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Beggar-thy-parents? A Lifecycle Model of Intergenerational Altruism

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Abstract

This paper constructs a quantitative general equilibrium model with both lifecycle and dynastic features along with uninsurable labor income to assess differences in wealth and intergenerational transfers across countries. The model features both 'pure' and 'impure' forms of altruism and investigates the role of borrowing constraints in accounting for the timing of intergenerational transfers between intervivos transfers and bequests. Under a perfect capital market, the timing of parental transfers is irrelevant. However, under borrowing constraints, parental transfer will be geared towards helping out borrowing-constrained children. The model is calibrated to match the US and Korean economy. Numerical experiments show that tightening borrowing constraints leads to more intervivos transfers geared towards younger children and lower level of bequest. Borrowing constraints also play a role in accounting for the observed differences in the wealth inequality between the two economies.

JEL classification : D52, D91, E21

Keywords : intervivos transfer, wealth accumulation, incomplete markets

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1 Introduction

In this paper, we investigate the implications of intergenerational transfers with specific emphasis on the motive and the timing of the private transfer motives and the role of borrowing constraints in Korea and the United States.

One aspect of intergenerational transfers is related to the existence of borrowing constraints. Seminal work by Becker (1974) [6] states that under a perfect capital market, the optimal timing of intergenerational transfers is indeterminate, which, in turn, implies Ricardian equivalence. However, when there exists capital market imperfection such as borrowing constraint in the early stages of the life cycle, then the timing of the altruistic transfers matters. This could potentially explain large financial support from parent to children when they become independent from their parents through marriage.

The most direct reference that relates borrowing constraints and intergenerational transfers comes from Cox (1990) [12], which investigates whether intervivos transfers are aimed towards liquidity-constrained households by using a data set containing information on private transfers and consumer balance sheets in the United States. Another empirical evidence is provided by Guiso and Japelli (2002) [16] which investigates Italian household data and suggests that housing market imperfections motivate the timing of transfers in conjunction with parental considerations that control behavioral incentives for their children. The paper estimates that inter vivos transfers shorten the saving time required to purchase a house by about two years and allow households to purchase considerably larger houses.

I set up a general equilibrium lifecycle model for the United States and Korea and calibrate the model to match the aggregate level of wealth and the ratio of intervivos transfer to total bequests. The model features both bequest and intervivos transfers. While the motive for bequest in the model is 'impure' in the sense that parents derive utility from leaving bequest[1], which could be viewed as a 'selfish' motive, intervivos transfers are modelled such that the parents directly care about the consumption of their children and

[1]This type of approach is also called 'warm-glow' or 'joy-of-giving' approach.

provide transfers out of 'pure' altruism. Next, I evaluate the model along dimensions not specifically matched by construction by looking at age-wealth profile, intergenerational transfers, and the overall wealth distribution. After highlighting the fit of the model, I assess some quantitative roles played by the borrowing constraint as well as other counterfactual policy changes.

For borrowing constraint, tightening the constraint in the US is simulated by lowering the loan-to-value ratio (LTV) from 75% to 25%, which leads to higher transfers from parents who are alive to their children, especially those in the earlier stages of lifecycle. In the United States, transfer to children in the ages of 25-30 and 30-35 increase by approximately 85% and 6%, respectively. This implies that while parents are alive and care directly about their children's consumption, more intergenerational transfer is channeled towards younger children facing more severe constraint in smoothing their lifecycle consumption. For aggregate statistics, capital output ratio remains mostly unchanged while transfer to bequest ratio increases by 4% points, implying that the timing of parental transfers are more geared towards intervivos transfers. While the average bequest decreases by 4%, the average intervivos transfer increases by 10%. Change in intergenerational transfers are also partly reflected in the re-distribution of wealth across the lifecycle as younger cohorts aged less than 55 become wealthier at the cost of older cohorts. While traditional lifecycle models would imply lower welfare under a tightening borrowing constraint, the welfare level remain mostly unchanged under our model as children can derive more transfers from their parents. Borrowing constraints also have implications on the wealth distribution as lower LTV ratio implies a drop in the Gini coefficient of wealth from 0.75 to 0.706.

For Korea, a reverse simulation of increasing the LTV from 25% to 75% implies a reverse re-distribution of wealth across generations with cohorts aged 55 and above becoming wealthier while the younger cohorts become poorer. Subsequently, average bequest also increases by 5.9 percent. While transfers to children aged 25-30 decrease by 8% due to a more relaxed borrowing constraint, the average intervivos transfer increases by 9% as a result of a widening wealth gap between the parents and the children. The transfer-to-bequest ratio therefore increases by 2.4% points. In terms of wealth distribution, relaxing borrowing constraint raises the Gini coefficient of wealth from 0.63 to 0.663.

Next, we simulate a numerical experiment of enabling parental assets as partial collateral by assuming that the children can borrow up to 25% of the assets held by their parents. In Korea, the qualitative implications are similar to the simulation of relaxing borrowing constraint. For the US, capital output ratio declines by 2% and average wealth declines for all cohorts, which also lowers the bequest left by the deceased (-3%). On the other hand, allowing for parental assets to be partially collateralized lowers the need for parental intervivos transfers. Thus, transfers to cohorts aged 25-30, 30-35, and 35-40 fall by 17%, 6%, and 3%, respectively.

Furthermore, we conduct several counter-factual experiments such as eliminating the social security system, increasing the tax rate on consumption, lowering the tax rate on capital income under government revenue neutrality assumption for robustness check of our model.

This paper adds to the rich empirical literature on market imperfection and intergenerational transfers started out with Bruce and Waldman (1990) [9] and Altig and Davis (1992) [3], among others. In terms of the model set-up, this paper is closest to the work done by Fuster, Imrohoroglu, and Imrohoroglu (2008) [14], which looks at the welfare effects of revenue-neutral tax reforms calibrated to the United States economy for a dynastic and a pure life-cycle economy framework. However, this paper distinguishes itself in two different aspects: First, the two extreme set-ups proposed by Fuster, Imrohoroglu, and Imrohoroglu (2008) [14] are unclear about matching the age-wealth profile or the overall distribution of wealth in the data. This paper proposes a single model featuring both dynastic and life-cycle aspects with the family as a tool for insurance and explicitly documents the age-wealth profile and the overall distribution of wealth. Second, as pointed out by Ábráham (2008) [1] , there is no borrowing in the model specification of Fuster, Imrohoroglu, and Imrohoroglu [14], which may limit the implications of intergenerational transfers and welfare. This paper, on the other hand, endogenizes borrowing constraint into the model by incorporating the notion that children can borrow against their current income but also the asset of their parents as partial collateral, which is empirically more plausible.

In terms of calibration methodology, the paper takes similar approach to Nishiyama (2002) [25] which sets up a 4-period lifecycle model with bequest and intervivos transfers to analyze the wealth distribution in the United States and calibrates the parental altruism parameter to match the overall size of intergenerational transfers. However, the each period in the model represents 15 years, which makes it difficult to analyze the change of timing in intergenerational transfers. This paper defines each period in the model to represent 5 years which enables more specific attention to the different cohorts from the the numerical experiments for policy implication. In addition, the sole motivation for parental transfer is 'pure' altruism in his paper, while this paper introduces both 'pure' and 'impure' transfer motives.

The rest of this paper is organized as follows. Section 2 describes the empirical evidence, while Section 3 shows the model framework to illustrate the relationship between borrowing constraint and intergenerational transfers. Section 4 describes the calibrated parameters and Section 5 shows the benchmark simulation results and discusses the fit of the model. Section 6 conducts various numerical experiments, while a brief concluding remarks are provided in Section 7.

2 Empirical Evidence

2.1 Wealth by Age

For Korea, I use Korean Labor Income Panel Study (KLIPS), which is an annual socio-demographic panel study starting from 1998 and includes questions about household income and wealth as well as other demographic factors. The KLIPS survey is particularly useful to study intergenerational linkages since it provides information about financial transfers between family members as well as non-financial in-kind services such as number of visits children make to their parents living separately. For the US, the sample comes from the PSID data, which was used as a basis for Gale and Scholz (1994) [15] and Villanueva (2005) [28].

Figure 2.1 below shows the profile of wealth over age groups in Korea and the US. For Korea, using the KLIPS data, I follow the cohorts of 5 year difference (households aged 20, 25, 30, etc in the year 1999) over the survey period (1999-2005) and look at the average profile. For the United States, the age profile of wealth composition was taken from the cross-section study of Panel of Income Dynamics 2001 survey data. The profiles are normalized by the average incomes in both countries.

