South Korean woman only makes 63% of the salary of the average man), the

[1]Unpaid care work in poor households is higher than in rich households. For this reason, the design of an equitable provisioning of care requires to consider gender inequality in interaction with wealth inequality.

female labor force participation rate in Korea has been increasing (Figure 1) while the labor force participation rate of men has been stable. South Korean women also provide most of the carework both in the home and in the market. Suh (2019b) uses the 2014 Korea Time Use Survey data to estimate that women spend approximately 110 hours a month on unpaid household work and unpaid care work, while men spend 27 hours on such activities. Workers employed in the care services sector are also predominantly female, comprising 92.8% of paid care workers. However, women still earn significantly less than their male counterparts in the care services sector (Table 1).

Table 1: Paid Care Sector in Korea, 2014

	All	Women	Men
Number of Employees	1,383,217	1,284,247	98,870
Share of Employees		92.84%	7.15%
Median Monthly Earnings (2014 US$)	2,045	1,466	2,483

Data source: Calculations by Suh (2019a)

All in all, this requires a dynamic analysis of the potential trade-offs between female labor force participation rates and unpaid elder care. We will show that trade-off will depend on the level of public provisioning for elder care vis-à-vis subsidies on market-based care services. Our model predicts large aggregate and welfare costs if the demand for elderly care intensifies (as it is expected to happen due to the evolution of the elderly-to-working-age-population ratio) and there is insufficient public investment provision in elder care. Of course, the insights provided by the model will be useful to analyze policies and outcomes in other countries beyond South Korea.

The paper proceeds as follows. The next subsection discusses related literature. Section 2 develops a simple theoretical framework to illustrate the role of care needs in a standard OLG framework. Section 3 introduces unpaid care. Section 4 discusses the role of gender and proposes an extension of the model with unequal distribution of unpaid work. Sections 5 refers to future extensions of the model. Section 6 summarizes and concludes.

Literature review

This paper contributes to the macroeconomic literature of modeling long-term care (LTC) needs in an overlapping generations model with both paid and unpaid care and explicit gender dynamics. LTC needs have been dealt with in the literature in the following ways.

There is a strand of literature that studies the LTC needs as a driver of the savings behavior of the elderly. Ameriks et al. (2015) demonstrate that older wealthholders spend down assets much more slowly than predicted by standard life-cycle models and that this is due to the desire to insure against LTC needs. Bueren (2018) quantifies the importance of LTC needs as a determinant of savings, relative to medical expenses and bequests. Curtis et al. (2015) develop a structural OLG model to study the effect of the demographic transition in China, particularly in terms of ageing population and aggregate household saving.

Another strand of the literature employs both general and partial equilibrium dynamic models in order to examine the role of informal (or unpaid) care by family members. Tabata (2005) for example, employs an OLG model with endogenous growth in which altruistic young agents provide care for their aged parents. Mommaerts (2015) analyzes to what extent unpaid care explains the limited demand for long term care insurance by developing a partial equilibrium model of long term care decisions between an elderly parent and an adult child. Additionally, there are macroeconomic models incorporating LTC needs. Kydland and Pretnar (2019) study the effect of aging on aggregate GDP growth using an overlapping generations model in which young agents can choose to provide eldercare. They find that projected population aging will lead to future reductions in aggregate output of 17% by 2056 and 39% by 2096 relative to an economy with a constant population distribution. Barczyk and Kredler (2018) propose a dynamic non-cooperative model for LTC decisions of families. They use an heterogeneous agents model with imperfectly altruistic households in which both young and old households can save but cannot commit to future transfers. They find that relatively small subsidies to private payers of nursing homes and informal caregivers substantially reduce the use of Medicaid and are welfare-improving.

The issue of financing retirement and long-term care is a subject of the third strand of the literature on eldercare. The experiences of Japan, China and Korea among others provided stylized facts for developing general equilibrium OLG models such as those of McGrattan et al. (2019) and Song et al. (2015) . The former uses Japanese data to analyze the impact of various policy options including a rise in consumption tax for financing the costs of aging. The latter also develops a dynamic OLG model to examine the welfare effect of different pension reforms in China.

While the literature concerned with eldercare and related policy concerns has been growing, there is paucity of studies on the gender dimensions of eldercare and macroeconomic policies in general equilibrium models. There are important contributions that exploit the OLG framework and endogenize fertility rates, like Galor and Weil (1996) and Lagerlof (2003). Agénor (2017) further models intra-spousal bargaining and gender bias into an OLG framework with endogenous fertility and Agénor and Aénor (2014) use a gender-based OLG model to study the impact of infrastructure on women's time allocation. However, to the best of our knowledge, none of the existing studies takes into account the dynamic interaction between eldercare, female labor force participation, and macroeconomic policies e.g. fiscal policies. A gendered analysis of eldercare is important because the slow change in the distribution of domestic work among household members combined with growth in female labor force participation poses serious implications for womens ability to provide effective care.

2 Model with elderly care needs

The purpose of this section is to show how the inclusion of elderly care changes the results of the canonical OLG model. In particular, we demonstrate that elderly care needs increase the demand for savings and aggravate the classic dynamic inefficiency problem that can emerge in the standard OLG model.