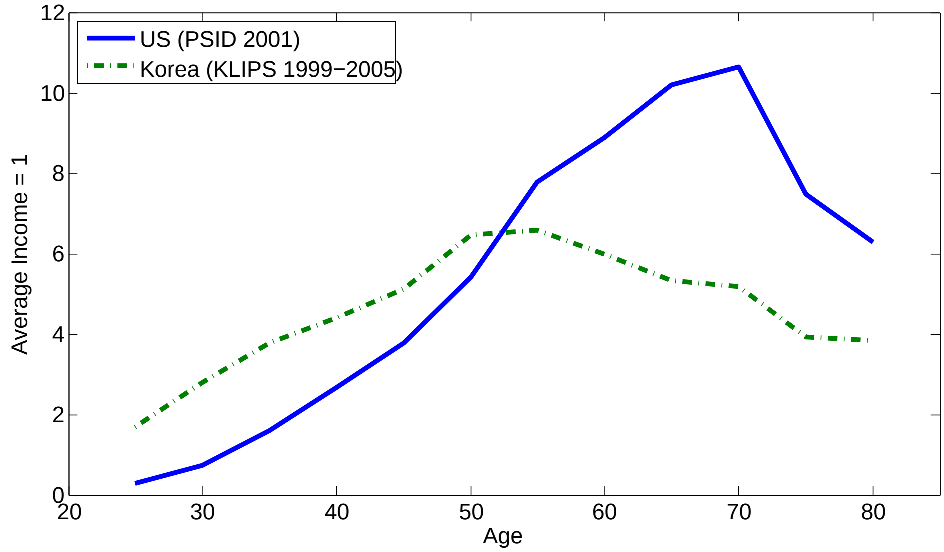

Figure 2.1 Age-profile of Wealth Accumulation (US vs Korea)

The main features of wealth over the life cycle are summarized as follows:

1. The profiles of net worth show hump-shaped pattern in both countries, but the peak reaches at the ages of 65-70 in the United States and 50-55 in Korea. This difference can be attributed to the difference in the retirement age (65 in the United States versus 60 in Korea), but also the fact that the cross-section data does not take into account the lifecycle effects (time, age, and cohort effects).

2. Another difference comes from the level of wealth held across different age groups. For households aged 55 and above, the American households hold significantly larger

amount of wealth than the Korean households. Comparing the net worth held at the peak ages, the US households hold more than 60 percent more wealth than the Korean households at their peak level. On the other hand, for younger households in Korea hold more wealth than the US counterparts.

2.2 Transfer Wealth

People accumulate wealth from different sources. As indicated by Gale and Scholz (1994) [15], one source of wealth is lifecycle wealth, which comes from precautionary savings or saving for retirement, among other reasons. Another source comes from transfers, usually from within close families in the case of private transfers and from the government in the case of public transfers. There has been studies in the US economy as for estimating the share of intergenerational transfers as a fraction of total net worth, as well as the composition of intergenerational transfers. Gale and Scholz (1994) [15] uses the annual flow of

Intervivos transfers and bequests from the Survey of Consumer Finances to estimate the stock of transfer wealth. The figures were around 21% and 31%, respectively. Villanueva [28] reports the annual flow of bequests in the United States to be around 2.6% of the GDP, and the annual flow of intervivos transfers is about a third of the flow of bequests.[2]

Analogous aggregate numbers for Korea is hard to calculate since the household surveys do not explicitly separate the amount of gift versus bequests received. However, the National Statistics Office provides the aggregate amounts of bequests and intervivos transfers reported for tax purpose since 2002. The annual flow of bequests between 2002 and 2006 ranged between 1.68% and 2.10%, with an average of 1.87% of the GDP. As for the ratio between intervivos transfers and bequests, the numbers were significantly larger, ranging from 0.60 to 1.07, with an average of 0.91, implying that the annual flow of bequests and inter-vivos transfers are almost equal in Korea.

[2] Villanueva reports that the ratio is similar in other OECD countries as evidenced in Germany and the United Kingdom.

2.3 Intervivos Transfer

2.3.1 Aggregate Intervivos Transfer

Table 1 gives the summary statistics of intervivos transfers from parents to children in the United States and Korea. For the United States, Altonji, Hayashi, and Kotlikoff (1997) [4] uses the PSID 1988 wave data[3] to look at the transfers received by the children, whereas McGarry (1999) [24] uses the HRS 1992 wave data[4] to look at the transfers given by the parents. For Korea, Kim and Song (2004) [21] uses the KLIPS 2002 wave to look at the transfers received by the children. Comparing the average transfer to household income[5] ratios, we note that the ratio is 2-3 times greater in Korea than in the United States.

Table 1: Summary Statistics of Intervivos Transfers - US, Korea

Author	Source	Percentage	$\overline{TR}$	$\frac{\overline{TR}}{\overline{Y}}$
Altonji et al. (1997)	PSID (1988)	23% (received)	\$1810	5.2%
McGarry (1999)	HRS (1992)	29% (gave)	\$3013	7.5%
Kim et al. (2004)	KLIPS (2002)	21% (received)	\$3273	15.8%

2.3.2 Intervivos Transfer by Age Groups

Looking at different age groups, Table 2 looks at the fraction of households receiving transfers, the average transfer to income ratio, and the average transfer to cohort income ratio. For the United States, the data source is the supplemental data of 1988 PSID survey, and for Korea the data comes from 2002 wave of KLIPS data. We note that while the fraction of households receiving transfers from parents is decreasing with age in the United States, the ratio is flat and high for Korean households aged until 39 years old

[3] Receipt of loans or transfers of \$100 or more are reported.

[4] Transfers of \$500 or more are reported.

[5] Average household income in PSID, HRS and KLIPS were \$35,000, \$41,000, and \$22,000 respectively.

and declines for households aged 40 and above. The transfer amounts are also higher in Korea than in the United States for most age groups, both as a fraction of average household income as well as average cohort income. For Korea, the biggest transfer goes to households aged between 30 and 34.

Table 2: Intervivos Transfers to Different Age Groups - US, Korea

	Age Groups				
	-29	30-34	35-39	40-44	45-49
	Fraction of households receiving transfers				
US	29.5%	22.6%	19.1%	16.5%	11.8%
Korea	26.6%	28.6%	27.3%	19.1%	13.7%
	Transfer as a fraction of average household income				
US	4.3%	5.6%	6.5%	6.7%	4.8%
Korea	5.2%	14.7%	9.9%	6.2%	9.2%
	Transfer as a fraction of average cohort income				
US	5.6%	5.2%	5.2%	5.2%	3.5%
Korea	13.3%	14.0%	8.3%	5.5%	7.7%

2.4 Evidence of Borrowing Constraints

Among many other factors, this paper focuses on the role of borrowing constraints in accounting for the differences in wealth accumulation and the intergenerational transfers. Borrowing constraints differ among countries in terms of magnitude. One way to compare the degree of borrowing constraint is to compare household credit and mortgage markets. Lam (2002) [22] reports the differences in household credit and mortgage markets in Korea and the US by comparing the difference in the outstanding mortgage-GDP ratio and the loan to value ratios. First, mortgage-GDP ratio in Korea during 1996-2000 have been around 20 percent the level of the US, indicating lower access for Korean households to tap into the credit market. Similar story holds for the loan to value ratio, measuring the fraction in which people can borrow against the value of the collateral, has only been around 25-35 percent in Korea, less than half that of the US. Low loan-to-value ratio in Korea also forces young households to partly collateralize their parental assets. This, in turn, implies that when households buy the house, they need as high as 75% of the value of the house as an upfront downpayment. Table 3 summarizes the household credit and mortgage markets in the two countries.

Table 3: Mortgage-GDP ratio and Loan-to-value ratios - US, Korea

	Year				
	1996	1997	1998	1999	2000
	Outstanding Mortgage-to-GDP Ratio				
US	53%	52%	54%	56%	55%
Korea	10%	11%	12%	12%	13%
	Loan-to-value ratio				
US	78%	80%	80%	78%	79%
Korea	25%	26%	28%	28%	33%

2.5 Summarizing Empirical Evidence

From the data shown in this section, we can list a few stylized facts on the household wealth and intergenerational transfers in the two countries.

- Lifecycle estimate of wealth profile shows that

    1. wealth peaks earlier and decumulates faster after the peak in Korea than in the United States

    2. younger Korean households hold more wealth than the corresponding cohorts in the United States, while for older households, the relation is reversed.

- Estimate of transfer wealth shows that

    1. on average, more households in Korea receive positive parental transfers than in the United States

    2. the relative importance of transfer income is larger for Korean households, especially in the younger cohorts aged less than 35.

- The degree of credit constraint in Korea is larger as evidenced from the size of the mortgage market and the down-payment requirements.

3 Model

In this section, I formulate the model set-up. Following the stylized facts shown in the previous section, the model will have enough parsimonious features to capture the stylized facts. In an economy with perfect capital market, agents can fully borrow against their lifetime income when they are young, therefore the timing of transfers becomes irrelevant. However, with market imperfections, especially with larger credit constraint in the early part of the life cycle, as children are unable to borrow to smooth their lifetime consumption, parents would rather draw their wealth and help out their credit-constrained children. The model is similar to the set-up of Nishiyama (2002)[25] in the sense that parents give intervivos transfer[6] as well as bequest. However, the motive for the two transfers are different. While intervivos transfers are geared towards the poor children, thus making the transfer motive altruistic, bequest is more ambiguous whether it is strategic or purely altruistic. Therefore, we take a neutral stance by assuming a 'warm-glow' approach to leaving bequest. This type of impure altruism is introduced by Andreoni (1989)[2]. In the model set-up, I also pay attention to the role of borrowing constraints in accounting for the timing of intergenerational transfers.

3.1 Demographics

Households[7] live for 12 periods at most, with each period representing 5 years. They are enter life cycle at the age 25 ($j = 1$) with zero asset and no labor income but possibly some intervivos transfer from their parent generation. When agents are 55 ($j = 7$), their children enter into the life cycle. Agents work until the age of 70 ($j = 9$) after which they are retired and face positive and increasing mortality risk. The exogenously given survival probability at age $j + 1$ conditional on being alive at age j is denoted by s_j. The unconditional survival probability for an agent aged j is thus given by $\prod_{t=1}^{j} s_t$. Since death is certain after age J, $s_J = 0$. When people die, the remaining assets will be left as

[6]The model abstracts from transfers from children to parents. This 'upstream' transfer is reported to be not quite significant in the United States at least.

[7]I will use the term households and agents interchangeably.

bequest. There is no population growth in the economy and the new agents entering into lifecycle exactly replaces the number of agents not being able to survive until the next period. In addition, the model abstracts from the changes in the family size over the life cycle or existence of annuities market.

3.2 Technology

There is one type of good produced by a single perfectly competitive firm according to the aggregate production function with Cobb-Douglas technology $Y = F(K, L) = K^{\alpha}L^{1-\alpha}$, where K and L are capital stock and labor input, respectively. The final good is either consumed (C), taken as government expenditure (G), or invested (I), where the law of motion for capital is $K' = (1 - \delta)K + I$. The profit-maximizing conditions lead to the net return on capital and labor equal to the respective marginal products.

$$r = F_K(K, L) - \delta \quad (1)$$

$$\omega = F_L(K, L) \quad (2)$$

where δ is the depreciation rate on physical capital.

3.3 Preference and Intergenerational Transfers

Preferences are assumed to be time separable, with a constant discount factor β. The utility function is given as a constant relative-risk aversion type, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. Agents also derive utility from bequests, q, left upon death. This 'warm glow' bequest motive is a simple way to incorporate bequest into the model without introducing the complexities of strategies between parents and children. As for the utility derived from leaving bequests, q, we follow the specification made by De Nardi (2004)[13] denoted as:

$$\varphi(q) = \varphi_1 \left[1 + \frac{q}{\varphi_2}\right]^{1-\sigma} \quad (3)$$

The term φ_1 reflects the parent's concern about leaving bequests to children, while φ_2 measures the extent to which bequests are luxury goods. It is assumed that bequests are seized by the government and equally redistributed to all people between the ages of 40 and 55 ($j = 4, 5, 6$).

Every parent also cares about the consumption of their children directly when the children enter into lifecycle and relatively 'young' (from 25 to 40, $\tilde{j} = 1, 2, 3$).[8] This corresponds to the ages between 55 and 70 for the parent ($j = 7, 8, 9$). I assume that children take the resources they receive from their parents as given. Parents incorporate the children's actions when making their decisions. Children receive whatever transfers are given and make optimal decisions to the given level of parental transfers. Thus in these periods, the utility of the parents is given as

$$u(c_t, \tilde{c}_{t-6}) = u(c_t) + \gamma u(\tilde{c}_{t-6}) \tag{4}$$

where γ is the discount factor for the utility of the children in the same period, which effectively measures the degree of parental altruism. Note that intergenerational altruism shows in two different channels; either parents give transfers intervivos (denoted as tr) when the children enters into the life cycle, or leave bequest after retirement upon death, which will be available to the children next period (denoted as q).

3.4 Labor Productivity Shock

Working agents are endowed with one unit of time which they supply inelastically. Agents also face the same exogenous age-efficiency profile, ϵ_j, during their working years. This profile is estimated from the data and recovers the fact that productive ability changes over the life cycle. Each unit of effective labor is paid the wage rate ω. Each period working households also receive a stochastic shock to their productivity level $y_j \in E = \{e_j^1, e_j^2, \ldots, e_j^{n_e}\}$ for $j = \{1, 2, 3, \ldots, 9\}$. The shock follows a Markov process with transition matrix $\pi_{e,e'}$. These shocks are represented by a finite-state Markov process defined

[8] I denote children's age with a tilde(˜) sign.

on $(Y, \mathcal{B}(Y))$ and characterized by a transition function Q_y, where $Y \subset R_{++}$ and $\mathcal{B}(Y)$ Borel algebra on Y. This Markov process is the same for all households.

In the first period, the agent inherits the productivity shock of the parents according to a transition function Q_{yh}, defined on $(Y, \mathcal{B}(Y))$. What the children inherit is only their first draw; from next period onwards, their productivity y_j evolves stochastically according to Q_y. The total productivity of a worker of age j is given by the product of the worker's stochastic productivity in that period and the worker's deterministic efficiency index at the same age: $\epsilon_j y_j$.

3.5 Market Arrangements

I assume there are no state contingent markets for household specific shocks. Households hold financial assets a that pay a net interest rate r. For borrowing constraints, I assume that working agents can borrow upto some fraction of their current period income. For agents in the early stages of their lifecycle ($j = 1, 2, 3$), I assume that they can also partially collateralize asset of their parents.

$$a_{j+1} \geq -\kappa_1 \omega \epsilon_j y_j - I_{j=1,2,3} \kappa_2 a_{j+6}^{-1} \qquad \forall \quad j = 1, \ldots, 9$$

where a_{j+6}^{-1} denote the asset of the parents aged $j + 6$ and $I_{j=1,2,3}$ is an indicator with value 1 if the agent is aged between 20 and 35.

For retired households, assets or bequests cannot be negative, thus,

$$a_{j+1} \geq 0 \qquad \forall \quad j = 10, \ldots, 12$$

3.6 Government

One role of the government is to take away the bequest and re-distribute equally to children in periods $\tilde{j} = 4, 5, 6$. Thus, the transfer, T, would be equal to:

$$T = \frac{\int_{j=10,11,12} q \ m^*(dx)}{\int_{\tilde{j}=4,\ldots,6} m^*(dx)} \tag{5}$$

Government also provides social security benefits, b, to retired households using the payroll tax collected on the working households, with the tax rate denoted as τ_{ss}. This would lead to the following:

$$b \int_{j=10,11,12} m^*(dx) = \tau_{ss} \int_{\tilde{j}=1,\ldots,9} \omega \epsilon y \ m^*(dx) \tag{6}$$

Finally, revenues from consumption tax and capital income tax are used for government expenditure G.

$$\tau_c C + \tau_k r K = G \tag{7}$$

3.7 Household Problem

The state variables for the households differ according to which period in the lifecycle the households are in. The lifecycle stages will be clustered into four subperiods: $j = 1, 2, 3$ when agents work and may receive transfers from parents, $j = 4, 5, 6$ when agents work and receive equally distributed bequest, $t = 7, 8, 9$ when agents work and become parents and may give transfers to children, and $t = 10, 11, 12$ when agents are retired and may die next period with their assets taken as bequests. While the model essentially captures a lifecycle framework, the interaction between parents and children take an important role and we highlight the joint interaction of the generations by looking at the value functions of parents and children in different lifecycle stages. For notation, the state variables for parents are denoted as (a, y) and for children $(\tilde{a}, \tilde{y})$, where a denotes financial assets carried from the last period and y denotes the productivity.