In the OLG framework, young people save for retirement. The more they save, the greater is the amount of future capital and the lower is the future rate of return. Since future capital is the outcome of savings made by current generations, an excess of savings imposes a pecuniary externality on the next generation in form of a lower rate of return r. If population grows at rate n and $r < n$, the competitive equilibrium will not be optimal and will be characterized by overaccumulation. This gives the government an important role: it can correct the dynamic inefficiency by establishing a social security scheme based on a system of transfers that provides consumption to individuals in their old age. Of course, such system of transfers has an implicit return n. This way, overaccumulation can be ameliorated.

Despite the possibility of having an excess of savings and dynamic inefficiency, standard life-cycle models are known for predicting aggregate savings that are too low compared to the data. In the standard model, young and old generations derive utility only from consumption, and the saving rate is determined by the relation between the discount factor β and rate of return r.[2] However, savings also respond to other forces, like precautionary behavior (Huggett, 1996) and bequest motives (Kotlikof and Summers, 1981), among others. Recently, empirical literature has explored the role of another important factor: long-term care needs (Ameriks et al., 2015; Bueren, 2018).

We extend the standard two-period OLG model by introducing a need for care in the household utility function. We assume that old households are less able to transform consumption goods into effective utility. However, care services can help with the actions needed for the elderly to derive utility from consumption goods. This provides a rationale for the demand for eldercare. The following simple model shows that this demand has a positive effect on households' savings and can exacerbate the classic dynamic inefficiency problem.[3]

Households

For now, we just focus on the partial equilibrium problem of households.[4] We assume that households have two choices: an intertemporal one between consuming when young and saving; and an intratemporal one between devoting future savings to consumption of goods or to care

[2]Except for the log utility case, where savings do not depend on the interest rate.

[3]This paper uses a two-period OLG model to show analytical results. In a future version of the paper, we will use a multiperiod model and assume that the ability to transform consumption into utility worsens as households age.

[4]This version abstracts from unpaid care arrangements. See more later.

services. The household solves the following problem:

$$U = u(c_t^Y) + \beta u(h(s_{t+1})c_{t+1}^O)$$

$$\text{subject to:} \quad c_t^Y + a_t = w_t \tag{1}$$

$$c_{t+1}^O + p_{t+1}^S s_{t+1} = (1 + r_{t+1})a_t \tag{2}$$

$$h(s_{t+1}) = 1 - (1-\theta)\exp\{-s_{t+1}\} \quad \text{where} \quad 0 \leq \theta \leq 1 \tag{3}$$

$$s_t \geq 0 \quad \forall t$$

where $u(\cdot)$ is a standard utility function, s_{t+1} denotes care services, c_t^Y and c_{t+1}^O refer to consumption during young and old age, a_t is savings and w_t, r_{t+1} and p_{t+1}^s indicate wages, return to savings and the relative price of care, respectively. This problem has the following first order conditions (FOCs):

$$u'(c_t^Y) = \beta(1 + r_{t+1})u'(h(s_{t+1})c_{t+1}^O)h(s_{t+1}) \tag{4}$$

$$h'(s_{t+1})c_{t+1}^O = p_{t+1}^S h(s_{t+1}) \tag{5}$$

We discuss the functional form $h(\cdot)$ in a subsection below. For now, we just focus on its interpretation by assuming that $h(s)$ is increasing in s. The first FOC is our version of the traditional Euler Equation. Here, the marginal utility of future consumption is weighted by $h(s)$, because the impact of an additional unit of future consumption depends on the amount of care enjoyed by the household. The second FOC represents the benefit of an additional unit of care $h'(s_{t+1})c_{t+1}^O$ against the marginal cost of foregone consumption $p_{t+1}^S h(s_{t+1})$. This marginal cost depends on the relative price of care p_{t+1}^S and $h(s_{t+1})$, which determines the effective utility that an additional consumption unit would yield. Using a standard CRRA utility function $u(x) = \frac{x^{1-\sigma}}{1-\sigma}$ and plugging in the budget constraint in the Euler equation, we have the following expression of savings:

$$a_t = \frac{\tilde{\beta}}{1+\tilde{\beta}} w_t + \frac{p_{t+1}^S s_{t+1}}{(1+\tilde{\beta})(1+r_{t+1})} \tag{6}$$

where $\tilde{\beta} = \left(\beta\big((1+r)h(s_{t+1})\big)^{1-\sigma}\right)^{\frac{1}{\sigma}}$.

Equation 6 establishes a relationship between savings and the demand for care. Note that in the standard version of the OLG model, where $(s_{t+1}) = 1$, savings are simply given by the first term in 6: $a_t = \frac{\tilde{\beta}}{1+\tilde{\beta}} w_t$. In our model, however, the need for care introduces an additional motive for saving. For a given interest rate, this motive expands households' saving and shifts the supply of capital to the right. The second FOC, which reflects the intra-period allocation of resources between consumption and care, determines another relationship between savings and care:

$$a_t = \frac{p^S_{t+1}}{1+r_{t+1}}\big(s_{t+1} + \frac{h(s_{t+1})}{h'(s_{t+1})}\big) \tag{7}$$

This is a system of two equations and two unknowns that can be solved numerically and whose solution we discuss below. Before that, we explain the role of our function $h(\cdot)$.

Function $h(\cdot)$

Our model uses function $h(\cdot)$ to rationalize the demand for care services. In the households' problem, we anticipated the following function h:

$$h(s) = 1 - (1-\theta)\exp\{-s\} \tag{8}$$

where $0 \le \theta \le 1$. Note that in absence of any care (e.g. $s = 0$), effective consumption is simply reduced by θ units. This reflects the idea that, when they are old, households are less able to transform consumption goods into utility. This a convenient property for the two-period model. Of course, since the function is increasing in the level of care s, lower values of θ will imply a higher demand of care.

For the multiperiod version of the model, we expect to use the following function:

$$h(t,s) = 1 - (1-\theta(t))\exp\{-s\} \tag{9}$$

where

$$\theta(t) = \begin{cases} 1 & \text{if} \quad t \leq t_{ret} \\ 1 - \left(\frac{t-t_{ret}}{T-t_{ret}}\right)^2 & \text{otherwise} \end{cases} \tag{10}$$

t is age, T is the household's lifespan and t_{ret} is the age at which they retire. $\theta(t)$ determines the intercept of $h(t, s)$ when s is equal to zero. This intercept becomes lower as households age. This function satisfies the following properties:

$$h(t, s) = \begin{cases} 1 & \text{if} \quad t \leq t_{ret} \\ \tilde{h}(t, s) & \text{otherwise} \end{cases}$$

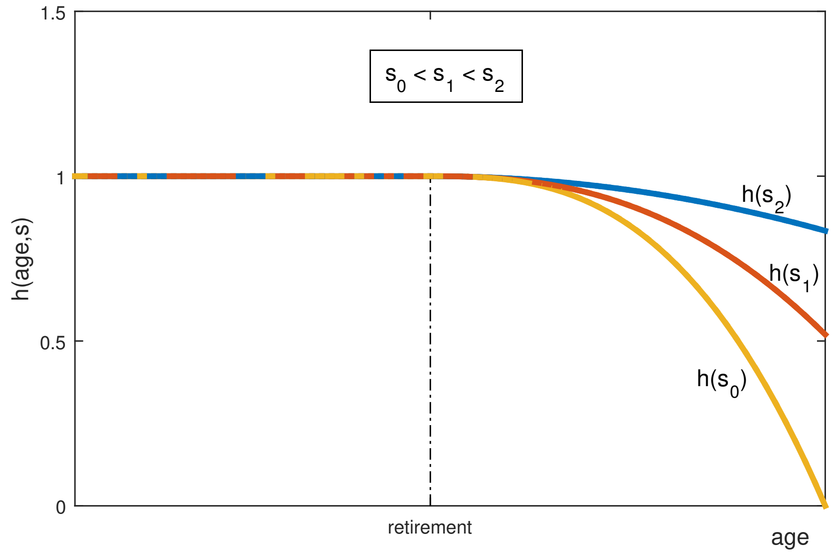
$$\text{and} \quad \frac{\partial \tilde{h}(t, s)}{\partial t} < 0; \quad \frac{\partial^2 \tilde{h}(t, s)}{\partial t^2} < 0; \quad \frac{\partial \tilde{h}(t, s)}{\partial s} > 0; \quad \frac{\partial^2 \tilde{h}(t, s)}{\partial s^2} < 0; \quad \frac{\partial^2 \tilde{h}(t, s)}{\partial t \partial s} > 0;$$

The first condition indicates that, before retirement, there are no care needs and, consequently, households do not demand care services. The set of partial derivatives simply shows that, after retirement, the function $h(t, s)$ is i) decreasing and concave with respect to t, ii) increasing and concave with respect to s, and iii) that the impact of care is higher as households age. Concavity with respect to t is a realistic feature as it denotes that care needs increase slowly after retirement but increase rapidly when households are very old. Concavity with respect to s is also a reasonable assumption, as it reflects that care services have a positive but marginally decreasing effect on effective consumption.

Figure 2 plots h both as a function of age. When households retire, their ability to transform consumption into utility worsens, and this inability gets worse as households age. Care services, though, can partially offset this problem, as a higher s reduces the slope with which utility deteriorates with age. The next section shows how the existence of $h(t, s)$ can worsen the classic OLG inefficiency, as households will over save to smooth their effective consumption $c^O h(s)$.[5]

[5]The h friction can even generate overaccumulation for parametrizations in which the canonical model yields an equilibrium return $r > n$

Figure 2: The function $h(t, s)$



Partial Equilibrium Analysis

Figure 3 plots the solution to the households' problem. Savings and the demand for care are plotted as a function of the relative price of care (upper panels) and parameter θ which, in our multi-period model, will be decreasing with age (bottom panels).

As any other demand, we observe that the demand of care s is downward sloping with respect to its price p^s. Of course, if $\theta = 1$, the demand does not respond to changes in prices because the household does not need any care at all. Interestingly, savings are not always decreasing with respect to p^s. If θ is very low, since the demand of care is necessarily high, households are forced to save more to pay the higher price.