3.7.1 Retired Parents ($j = 10, 11, 12$) and Children ($\tilde{j} = 4, 5, 6$)

Retired parents receive pension benefit, b, and may not survive until the next period as they face positive mortality shocks, with the survival probability denoted as s. Upon death, the remaining assets are left as bequest. Since parents have 'warm glow' approach to leaving bequest, they derive utility from the amount of bequest left for their children. The state variable for the retired parents is simply their assets brought from the previous period. The value function for retired parents are as follows:

$$
\begin{aligned}
(8) \qquad V(j,a) &= \max_{c,a'} \left[U(c) + s\beta V(j+1,a') + (1-s)\varphi(q)\right] \\
&\text{subject to} \\
(1+\tau_c)c + a' &\leq (1 + r(1-\tau_k))a + b \\
c &\geq 0 \\
q &= a' \geq 0
\end{aligned}
$$

For children, they don't have information on the bequest left by their parents as the amount is taken away by the government and equally redistributed as transfers T. Since the children are in working age, they can use a fraction κ_1 of their current income as collateral to borrow. The state variables for the children in periods $\tilde{j} = 4, 5, 6$ are the assets brought up from the previous period as well as their productivity level.

$$
\begin{aligned}
(9) \qquad V(\tilde{j},\tilde{a},\tilde{y}) &= \max_{\tilde{c},\tilde{a}'} \left[U(\tilde{c}) + \beta E V(\tilde{j}+1,\tilde{a}',\tilde{y}')\right] \\
&\text{subject to} \\
(1+\tau_c)\tilde{c} + \tilde{a}' &\leq (1-\tau_{ss})\omega\epsilon\tilde{y} + (1 + r(1-\tau_k))\tilde{a} + T \\
\tilde{c} &\geq 0 \\
\tilde{a}' &\geq -\kappa_1\omega\epsilon\tilde{y}
\end{aligned}
$$

3.7.2 Parents at $(j = 7, 8, 9)$ and Children at $(\tilde{j} = 1, 2, 3)$

Parents are working and directly care about the consumption of their children, and may give transfers. The transfers will be dependent on the asset level and the productivity of both the parents and the children. As parents have full information on the state of their children, the state variables include their own asset and productivity but also those of their children, $\{a, y, \tilde{a}, \tilde{y}\}$. For parents in period $j = 9$, they retire next period and are not subject to stochastic productivity shocks nor considerations for their children's consumption. The value function for parents are as follows:

$$
\begin{aligned}
V(j, a, y, \tilde{a}, \tilde{y}) &= \max_{c, a', tr} \left[U(c) + \gamma U(\tilde{c}) + I_{j=7,8}\beta EV(j+1, a', y', \tilde{a}', \tilde{y}') + I_{j=9}\beta V(j+1, a')\right] \\
&\quad \text{subject to} \\
(1+\tau_c)c + tr + a' &\leq (1-\tau_{ss})\omega\epsilon y + (1 + r(1-\tau_k))a \\
c &\geq 0 \\
a' &\geq -\kappa_1 \omega \epsilon y
\end{aligned} \tag{10}
$$

Children in periods $\tilde{j} = 1, 2, 3$ are subject to transfers from parents. They will take the transfer as given and choose their consumption and asset for the next period. Since the transfer from parents depend on the asset and productivity of both the parents and the children, the state variables are denoted as $\{a, y, \tilde{a}, \tilde{y}\}$. They can also borrow against a fraction κ_1 of their current income but also a fraction κ_2 of their parents' asset.

$$
\begin{aligned}
V(\tilde{j}, a, y, \tilde{a}, \tilde{y}) &= \max_{\tilde{c}, \tilde{a}'} \left[U(\tilde{c}) + I_{\tilde{j}=1,2}\beta EV(\tilde{j}+1, a', y', \tilde{a}', \tilde{y}') + I_{\tilde{j}=3}\beta EV(\tilde{j}+1, \tilde{a}', \tilde{y}')\right] \\
&\quad \text{subject to} \\
(1+\tau_c)\tilde{c} + \tilde{a}' &\leq (1-\tau_{ss})\omega\epsilon\tilde{y} + (1 + r(1-\tau_k))\tilde{a} + tr \\
\tilde{c} &\geq 0 \\
\tilde{a}' &\geq -\kappa_1 \omega \epsilon \tilde{y} - \kappa_2 a
\end{aligned} \tag{11}
$$

3.8 Stationary Equilibrium

A stationary equilibrium is given by government policy arrangements $\{T, G, \tau_{SS}, \tau_c, \tau_k\}$; a set of prices $\{r, w\}$; value functions $V(x)$; and allocations $c(x), a'(x), tr(x)$; a time-invariant distribution of agents over the state variables $x = \{j, a, y, \tilde{a}, \tilde{y}\}$, $m^*(x)$; and aggregate quantities $\{Y, C, K, L\}$ such that given prices and the government policies:

(i) the functions $V(x), c(x), a'(x), tr(x)$ solve the dynamic maximization problem of the households.

(ii) factor prices are equal to their marginal products:

$$r = F_K(K, L) - \delta \tag{12}$$

$$w = F_L(K, L) \tag{13}$$

(iii) the government policy satisfies (5), (6), (7).

(v) m^* is the invariant distribution of households over the state variables for this economy.

(vi) all markets clear.

$$K = \int a \ m^*(dx) \tag{14}$$

$$L = \int \epsilon y \ m^*(dx) \tag{15}$$

$$C = \int c \ m^*(dx) \tag{16}$$

$$Y = C + \delta^k K + G \tag{17}$$

4 Calibration

The set of parameters will be divided into those that can be estimated independently of the model or are based on estimates provided by other literature and data, and those that are chosen such that the predictions generated by the model can match a given set of targets. All parameters were adjusted to the five year span that each period in the model represents. For the first group of calibrated parameters, Table 4 lists the parameters chosen to be common across the two countries.

Table 4: Common Parameter Definition and Values

Parameters	Definition	Values
σ	Risk-aversion coefficient	1.5
α	Capital income share	0.237
δ	Depreciation rate	0.042
ϕ_1	Bequest parameter	-9.5
ϕ_2	Bequest parameter	11.6
b	Replacement ratio	0.4
τ_c	Consumption tax rate	0.05
ρ	Persistence of income process	0.85

The relative risk aversion coefficient, σ, is taken from Attanasio, et al. (1999)[5], which falls in the range commonly used in the macroeconomics literature. In the aggregate production function, α, the share of income attributed to physical capital, is calibrated at 23.7% in both countries. The annual depreciation rate of the capital stock is 4.2%. For the bequest parameter, ϕ_1 governs the degree in which parents care about leaving bequest, while ϕ_2 measures the degree in which bequest is considered as a luxury good. The bequest parameters are taken from De Nardi (2004)[13], which tries to match the transfer wealth share of 60% in the United States as found in Gale and Scholz (1994) [15] and the ratio of average bequest in the lowest 30% percentile to median household income in the United States. The replacement ratio for retirement benefit was taken to be 40% of the average income and the consumption tax rate was 5%. The conditional survival probabilities for households until the age of 70 were assumed to be 1. For households aged more than 70, the probabilities are taken from Bell, Wade and Goss (1992)[7] commonly applied over both countries.

The logarithm of the stochastic productivity process is assumed to be an AR(1) following Huggett (1996)[19].

$$(18) \qquad \ln y_t = \rho \ln y_{t-1} + \mu_t$$

The disturbance term μ_t is normally distributed with mean zero and variance σ_y^2. The persistence parameter ρ for the United States is taken from estimates by De Nardi (2004)[13]. For Korea, it is assumed that the persistence parameter is identical to the case of the United States. The productivity shocks are discretized into a four-state Markov chain according to Tauchen and Hussey (1991)[26]. The resulting values for the productivity process are $\{0.2594, 0.6513, 1.5355, 3.8547\}$ for the United States and $\{0.2941, 0.7438, 1.3444, 2.5373\}$ for Korea, respectively. The transition matrix Q_y and the productivity inheritance matrix Q_{yh} are given by:

$$\begin{Bmatrix} 0.7132 & 0.2764 & 0.0104 & 0.0000 \\ 0.1467 & 0.6268 & 0.2210 & 0.0055 \\ 0.0055 & 0.2210 & 0.6268 & 0.1467 \\ 0.0000 & 0.0104 & 0.2764 & 0.7132 \end{Bmatrix}$$

$$\begin{Bmatrix} 0.5256 & 0.4228 & 0.0509 & 0.0007 \\ 0.1461 & 0.5538 & 0.2825 & 0.0176 \\ 0.0176 & 0.2825 & 0.5538 & 0.1461 \\ 0.0007 & 0.0509 & 0.4228 & 0.5256 \end{Bmatrix}$$

Table 5: Country-Specific Parameter Definition and Values

Parameters	Definition	US	Korea
κ_1	Borrowing constraint parameter	0.75	0.25
κ_2	Borrowing constraint parameter	0.0	0.0
σ_y^2	Innovation of income process	0.30	0.07
ϵ_j	Age-efficiency profile	Hansen(1993)	Hansen, adjusted
τ_{ss}	Payroll tax rate	9.0%	12.4%
τ_k	Capital income tax rate	50.2%	13.0%
j^*	Retirement period	10	9

Table 5 lists country-specific parameters. For the borrowing constraint parameter, κ_1, I take the average loan-to-value ratios in the two countries. The values are similar to those reported in Jappelli and Pagano (1994) [20], which reports the maximum loan-to-value ratios of 89% and 30% for the United States and Korea, respectively. For κ_2, due to lack of available data on parental collateral, I take a value of 0 for both countries and relax this constraint later on in the policy experiment section. The variance term in the productivity process, σ_y^2, in the US is taken from estimates by De Nardi (2004) [13]. For Korea, I adjust and re-scale to match the Gini coefficient for earnings in Korea. The deterministic age-efficiency profile ϵ_j, for the United States is taken from the estimate of the mean age-income profile from Hansen (1993)[17]. The corresponding age-efficiency profile in Korea is adjusted accordingly taking into account the difference in the retirement age. As for tax rates, the social security payroll tax rate was chosen to match the replacement ratio of 0.4. Since the retirement age in Korea is earlier than the United States (60 vs. 65), the tax burden on the working households is subsequently higher. The tax rate on capital income, τ_k, was chosen so that the government balances budget and its expenditure is fixed at 20% of total GDP in each countries.