We also observe that savings and the demand of care are negatively related to θ. If the value of θ is low, so will be the level of effective consumption and the household will increase its demand of care services to offset the effect of θ. Since households are forward looking and anticipate the impact of θ, they will increase their savings when they are young in order to smooth effective consumption $c^O h(s)$. This is the mechanism that aggravates the potential dynamic inefficiency in our OLG model. For a given demand of capital, households' extra savings due to the role of

θ put downward pressure on the return r and increase the probability of having $r < n$.

Figure 3: Savings and the demand for care

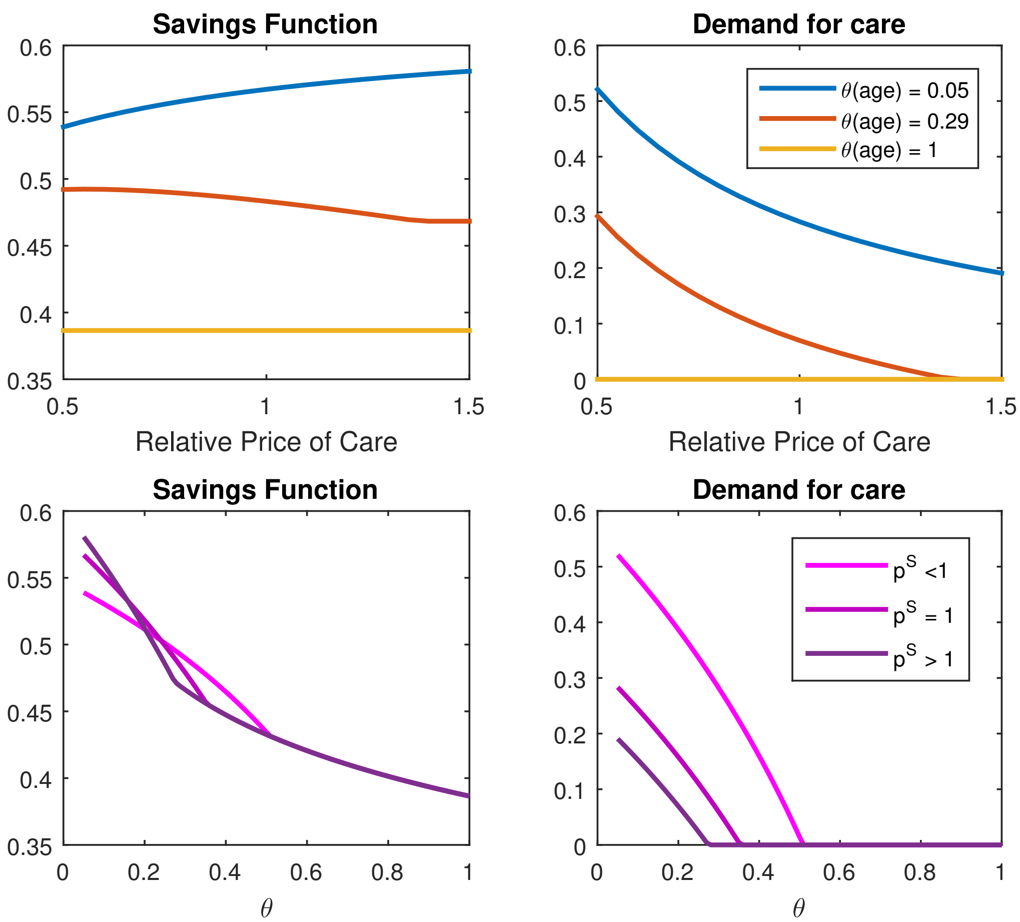
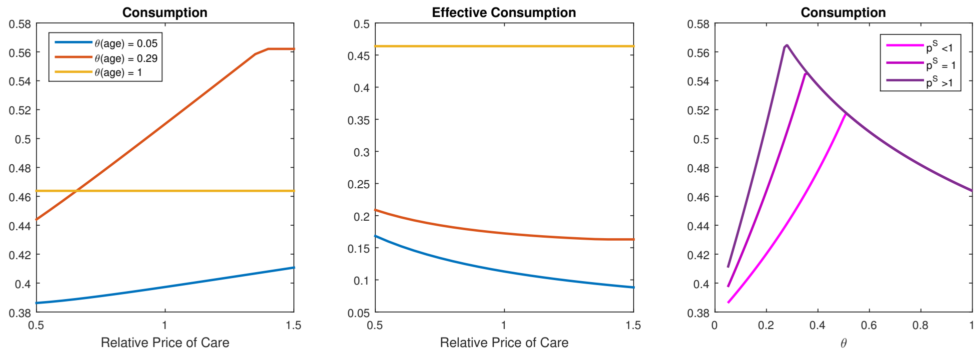


Figure 4 plots consumption expenditures and effective consumption as a function of p^s and consumption as a function of parameter θ. Consumption is increasing with respect to p^s because there is certain degree of substitution between care and consumption. However, if θ is very low, the impact of p_s on consumption is very small because in such circumstances, the demand of care can not be easily replaced by consumption. That is also what explains why effective consumption negative response to changes in p^s is slightly stronger for the low value of θ.

3 A model with unpaid care

We now introduce the possibility of unpaid care within the household in the form of a time transfer from the young to the old generation. We will do this by assuming imperfect altruism

Figure 4: Consumption



in the young household's preferences, which will ensure that young households devote a positive amount of time to taking care of their parents.

The rest of the model is analogous to the previous one. Households live two periods; the first period is the working age, while the second period is the retirement age. When they are young, households work, consume, save and provide care for their parents. Thus, young households have now two different trade-offs, as compared to the previous situation. First, they have the standard inter-temporal consumption smoothing problem: how much to consume vs how much to save. But now they have an additional choice to make: a time allocation decision on how much care to provide to their parents, at the opportunity cost of foregone labor earnings. Young households are time constrained: $s_t^H + l_t = 1$.

When they are old, households do not receive any income, but they have the return on their savings available, and receive care from their children. Old households consume goods and demand care, both from the market and informally. They have the same intra-temporal decision as before: how to split their savings income between consumption goods and market care services in excess of what their children have provided. Thus, with this specification, household's demand for market care in the second period depends on how much domestic care they receive from their children. This will also enter their savings decision, because young households will internalize that their children will be providing care when they are old.

Households maximize lifetime utility:

$$\max \quad U = u(c_t^Y) + v(h(s_t), c_t^O) + \beta u(h(s_{t+1}), c_{t+1}^O)$$

$$\text{subject to:} \quad c_t^Y + a_t = w_t l_t \tag{11}$$

$$p_{t+1}^S s_{t+1}^M + c_{t+1}^O = (1 + r_{t+1}) a_t \tag{12}$$

$$s_t^H + l_t = 1 \tag{13}$$

$$s_{t+1} = s_{t+1}^M + (1+n) s_{t+1}^H \tag{14}$$

Old households' total care services are the sum of their children's unpaid care provision plus the one that they buy from the market. Since we are expressing everything in per capita terms, and the young generation is $1 + n$ times bigger than the older one, their per capita care provision needs to be weighted against the older generation's size. In a sense, the more siblings one has among which to split the care needs of the parents, the less care burden one has to endure. So s_{t+1} and s_t^M are expressed in per capita terms of the old generation, because these are choices that concern them, while s_t^H is in per capita terms of the young generation, as this is a choice variable for the young. Of course, it is also the young generation that supplies the labor force that care services firms use to produce market care s_t^M; without loss of generality, we input the generation weighting transformation into the care services firms' production function.

The First Order Conditions are:

$$\frac{\partial U}{\partial c_{t+1}^O} = 0 \quad \leftrightarrow \quad u'(c_t^Y) = \beta(1 + r_{t+1}) u'(h(s_{t+1}) c_{t+1}^O) h(s_{t+1}) \tag{15}$$

The Euler Equation captures the inter-temporal consumption smoothing desire of the household. The function $h(s_t)$ lowers the effective utility of consumption tomorrow, which means that households will have to devote additional savings to enjoy the same utility.

$$\frac{\partial U}{\partial s_{t+1}} = 0 \quad \leftrightarrow h'(s_{t+1}) c_{t+1}^O = h(s_{t+1}) p_{t+1}^S \tag{16}$$

Households do not only save to consume when old but also to pay for private care. The utility from higher care services when old that this additional saving allows has to be weighted against the marginal utility of consuming. The relative prices of care services reflect the marginal rate of substitution between consumption goods and care services. This equation captures the demand for care services of the old generation.

The two previous equations are analogous to the FOCs of the previous model and have the same interpretation. But there is now an additional FOC, linked to the young household's intra-temporal time allocation problem:

$$\frac{\partial U}{\partial s_t^H} = 0 \quad \leftrightarrow \quad w_t u'(c_t^Y) = (1+n) v'(h(s_t) c_t^O) h'(s_t) c_t^O \tag{17}$$

The intra-temporal time allocation choice between providing care and working determines the young household's labor supply. Marginal utility of providing care to one's parents is equal to the marginal cost of not working an additional hour in terms of foregone consumption. This condition depends on population growth, as it determines the number of siblings among which care is divided. The higher the population growth, the higher the labor supply for a given wage.

Take equation 17 and put it forward 1 period:

$$w_{t+1} u'(c_{t+1}^Y) = (1+n) v'(h(s_{t+1}) c_{t+1}^O) h'(s_{t+1}) c_{t+1}^O$$

Combine this with 15 to obtain:

$$\frac{w_{t+1}}{p_{t+1}^S} \frac{u'(c_{t+1}^Y)}{u'(c_t^Y)} = \frac{1+n}{\beta(1+r_{t+1})} \frac{v'(h(s_{t+1}) c_{t+1}^O)}{u'(h(s_{t+1}) c_{t+1}^O)}$$

Define $\gamma_t = \frac{v'(h(s_{t+1}) c_{t+1}^O)}{u'(h(s_{t+1}) c_{t+1}^O)}$ as the ratio of the utility children derive from their parents' consumption over the utility of the parents from their own consumption. It is a ratio of the altruism children experience over their parents' well being. Re-arranging, we find that:

$$1 + r_{t+1} = (1+n) \frac{\gamma_t}{\beta} \frac{p_{t+1}^S}{w_{t+1}} \frac{u'(c_t^Y)}{u'(c_{t+1}^Y)} \tag{18}$$