The next set of parameters were chosen such that the predictions generated by the model can match a given set of targets, specifically, some aggregate ratios in the data. Table 6 shows the parameters used to match some given set of targets in the data in each country.

Table 6: Parameters to match given set of targets

Parameters	Definition	US	Korea
β	Discount factor	0.982	0.943
γ	Pure altruism parameter	0.155	0.385

The discount factor, β, was calibrated to match the capital-output ratios in each country. For the United States, the capital-output ratio was 3.173, whereas for Korea the ratio was 2.448. The intergenerational discount factor, γ was chosen to match the ratio of intervivos transfer to total bequests. The ratio was 0.28 for the US and 0.91 for Korea.

5 Results

In this section, the results from the benchmark simulation for the United States and Korea are presented and the fit of the model is evaluated along the dimensions not specifically matched by model construction such as age-wealth profile, intergenerational transfers given to respective cohorts, and wealth distribution.

5.1 United States

To begin with, Table 7 reports the summary statistics of the benchmark simulation and the data.

Table 7: Summary Statistics of Benchmark Simulation

Variable	US Benchmark	US Data
Capital output ratio	3.187	3.173
Transfer-to-bequest ratio	0.27	0.28
Average Wealth		
25-40	0.50	0.87
40-55	4.95	3.95
55-70	9.51	8.94
70-85	7.13	8.13
Average flow of bequest (% of GDP)	1.6%	2.6%
Transfer to 25-30 (% of GDP)	0.54%	4.3%
Transfer to 30-35 (% of GDP)	1.94%	5.6%
Transfer to 35-40 (% of GDP)	2.66%	6.5%
Gini (wealth)	0.75	0.78

While the benchmark model is calibrated to match the aggregate wealth to output ratio, we also highlight the average wealth (as a fraction of average income) held by broad age cohorts. The age-wealth profile shows a hump-shaped pattern matching the data, with peak occurring in the cohorts aged between 55 and 70. As for intergenerational transfers, the model accounts for around 60% of the bequest flow in the data. One possible reason for this under-estimation of actual flow of bequest is that the model assumes all bequests are equally re-distributed to cohorts aged between 40-55. In addition, large fraction of actual bequests come from the top percentile of the wealth distribution, which the benchmark model is not specifically modeled for. As for intervivos transfers given to younger households, the model predicts that the transfer increases with age, which matches the data. Quantitatively, while the model only accounts for 13% of the transfers given to cohorts aged 25-30, it does better job of accounting for 35% and 41% of the transfers given to cohorts aged 30-35 and 35-40, respectively. Finally, the model closely captures the Gini coefficient of wealth in the data reported by Cagetti and De Nardi (2008) [10]. The reported Gini coefficient of 0.75 is closer than the values predicted by standard life-cycle models or dynastic models.

5.2 Korea

Table 8 reports the summary statistics of the benchmark simulation and the data for Korea.

Table 8: Summary Statistics of Benchmark Simulation

Variable	Korea Benchmark	Korea Data
Capital output ratio	2.455	2.448
Transfer-to-bequest ratio	0.904	0.91
Average Wealth		
25-40	0.70	2.74
40-55	4.68	5.33
55-70	8.21	5.97
70-85	4.32	4.32
Average flow of bequest (% of GDP)	1.2%	1.9%
Transfer to 25-30 (% of GDP)	1.97%	5.2%
Transfer to 30-35 (% of GDP)	3.17%	14.7%
Transfer to 35-40 (% of GDP)	3.70%	9.9%
Gini (wealth)	0.63	0.66

The age-wealth profile predicted by the model shows a hump-shaped pattern matching the data with peak occurring in the cohorts aged between 55 and 70. Quantitatively, the model under-predicts the wealth held by households aged between 25 and 55, while over-estimating the wealth held by cohorts aged between 55 and 70. As for intergenerational transfers, the model also accounts for around 60% of the bequest flow in the data. As for intervivos transfers given to younger households, the model predicts that the transfer increases with age, whereas in the data, the age-transfer profile is hump-shaped with peak at the age group of 30-35. Quantitatively, the model accounts best (38%) for the transfers given to cohorts aged 25-30. For cohorts aged 30-35 and 35-40, the model accounts for 22% and 37%, respectively. Finally, the model closely captures the Gini coefficient of wealth in the data. The reported Gini coefficient of 0.63 is close to the value reported by Lee and Lee (2001) [23].

6 Policy Experiments

Given the results shown in the benchmark results, we move on to conduct various counterfactual policy experiments and analyze the quantitative effects on aggregate ratios, intergenerational transfers and wealth by age, prices, welfare, and wealth inequality. All the other calibrated parameters remained unchanged.

6.1 Role of Borrowing Constraint

One case is to see whether the borrowing constraint for younger households would impact the profile of wealth and intergenerational transfers as well as the overall welfare level. To simulate different degrees of borrowing constraint, I change the borrowing constraint parameter κ_1 from 0.75 to 0.25 for the United States and from 0.25 to 0.75 for Korea. Table 9 shows the change in the aggregate ratios, tax rates, intergenerational transfers, welfare, and the interest rate. For intergenerational transfers, we report the change in average bequest (T), and intervivos transfers given for children at period 1,2, and 3 (tr_1, tr_2, tr_3).

As for aggregate ratios, tighter (looser) borrowing constraint leads to higher (lower) capital output ratio, although the quantitative magnitude is small. For the US, changing κ_1 from 0.75 to 0.25 leads to an increase in the capital output ratio of 0.6%, and for Korea, changing κ_1 from 0.25 to 0.75 leads to a decrease in the capital output ratio of 0.4%. Wealth implications are different across age-groups as tighter borrowing constraint leads to higher wealth for younger household aged up to 55, whereas households aged 55

Table 9: Aggregate Statistics (Borrowing Constraint)

Parameter	US ($\kappa_1 = 0.75$)	US ($\kappa_1 = 0.25$)	Korea ($\kappa_1 = 0.25$)	Korea ($\kappa_1 = 0.75$)
Capital output ratio	3.187	3.206	2.455	2.445
Transfer-to-bequest ratio	0.27	0.31	0.91	0.934
Average Wealth				
25-40	100.0	138.2	100.0	85.8
40-55	100.0	104.6	100.0	98.5
55-70	100.0	99.4	100.0	102.0
70-85	100.0	98.0	100.0	104.7
T	100.0	96.2	100.0	105.9
tr_1	100.0	184.9	100.0	91.9
tr_2	100.0	105.7	100.0	108.1
tr_3	100.0	97.4	100.0	119.9
τ_k	50.2%	51.9%	13.0%	12.3%
r	3.8%	3.7%	5.7%	5.7%
Welfare	100.0	99.3	100.0	99.8
Gini	0.75	0.706	0.63	0.663

and above accumulate less wealth. Reverse implication for re-distribution of wealth holds for Korea under a more relaxed borrowing constraint.

For intergenerational transfers, tighter borrowing constraint leads to lower bequest left due to lower level of wealth during retirement and death. For the US, average bequest falls by 4%. On the other hand, average bequest rises by 6% in Korea. Overall intervivos transfers rise in the US and Korea, but possibly for different reasons. While tighter borrowing constraint leads to higher level of intervivos transfer, it also leads to re-distribution of wealth across age groups and reduces the wealth gap between young and old cohorts, reducing the need to provide transfers. As a result, the overall transfer-to-bequest ratio increases in both countries.

As for intervivos transfers to different cohorts in the US, not only do parents give more transfers while they are alive, but also shift their intervivos transfers to children who are more likely to be constrained. Transfers given to cohorts aged 25-30 and 30-35 increase by 85% and 6%, respectively, at the expense of lower transfers to cohorts aged 35-40. In Korea, relaxing the borrowing constraint leads to a reduction of transfers to cohorts aged

25-30 by 8%, while the transfers to cohorts aged 30-35 and 35-40 rises by 8% and 20%, respectively.