Note that in the Steady State, $u'(c_t^Y) = u'(c_{t+1}^Y)$, such that: $1 + r = (1 + n)\frac{\gamma}{\beta}\frac{p^S}{w}$. The higher the children's altruism over their parents, the higher the interest rate, so the closer the market rate r is to the optimum transfer return n, and the lower the inefficiency. In the extreme case of perfect altruism (e.g. $\gamma = 1$), the OLG inefficiency disappears and equilibrium returns to saving r_{t+1} are those of the representative agent equilibrium. The interest rate also depends on the relative prices of care and labor: the higher the care prices, the more will households rely on the domestic provision of unpaid care, so they will save less and the market return to savings will be higher. On the other hand, if wages are high, the opportunity cost of providing domestic care rises, and children provide less unpaid care, such that the old generation has to save more and the market return to savings falls.

4 Introducing gender in a OLG model with care

The distribution of care within the household is not gender neutral. In Korea, women are in charge of about 80% of the overall domestic care provision, as opposed to less than 20% for man. This already highly unequal distribution includes child care and other tasks that men are more likely to perform other than taking care of the elderly (Suh, 2019b). Korea's gender norms stem deeply from familialism and the male breadwinner regime, and the government has mostly relied on families to provide unpaid care in the past (Peng, 2009). Since 1990, the government has been slowly increasing social spending to support childcare and eldercare. There have been recent strides with total government expenditure on families increasing from 0.7% in 2010 to 1.7% in 2015, but this figure still is below the OECD average of 2% (OECD, 2015).

Women's bargaining power within the household is also intimately related to the existence of available and attractive "outside options", and thus to the income and job opportunities women expect to have in the labor market. Women suffer discrimination of various forms in the labor market. The more obvious is labor market segregation, which diverts female labor force into certain categories of jobs that tend to be badly rewarded. Importantly, the feminization of certain sectors has to do with the fact that they are care related (Addati et al., 2018). There exists a "care penalty" in which low skilled jobs for women, such as nurses, teachers or social workers, which are mostly care-related, are less well paid than low skilled jobs for men, such as factory workers, construction workers and truck drivers (England et al., 2002). Research has found that the female labor force tends to accept lower earnings and worse job conditions because of a higher willingness to pay for work flexibility and job stability (Wiswall and Zafar, 2018). Lower earnings for women are also related to active gender discrimination (unequal pay for the same job) and the so-called "glass ceiling" of promotion opportunities during careers. Finally, several recent studies have found a huge motherhood penalty for women in terms of their expected lifetime earnings (Anderson et al., 2002; Gangl and Ziefle, 2009; Folbre, 2017).

Accounting for such complex and structural gender dynamics in a macro model of optimizing agents is challenging, both in terms of keeping model tractability and in terms of avoiding ad hoc modelling choices that imply gender discrimination is preferred or rational in any way. Moreover, structural, pervasive social norms that yield unfair and inefficient economic outcomes operate at the same time as the consequences of the interaction between various forms of discrimination. For example, the negative feedback loop between female labor market discrimination and the sexist distribution of unpaid care within the household reinforces both: women are more likely to take care of domestic needs because they do not expect to earn as much in the labor market, and companies discriminate against women, among other things, because they expect them to be the ones to take care of household needs.

The gender implications of our framework are not only gender-relevant but also affect aggregate economic outcomes. The classic inefficiency embedded in OLG models, which fail to generate a system of transfers based on inter-generational solidarity, yields overaccumulation and a market return r that is lower than the socially possible return n, thus creating room for a government to improve on the market outcome with a public pensions system. As we showed above, overaccumulation inefficiency is aggravated by the existence of care needs in the old age, as captured by our function $h(t, s)$, which provides a rationale for the persistently high savings of the elderly that is unaccountable for by a traditional life-cycle savings profile. As we have shown, the unpaid provision of domestic care is able to partially or fully revert the inefficiency. However, introducing gender shows that while relying on unpaid domestic care may yield socially desirable outcomes, it actually places an unfair, inefficient and unsustainable burden on women.

Moreover, the distribution of care, both within the household and between the household and the market, generates negative externalities. On the one hand, if productive women that could be earning a high wage in the labor market give up their careers to provide care within the household, gender discrimination implies an inefficient allocation of time between men and women's productive and reproductive responsibilities that reduces economic potential (Bertrand et al., 2015). In the context of our model, since it is labor in the productive sector that interacts with capital and allows to build a capital stock and increase productivity, a reduced female labor force participation reduces steady state capital. On the other hand, the market provision of care liberates female human resources from domestic care provision that can be used productively, but the care sector does not fully capture the increased labor supply. While it may be socially optimal that there is a wider market provision of care, since care sector firms do not internalize its social benefits, they provide less care and at a more expensive price than they optimally should.[6]

Here we discuss several ways of introducing gender discrimination, and evaluate how changing social norms affect care arrangements. Our aim is to understand how the increase in the female labor force participation has shifted the care burden from the unpaid provision by women within the household to the paid market provision, and its welfare implications. We expect to integrate some of this channel into our general equilibrium OLG framework.[7]