Finally, given the revenue neutrality assumption, tighter borrowing constraint leads to higher capital income taxes. In the US, the ratio increases by 1.7% points, while in Korea, more relaxed borrowing constraint lowers the tax rate by 0.7% points. Interest rates and welfare level, measured by the average discounted lifetime utility, remain almost unchanged. For the Gini coefficient for wealth, tightening (relaxing) borrowing constraint improves (deteriorates) wealth inequality. Gini coefficient decreases in the US by 4.4% points and rises in Korea by 3.3% points.

6.2 Collateralizing Parental Asset

Next experiment looks at the role of using parental asset for partial collateralization by changing the parameter κ_2 value, initially set at zero in benchmark, to 0.25, enabling children to borrow up to 25% of the assets held by their parents.

Table 10: Aggregate Statistics (Parental Asset Collateralization)

Parameter	US		Korea	
	$(\kappa_2 = 0)$	$(\kappa_2 = 0.25)$	$(\kappa_2 = 0)$	$(\kappa_2 = 0.25)$
Capital output ratio	3.187	3.126	2.455	2.448
Transfer-to-bequest ratio	0.27	0.262	0.91	0.929
Average Wealth				
25-40	100.0	93.4	100.0	90.6
40-55	100.0	97.6	100.0	99.5
55-70	100.0	97.5	100.0	101.0
70-85	100.0	98.3	100.0	101.8
T	100.0	97.4	100.0	102.2
tr_1	100.0	82.8	100.0	76.0
tr_2	100.0	93.7	100.0	108.7
tr_3	100.0	97.4	100.0	117.3
τ_k	50.2%	49.6%	13.0%	12.8%
r	3.8%	3.9%	5.7%	5.7%
Welfare	100.0	100.1	100.0	99.9
Gini	0.75	0.753	0.63	0.644

Enabling parental assets as partial collateral implies relaxing borrowing constraint for the children. Aggregate implications are similar to the case of relaxing borrowing constraint in the previous section, with lower capital output ratio. Quantitatively, the ratio declines 1.9% and 0.3% in the US and Korea, respectively. However, wealth implications are different across age-groups. In the US, wealth level decreases for all age groups, with the youngest cohort facing the largest decline. In Korea, on the other hand, re-distribution of wealth favors the older households as cohorts aged above 55 have higher level of wealth. Similar to the US, the youngest cohort faces largest decline in wealth.

For intergenerational transfers, partial collateral leads to lower bequest in the US (-2.6%) but higher bequest in Korea (2.2%), which reflects the change in the level of wealth held by the retired households. Similarly, overall intervivos transfers fall in the US (-5.5%) while rising in Korea (5.0%).

As for intervivos transfers to different cohorts in the US, while parents give less transfers to all cohorts, the fall is larger for younger households. Transfers given to cohorts aged 25-30 fall by 13%, while those given to cohorts aged 30-35 and 35-40 fall by 6% and 3%, respectively. In Korea, allowing for parental asset as partial collateral leads to a reduction of transfers to cohorts aged 25-30 by 24%, while the transfers to cohorts aged 30-35 and 35-40 rises by 9% and 17%, respectively.

Finally, given revenue neutrality assumption, relaxing borrowing constraint leads to lower capital income taxes. Tax rates fall by 0.6% points and 0.2% points in the US and Korea, respectively. Relaxing borrowing constraint do not lead to significant implications on the interest rates and the welfare level, whereas wealth inequality rises slightly.

6.3 Eliminating Social Security Tax

Next experiment looks at privatizing social security arrangements, by lowering the replacement ratio from 40% to 0% and eliminating the social security payroll tax. Table 11 shows the change in the aggregate ratios, tax rates, intergenerational transfers, welfare, and the interest rate.

Table 11: Aggregate Statistics (Eliminating Social Security)

Parameter	US ($\tau_{ss} = 9\%$)	US ($\tau_{ss} = 0$)	Korea ($\tau_{ss} = 12.4\%$)	Korea ($\tau_{ss} = 0$)
Capital output ratio	3.187	3.66	2.455	2.98
Transfer-to-bequest ratio	0.27	0.145	0.91	0.22
Average Wealth				
25-40	100.0	68.8	100.0	55.9
40-55	100.0	105.4	100.0	105.9
55-70	100.0	113.1	100.0	128.3
70-85	100.0	121.0	100.0	132.2
T	100.0	106.2	100.0	129.8
tr_1	100.0	52.7	100.0	29.2
tr_2	100.0	56.7	100.0	27.9
tr_3	100.0	58.3	100.0	35.8
τ_k	50.2%	87.2%	13.0%	27.2%
r	3.8%	2.8%	5.7%	3.9%
Welfare	100.0	91.7	100.0	105.0
Gini	0.75	0.708	0.63	0.589

Eliminating social security implies getting rid of mandatory savings for future retirement. In the aggregate, eliminating social security increases savings in the form of interest bearing assets as evidenced by higher capital output ratios in both countries. The capital output ratio rises by 15% in the US and 21% in Korea, respectively. For wealth across age groups, for both countries, the wealth of the youngest cohorts aged 25-40 are almost halved, while the wealth of other cohorts increase.

For intergenerational transfers, higher level of wealth accumulation during the retirement subsequently leads to higher level of bequests in both countries. Average bequest rises by 6% in the US and 30% in Korea. As for intervivos transfers, self-savings for future retirement leads to lower intergenerational altruism, with the level of intervivos transfers decreasing significantly in both countries. In the United States, the decrease ranges between 42% and 47%, while in Korea, the range is between 64% and 70%.

Given revenue neutrality assumption, rate of return on assets decreases and the capital income tax rate increases. Interest rates decline by 1.0% point and 1.8% points due to larger accumulation of assets, whereas tax rates increase by 37.2% points and 14.2%

points in the US and Korea, respectively. For welfare level in the US, there is a decline of 8% while there is an increase of 5% in Korea. Finally, the Gini coefficients decrease by approximately 4% points in both countries.

6.4 Raising Consumption Tax under Revenue-Neutrality

The next two experiment conducts revenue-neutral fiscal policies. First policy analyzes the potential effect of raising the current consumption tax from 5% to 10%. Due to revenue neutrality, tax on assets is lowered subsequently. Table 12 shows the change in the aggregate ratios, tax rates, intergenerational transfers, and welfare.

Table 12: Aggregate Statistics (Raising Consumption Tax)

	US		Korea	
Parameter	($\tau_c = 5\%$)	($\tau_c = 10\%$)	($\tau_c = 5\%$)	($\tau_c = 10\%$)
Capital output ratio	3.187	3.368	2.455	2.583
Transfer-to-bequest ratio	0.27	0.292	0.91	0.961
Average Wealth				
25-40	100.0	114.5	100.0	105.3
40-55	100.0	106.9	100.0	102.2
55-70	100.0	104.1	100.0	102.4
70-85	100.0	102.7	100.0	103.2
T	100.0	103.4	100.0	102.9
tr_1	100.0	130.1	100.0	114.2
tr_2	100.0	113.7	100.0	108.1
tr_3	100.0	106.9	100.0	108.0
τ_k	50.2%	46.9%	13.0%	10.7%
r	3.8%	3.5%	5.7%	5.5%
Welfare	100.0	98.5	100.0	98.0
Gini	0.75	0.727	0.63	0.631

Raising consumption tax under government revenue neutrality implies lower tax rate on capital returns, which mainly affects the increase in the savings in the economy and higher capital output ratios. Quantitatively, capital output ratios increase by 5.7% and 5.2% in the US and Korea, respectively. Average wealth of all cohorts increase, with the largest gain reported among the youngest cohorts aged 25-40.

For intergenerational transfers, higher level of wealth accumulation during the retirement subsequently leads to higher level of bequests in both countries, with average bequest rising by approximately 3% in both countries. Intervivos transfers to younger cohorts increase proportionally more than the increase in the average bequest, thus raising the overall transfer-to-bequest ratios in both countries. The transfer-to-bequest ratio rises by 2.2% points in the US and 5.1% points in Korea.

Higher asset accumulation lowers interest rates in both countries. Welfare declines due to lower consumption for all age groups. Finally, the Gini coefficient decreases in the US while remaining constant in Korea.

6.5 Lowering Capital Tax under Revenue-Neutrality

In this section, we look at the potential effect of lowering the capital income tax rate. Due to revenue neutrality, tax on consumption now adjusts to keep the government expenditure fixed. Table 13 shows the change in the aggregate ratios, tax rates, intergenerational transfers, and welfare.