4.1 Sexism within the household

Continuing with our simplified two period model, assume that households are composed of two generations, a young, working generation, and an old generation in need of care, their relative weights being $1 + n$ and 1 respectively. The young generation is composed of a man and a woman, both endowed with a fixed supply of time, equal to $1/2$, which they can devote to either

[6]We explore this externality channel in forthcoming work.
[7]We will do this in the next version of this paper.

working or taking care of the elderly. A parsimonious way to introduce gender in our framework is to assume that men do not provide care within the household, and thus $s_t^{H,man} = 0$. This is a sort of rigid assumption, although it is quite realistic to a first approximation. The rest of the model can be kept as before: men and women provide the same type of labor, and can work indistinctively either in the care sector or in the productive sector, and earn exactly the same wage. Thus, we have the same results and dynamics that we have described before for the model with care and altruism. The only difference is that now the domestic provision of care is constrained: $s_t^H = s_t^{H,woman} \in [0, \frac{1}{2}]$. Moreover, since male labor supply is inelastic, we can now interpret changes in s_t^H, which amount to changes in the labor supply, as increases in the labor market participation of women.

Despite the assumption's simplicity and restrictiveness, it allows us to characterize all the results of the previous section through a gender lens. By incorporating this assumption, we can use the model to simulate the changes in the allocation of care between unpaid domestic provision and market provision by inputting data on the increase in female labor force participation.

4.2 Labor market segregation

In a further step, we make things a little more complex by introducing labor market discrimination. We will assume that there is gender segregation in the care sector, such that only women work in it. To allow for different wages in the two sectors of the economy and maintain tractability, we will assume that the allocation of labor supply among sectors is random. Suppose that when young agents enter the labor market, they draw a realization of a skills shock, η: they can either receive a high skills shock η_{high} with probability π or a low skills job, η_{low}, with probability $1 - \pi$. Regardless of the shock they draw, men work in the productive sector, and receive an expected wage of $\mathbf{E}^{man}[w_j \eta l^{man}] = w_G((1-\pi)\eta_{low} + \pi\eta_{high})\frac{1}{2}$. On the other hand, if women receive a low skills shock they will work in the care sector, and receive a wage w_S, and if they receive a high skills shock, they will work in the goods sector and receive a wage w_G. The expected wage for women is thus $\mathbf{E}^{woman}[w_j \eta l^{woman}] = (w_S(1-\pi)\eta_{low} + w_G \pi \eta_{high}) l^{woman}$.

Given our assumption that the care sector is labor intensive, we will have that labor productivity in the care sector is lower than labor productivity in the goods sector, such that $w_S < w_G$. We can interpret the difference between η_{low} and η_{high} as an education premium, and allow these shocks to change with time to capture changing wage patterns that help us calibrate wage rates in the model. Moreover, we can think of an increase in η_{high} for women as an increase in women's educational attainment and an increase in π for women as a higher probability of women working in the productive sector, which improves their labor market expectations. In any case, as long as the probability for women to draw a low skills job is not much lower than that of men, or as long as the skills of women are not much higher than those of men, the fact that $w_S < w_G$ will imply that women's expected wage in the labor market is lower than that of men.

Finally, we will assume that the household first decides how much time to allocate to care and that the labor supply choice is a residual of such decision, such that households only learn about their skills after they decide on their unpaid care supply. This modelling assumption captures several realistic features in a stylized manner. First, since households decide on how to distribute care among men and women within the household based on expected and not realized wages, this will endogenously generate, as in Galor and Weil (1996), a gendered distribution of care in the household by which men do not take domestic care responsibilities unless women are devoting their full time to unpaid care and care needs are still not satiated. It will also imply that a closing (but not reversal) of the earnings gap for women does not equilibrate care responsibilities within the household, but generates an externalization of care to the market.

Women will devote part of their time to taking care of the older generation regardless of their potential in the labor market. This will have several externalitites that will feed back into aggregate outcomes and generate inefficient allocations of care responsibilities, both between men and women within the household as well as between the domestic and the market provision of care, that will rationalize an intervention of the public sector to maximize the economy's full potential at the same time that it guarantees a gender balanced distribution of care.

4.3 Glass ceiling

The previous specification allows for domestic situations in which the labor skills (and earnings) of the female are higher than those of the male, but it is the female that takes care of the elderly. Of course, while this feature can make sense in a two period model, it becomes a bit less rational in a multi-period model, where agents have already some labor market experience when their elder start being in need of care, and they can predict what their skills and earnings are going to be. A distribution of care within the household that penalizes the female when she has better opportunities than her male counterpart in the labor market results in a time inconsistency in the multi-period OLG model.