Table 13: Aggregate Statistics (Lowering Capital Tax)

Parameter	US ($\tau_k = 50.2\%$)	US ($\tau_k = 25\%$)	Korea ($\tau_k = 13.0\%$)	Korea ($\tau_k = 6.5\%$)
Capital output ratio	3.187	3.942	2.455	2.947
Transfer-to-bequest ratio	0.27	0.307	0.91	0.986
Average Wealth				
25-40	100.0	139.1	100.0	109.7
40-55	100.0	116.9	100.0	103.0
55-70	100.0	110.4	100.0	102.9
70-85	100.0	109.5	100.0	104.9
T	100.0	115.1	100.0	106.1
tr_1	100.0	215.1	100.0	122.8
tr_2	100.0	129.3	100.0	118.2
tr_3	100.0	115.0	100.0	109.6
τ_c	5%	30.1%	5%	30.3%
r	3.8%	2.9%	5.7%	5.5%
Welfare	100.0	93.0	100.0	89.3
Gini	0.75	0.712	0.63	0.629

Lowering the capital tax rate by half resulted in subsequent rise in the consumption tax rate to keep government revenue unchanged. In both countries, the consumption tax rate now increases from 5% to 30%. Lower taxes on savings leads to an increase in the capital output ratio by margin of 24% in the US and 20% in Korea. Across different age groups, the proportional increase in average wealth was largest for the youngest cohorts aged between 25 and 40. A big fraction of increase in this cohort comes from larger inflow of intervivos transfer from parents. Specifically, transfers to cohorts aged between 25 and 30 more than doubles in the US (215%) and increases by 23% in Korea. As wealth level is higher during retirement, the average bequest is larger under lower capital tax. The average bequest increases by 15% and 6% in the US and Korea, respectively.

For welfare change, the lowering in the capital tax results in the biggest welfare loss due to an increase in the consumption tax rate. Finally, for wealth distribution, similar to the case of consumption tax increase, lowering capital tax rate leads to lower Gini coefficient of wealth in the US. For Korea, the distribution was not sensitive to the changes in the tax rates.

7 Conclusion

In this paper, the relationship between the timing of intergenerational transfers and borrowing constraints are investigated by setting up a quantitative model calibrated to reflect some key features of the United States and the Korean economy.

It is important to note that the model abstracts from several issues. First, the model abstracts from different channels of intervivos transfers, specifically, the possibility of transfers from children to parents. While this type of 'upstream' transfer is not common in the United States, it plays more important role in Korea, especially since a formal social security system was only introduced recently. Second, the model does not allow for non-altruistic transfers coming from intergenerational risk-sharing arrangements. A two-sided intergenerational transfer can arise not only from pure altruism but also from exchange motive, where parents provide transfer to children to be paid back when they are retired. The existence of both types of intergenerational transfers involves incorporating both altruistic and exchange motives, which raises several challenging questions for future research. Second, the model constructed abstracts from different taxation issues. Different tax rates on gift and inheritance may also affect the timing of transfers from parents to children. These issues as well as other possible country-specific idiosyncracies are left as further research agenda in the future.

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Appendix: Korean Data and Estimation

In this study, we use the 2002 wave of Korean Labor Income Panel Study (KLIPS), which is a socio-demographic panel study which includes data about household income and wealth as well as other demographic factors. It's particularly useful to study intergenerational linkages since it provides information about financial transfers between family members as well as non-financial in-kind services such as number of visits children make to their parents living separately. As for the financial transfers, the KLIPS survey asks households whether they have received any financial support from their parents during the survey year. This financial support, however, does not include lump-sum transfers such as bequests which take place on a non-regular basis.[9] Since the KLIPS survey records the financial support received, we deleted cases where either one of the parents (or both) were not alive, restricting the sample to households with only both parents of the head of the household being alive. This also restricts the age distribution of the sample with the maximum age of the head of the household being 50 years old. One unique question in the KLIPS survey is the variable 'visit'. This refers to the number of visits the household made to their parents living separately during the survey year[10] This variable is not representative of the interaction between parents vs. children as it only covers interaction between generations living apart and also does not cover the length of the visit nor other types of interaction. However, it provides a useful information for our study. For household income variable, total income is the sum of labor earnings, financial and real estate earnings, as well as transfer earnings, including both public and private transfers. After filtering out the data, the total sample was reduced to 657 households. Table 14 shows the summary statistics of the total sample used for our study. Since the main focus is on the transfers, we also show in Table 15 the summary statistics for the subsample where households receive positive amount of transfers. All monetary magnitudes are expressed in 2002 US dollars.

Just to summarize subsample of households with positive transfers described in Table 15, it is noted that, on average, households receiving positive transfers are younger and more like to be homeowners, receive less income, and make more frequent visits to their parents.

[9] KLIPS survey also asks if the household has received bequests or other private transfers subject to taxation. We did not include this amount to the financial transfer category.

[10] In a more frequent case, the survey asks the frequency on a monthly basis.

Regression Results

Transfer Decision

This section outlines the basic framework to estimate how financial transfers received by children can be affected by various variables. Since the focus is on the borrowing constraints and the family interaction, the variables used in Table 14 represent some important factors determining the decision to make financial transfers.

The dependent variable is an indicator with value 1 if the household received transfers, and zero otherwise. Since the data observation incorporates households receiving transfers, the dependent variable incorporates the transfer decision made by the parents households. As for the list of the explanatory variables, first of all, the current income of the recipient is taken into account. Following Cox (1987) [11], both altruism and exchange motive would predict a negative coefficient for the income of the recipient. In addition, being poor may indicate the existence of borrowing constraints. Not only the current income, but also permanent income matters in our specification. However, since permanent income was not directly observable, we added the education level and the age as proxy variable for permanent income. Next, as one implication of transfer decision comes from whether the household is borrowing constrained or not, variables related to borrowing constraints are also considered. Homeownership could be one indicator of whether the household is borrowing constrained or not. Another indicator used is whether the household is employed or not. Since the usual mortgage lending practice is that the per-period mortgage payment cannot exceed a certain fraction of the current period income, it would be safe to assume that unemployed households are suffering from borrowing constraint. Finally, the number of visits was included to measure the amount of services provided by the household to their parents who live apart. Under exchange motive, the probability of receiving a transfer is related to the amount of service rendered to the parents. Household size was included because it would be plausible to assume two implications. Larger-sized households would have less time to make visits their parents, but at the same time, since the parents want to see their grandchildren, households might make more visits. The main findings from the Probit regression is shown in Table 16. The first column reports the Probit coefficient, and the second column reports the Z-statistics. The marginal effects dy/dx are reported in the third column.

Similar results were derived when a logit regression was conducted on the same specification. The results are shown in Table 17.

From both the Probit and Logit estimations, we find that the income of the recipient, age, homeownership and the parent vs. children contact are all individually significant. The income of the recipient, as measured by the log of the non-transfer income [11], is negatively correlated to the probability of receiving transfer. Same negative correlation holds between age and the probability of transfers. The younger the household, the higher the probability of receiving transfers. On the other hand, children's visit to their parents are positively correlated to the probability of receiving transfers, which is consistent with exchange motives. Finally, the homeownership is positively correlated to the probability of receiving transfers. Since the homeownership is a discrete variable, it's unclear whether this can be interpreted as a homeowner having higher probability of receiving transfers or as the shift from renter to homeowner will increase the probability or receiving transfers. Summarizing these findings, it occurs that transfers are being targeted to young but less well-off households who make more frequent visits to their parents.

Transfer Amount

As for the actual amount of transfers received, we first run a simple OLS regression with two different specification for the dependent variable. As shown in Table 18, we used the fraction of transfer income out of total income for the first specification and the actual transfer income amount for the second specification. In the second specification, we added the log of non-transfer income into the list of the explanatory variables.

We also run a generalized Tobit regression as a large fraction of respondents receive zero transfers from their parents. In this case, it is well-documented that the OLS estimates

[11] This refers to the total income minus the transfer income received by the household.

can become biased and inconsistent. In Table 19, we show the results from the Tobit regression.

From the generalized Tobit regression, there is a common evidence of age and the number of visits being statistically significant variables in the specification. The actual amount of transfer or the transfer income as a fraction of total income is negatively correlated to the age of the household, but positively correlated to the number of visits. Under altruistic transfer motive, the income of the transfer recipient has negative coefficient. However, the results from the Tobit regression show that the negative coefficient for the non-transfer income is not statistically significant.

Children's Service as Dependent Variable

Finally, we run a simple OLS regression with the number of visits as the dependent variable. Looking at the sign of the coefficient with respect to the income of the transfer recipient, Cox (1987) [11] argues that altruism implies the coefficient to be zero whereas under the exchange regime, the sign would be negative. The results of the regression are shown in Table 20.

From the regression results, the statistically significant variables turned out to be the age, transfer income and the homeownership. The number of visits that respondents make to their parents were positively associated with the transfer income they receive. As for homeownership variable, we can either interpret it as homeowners being more frequently visiting their parents or as the transition from renter to homeowner will increase the frequency of visit to the parents. Finally, younger households are more like to make more frequent visits to their parents.

Appendix: Computation

Since there is no closed form solution to the model, the stationary equilibrium of the model is solved numerically to work out optimal decision rules as a function of the state variables. The optimal decision rules were found by backward induction, starting at the terminal period T and working all the way recursively to the initial period. In period T, the value functions coincide with the sum of the period utility function and the bequest function, and, given the realization of the state variables, the consumption and bequest choices are trivial. Based on the period J policy functions, in every period prior to J, the values associated with the different choices of consumption and asset choices were obtained subsequently. For choices of control variables that violate various constraints, a large negative utility is given so that an optimizing household would never opt for these choices. The realization of the earnings process are approximated using a Markov process following Tauchen and Hussey (1991) [26]. The state space for assets was discretized into a finite number of grid points.

$$a \quad \in \quad \{a_{min}, \ldots, 0, \ldots, a_{max}\}$$

Whenever the upper limit for the grids turned out to be binding in the solution to the problem, the upper and lower bounds were increased and the problem was solved again. In the end, the boundaries for the grids became sufficiently large and no longer imposed any constraint on the optimization process.

Solving for the stationary equilibrium, I take the following steps similar to the method introduced by Nishiyama (2006):

1. Make a guess on the interest rate r^0 and use the factor market equilibrium conditions[12] to obtain ω^0.

2. Make a guess on the bequest received. Bequest is assumed to be seized by the government and re-distributed equally among agents in periods 4 to 6. (35 to 50)

3. Make a guess on the marginal value function in period 7. $\frac{\partial dV_7(a,y)}{\partial da}$

4. Solve the last 3 period problem of the parents ($t = 10 - 12$) in (8).

[12] $\omega = (1-\alpha)\left((\frac{r+\delta}{\alpha})^{\frac{\alpha}{\alpha-1}}\right)$

5. Solve for periods $\tilde{t} = 4, 5, 6$ problem of the children starting from period 6 as shown in (9). In period 6, the marginal value function in the next period is taken from the guess made at (3).

6. Make a guess on transfers received (in period 3) by children and the parents choice perceived by children.

7. Solve period 3 problem of the children ($\tilde{t} = 3$) taking guessed transfer and parents' choice as given in (11).

8. Solve period 9 problem of the parents ($t = 9$) taking children's consumption and transfers as given in (10).

9. Check whether $u'(c) \geq \gamma u'(\tilde{c})$ with equality when $tr > 0$. If not, update with tr^* that solves

$$\begin{aligned} \epsilon &= argmin \;\; |\gamma u'(\tilde{c} + \epsilon) - u'(c - \epsilon)| \\ s.t. & \qquad tr^* = tr + \epsilon \end{aligned}$$

   and go back to step 6.

   Otherwise, go to the next step.

10. Iterate backwards in periods $\tilde{t} = 1, 2$ for children and $t = 7, 8$ for parents.

11. Compare the guessed marginal value function with the actual marginal value function found in period $t = 7$. If they are sufficiently different, then update the marginal value function and go back to step 3. Otherwise, go to the next step.

12. With all the value function and decision rules calculated, find the stationary distribution of households. Find the average bequest and update the guessed bequest with the calculated bequest, and go back to step 2.

13. If the bequest level converges, find the aggregate quantities and calculate the factor price r^1 using the aggregate capital stock K and labor input L, and compare with

the initial values r^0. If the difference is sufficiently small, an equilibrium is found. If not, go to step 1 with updated factor prices.

Table 14: Summary Statistics of 2002 KLIPS Sample

Variable	**Mean**	**Standard Deviation**
Sample size	657	
Age	37.92	5.61
Fraction of Positive Transfers	0.30	0.46
Financial Transfers	692.25	3631.17
Total Income	30354.16	25357.37
Household Size	3.69	0.92
Fraction of Homeowners	0.49	0.40
Fraction of Positive Visits	0.97	0.14
Number of Visits Per Year	33.80	63.09
Education		
Below High School Degree	0.10	0.30
High School Degree	0.43	0.49
College Dropout	0.13	0.33
College Degree	0.34	0.48

Table 15: Summary Statistics of 2002 KLIPS Sub-Sample with Positive Transfers

Variable	**Mean**	**Standard Deviation**
Sample size	201	
Age	36.87	5.31
Financial Transfers	2262.77	6298.97
Total Income	29497.10	23741.15
Household Size	3.70	0.90
Fraction of Homeowners	0.53	0.50
Fraction of Positive Visits	0.98	0.14
Number of Visits Per Year	46.54	87.37
Education		
Below High School Degree	0.08	0.28
High School Degree	0.45	0.50
College Dropout	0.12	0.33
College Degree	0.34	0.48

Table 16: Probit Regression Results on the Positive Transfers †

	Estimate	Z-Statistic	Marginal Effects
Log of Non-transfer Income	-0.215	-2.20 ‡	-0.074
Age	-0.034	-3.21 ‡	-0.012
Household Size	0.094	1.49	0.032
Homeownership §	0.243	2.18 ‡	0.084
Number of Visits	0.002	2.55 ‡	0.0007
Employment §	-0.091	-0.37	-0.032
Education			
High School Degree §	0.074	0.38	0.027
College Dropout §	-0.043	-0.18	-0.014
College Degree §	0.069	0.33	0.024
Constant	2.001	2.41	
Pseudo R^2	0.0374		

† Dependent variable is an indicator with value 1 if the household received transfers, and 0 otherwise.

‡ Statistically significant at 95% confidence level.

§ dy/dx is for discrete change of dummy variable from 0 to 1.

Table 17: Logit Regression Results on the Positive Transfers †

	Estimate	Z-Statistic	Marginal Effects
Log of Non-transfer Income	-0.365	-2.22 ‡	-0.076
Age	-0.058	-3.18 ‡	-0.012
Household Size	0.153	1.45	0.032
Homeownership §	0.407	2.19 ‡	0.085
Number of Visits	0.003	2.60 ‡	0.0007
Employment §	-0.142	-0.35	-0.030
Education			
High School Degree §	0.134	0.41	0.028
College Dropout §	-0.069	-0.17	-0.014
College Degree §	0.134	0.38	0.028
Constant	3.404	2.44	
Pseudo R^2	0.0377		

† Dependent variable is an indicator with value 1 if the household received transfers, and 0 otherwise.

‡ Statistically significant at 95% confidence level.

§ dy/dx is for discrete change of dummy variable from 0 to 1.

Table 18: OLS Regression Results on the Transfer Amount

Dependent Variable	$\frac{TransferIncome}{TotalIncome}$		**Transfer Income**	
	Estimate	**T-Value**	**Estimate**	**T-Value**
Log of Non-transfer Income	–	–	122.494	0.47
Age	-0.0003	-0.51	-26.150	-0.91
Household Size	-0.0040	-1.02	146.293	0.87
Homeownership	0.0020	0.30	36.782	0.12
Number of Visits	0.0002	2.91 ‡	2.764	1.22
Employment	0.0517	-3.24 ‡	143.477	0.21
Education				
High School Degree	0.0020	0.10	-135.755	-0.26
College Dropout	-0.0100	-0.70	-161.548	-0.26
College Degree	0.0050	0.41	769.670	1.38
Constant	0.093	2.77	-536.387	-0.20
R^2	0.0357		0.0201	

‡ Statistically significant at 95% confidence level.

Table 19: Tobit Regression Results on the Transfer Amount

Dependent Variable	$\frac{TransferIncome}{TotalIncome}$		**Transfer Income**	
	Estimate	**T-Value**	**Estimate**	**T-Value**
Log of Non-transfer Income	–	–	-666.693	-1.01
Age	-0.0045	-2.40 ‡	-197.793	-2.56 ‡
Household Size	0.0018	0.17	698.164	1.55
Homeownership	0.0258	1.36	1105.303	1.42
Number of Visits	0.0004	3.01 ‡	12.102	2.31 ‡
Employment	-0.0943	-2.39 ‡	-228.029	-0.13
Education				
High School Degree	0.0058	0.17	201.531	0.14
College Dropout	-0.0107	-0.75	-384.116	-0.23
College Degree	0.0032	0.09	1615.172	1.09
Constant	0.1128	1.25	5196.321	0.76
adjusted R^2	0.0827		0.0047	

‡ Statistically significant at 95% confidence level.

Table 20: OLS Regression Results on the Number of Visits

Dependent Variable	Number of Visits	
	Estimate	**T-Value**
Age	-1.338	-2.74 ‡
Transfer Income	0.006	4.07 ‡
Non-Transfer Income	-0.000	-0.22
Household Size	-3.736	-1.31
Homeownership	11.361	2.20 ‡
Employment	-11.995	-1.05
Education		
High School Degree	0.229	0.03
College Dropout	2.460	0.23
College Degree	-9.957	-1.07
Constant	105.574	23.915
R^2	0.0504	

‡ Statistically significant at 95% confidence level.