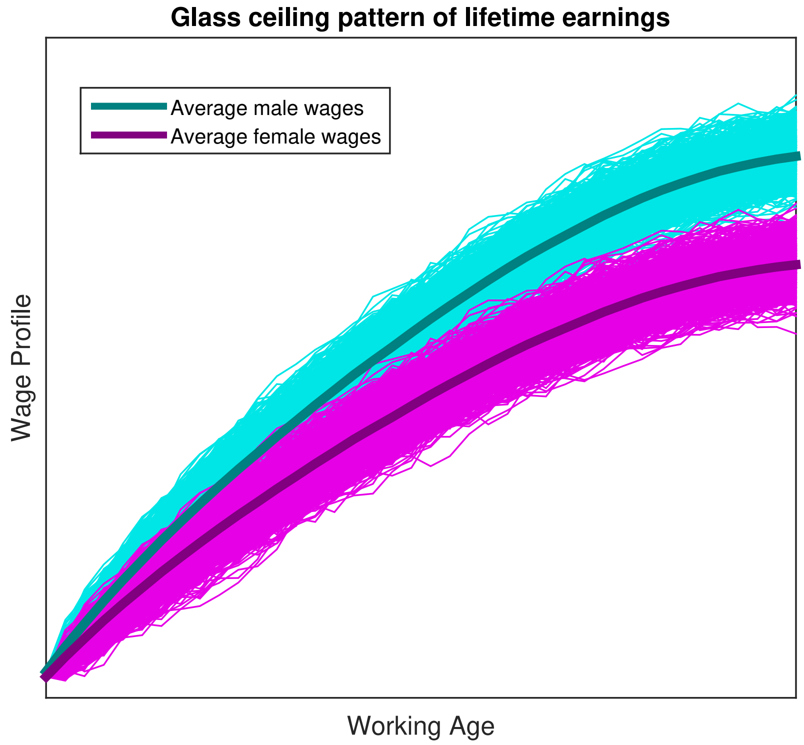
However, the data shows that highly skilled women continue to take on the role of providing unpaid care at the household level regardless of the labor market trajectories of their male counterparts (Bertrand et al., 2015). Therefore, we can think of several ways to maintain this feature without entering into model inconsistencies. For example, we can choose to impose some version of the sexist friction $s_t^{H,man} = 0$ which implies that the wage differences have to be large for men to start providing domestic care, such that this will happen in a tiny share of the population, depending on our calibrated probabilities, skills shocks, and wage differentials, but it won't be the most frequent arrangement. We can also keep the labor market skills realization as a random variable in each period, but allow for some time series correlation in the skills shock, $corr(\eta_t, \eta_{t-1})$, such that some women have a better bargaining position within the household, but are not able to fully enforce it because their realized earnings are still unknown.

Finally, we could allow for a "glass ceiling" friction that penalizes female trajectories in the labor market. Suppose that as households age they have a seniority wage premium, such that wages next period are updated following the rule:

$$w_{i,t+1} = \rho_i l_{i,t} w_{i,t} + \eta_t \tag{19}$$

where $\rho_{man} > \rho_{woman} > 1$.

Figure 5: Gendered wage profiles



Like figure 5 illustrates, with this specification, gender discrimination in earnings accumulates over time. Households would foresee these trends and choose to allocate unpaid care to the female of the household. Interestingly, the wage update can be made dependent on the labor supply. This wage updating process captures the feedback loop between domestic and labor market discrimination: since women will end up winning less in the labor market they are the ones more likely to provide care; but also, since women are the ones "sacrifice their careers" by providing care, they end up winning less. Moreover, we can keep a skills shock η_t that is independent of gender, reflecting the fact that men and women have exactly the same skills, despite not having the same opportunities. A woman with a particularly lucky trajectory of skills shocks could end up earning more than a man with a particularly unlucky trajectory, such that it is optimal for the household that he takes care of the elderly; but this would happen only in a minority of cases. An increase in the female labor force participation could be modelled by a reduction in the differences between the ρ's. Finally, wages would be normalized such that the average wage is equal to the marginal productivity of labor, and differences in wages between workers are idiosyncratic and do not affect firms' hiring decisions.

5 Future work

There are several things that we must address in order to have a polished paper. First, we need to solve the model in general equilibrium. This requires two immediate tasks: i) we need to build the supply side of the economy, which will be formed by both a standard and a paid care sector and, following our discussion in the previous section, ii) we need to introduce gender in the model. Finally, we need to calibrate the model using Korean data and simulate the aggregate effects of the observed increase in female labor participation, including a counterfactual analysis to compare the prevalence of unpaid care work and its effects with alternative care policies, either market-based or publicly provided care which, inevitably, we will also have to model.

Our future work also must address why the market provision of care is so low and expensive. We guess two reasons:

- **Market Power** With the growth in female labor force participation over the last decades and the debilitation of traditional care arrangements, the demand for market-based (private) care services might have become more inelastic, increasing the market power of their providers. Such concern provides a rationale for stricter market regulation and additional provision of public old-age insurance.

- **Externality argument** Eldercare provision might have an externality that might explain why its market provision is so low. An optimal market provision of care liberates female human resources from domestic care provision that can be used productively in the rest of the economy. However, the care sector might not internalize the benefits of a higher female labor supply. This might deviate the market provision from the socially optimal provision, with care sector firms providing less care at a more expensive price. We believe this point deserves further research.

Finally, our future work should also address the interaction of care arrangements and wealth inequality. So far, our OLG analysis has abstracted from wealth inequality. However, since the seminal work of Huggett (1996), there is an increasing use of life-cycle models with heterogeneous agents in pubic finance literature. Given the existing evidence on the higher reliance on unpaid care in poor households, these models are particularly suitable to design an equitable provisioning of care.

6 Conclusion

TBC

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