The Impact of Korean Fiscal Policy Changes: A Multi-Region Life Cycle DSGE Approach

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Our question

The goal of this project is to use a dynamic general equilibrium model to examine the micro and macroeconomic effects of a broad array of demographic, economic, and policy issues in six major world players: the US, Europe, Japan, Korea, China, India, and Russia. Specifically, we hope to first examine the impact of fiscal policy changes in Korea on both the Korean economy and the world economy. We will model the impact of social security/penchant reform to better understand the implications of fiscal reform. However, the versatile model has the potential to yield a variety of different outcomes.

The Multi-Regional World Model

The multi-regional world model is based on previous work in Fehr et al. (2007, 2008, 2010). In each region, there are 90 overlapping generations split into three skill classes producing six goods - two traded and two non traded consumer goods, a traded investment good and a non-traded public consumption good. There are heterogeneous labor inputs with varying wages relative to other groups. And the model includes age specific demands for certain goods like healthcare. Capital is assumed as internationally mobile while labor is not (except immigration).

Demographics

Agents live until age 90, so there are 91 generations of surviving members at any point in time. From ages 0-20, agents are non-working children supported by their parents. From age 21, agents become independent households and between ages 23 and 45, agents give birth to fractions of children each year. Agents die between ages 68 and 90, with probability of death $= 1$ at age 91.

In each year new immigrants in each skill and age group arrive with the same number and age distribution of children and the same level of assets as natives of the identical skill and age. Once they join a native cohort, they experience the same future age-specific fertility and mortality rates as native-born agents.

Household Sector

The model's preference structure is represented by a time seperable nested CES utility function where remaining lifetime utility of generation age l at time t in skill group k is

$$U(l, t, k) = V(l, t, k) + H(l, t, k)$$

where $V(l, t, k)$ is utility from own consumption and $H(l, t, k)$ is utility from children's consumption.

Household Sector

$$V(I,t,k) = \frac{1}{1-\frac{1}{\gamma}} \sum_{a=I}^{90} (\frac{1}{1+\delta})^{a-I} P(a,i)[\bar{c}(a,i,k)^{1-\frac{1}{\rho}} + \epsilon l(a,i,k)^{1-\frac{1}{\rho}}]^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}}$$

$$H(I,t,k) = \frac{1}{1-\frac{1}{\gamma}} \sum_{a=I}^{90} (\frac{1}{1+\delta})^{a-I} P(a,i) KID*(a,i,k) \bar{c}_K(a,i,k)^{1-\frac{1}{\rho}}$$

$c(j,a,i,k)$, $l(a,i,k)$ are respectively private consumption of goods j and private consumption of leisure. $\kappa(j,a)$ is the consumption share of good j at age a where $\sum_{j \in G_c} \kappa(j,a) = 1$

$\bar{c}(a,i,k)$ is the aggregate private consumption good and $\bar{c}_K(a,i,k)$ is the aggregate consumption of children. Number of children supported by parents age a is $KID(a,i,k)$.

Household Sector

The price index of the aggregate consumption good $\bar{c}(a, i, k)$ is

$$\bar{p}(a, i) = [\sum_{j \in G_c} \kappa(j, a)^{\omega} p(j, i)^{1-\omega}]^{\frac{1}{1-\omega}}$$

Utility in future periods is weighted by the probability of reaching age a in year i is

$$P(a, i) = \prod_{u=l}^{a} [1 - d(u, u - a + i)]$$

Household Sector

Given price indixes $\bar{p}(a, i)$, interest rates $r(i)$ and wages $w(i, k)$, agents maximize utility subject to the intertemporal budget constraint by choosing leisure and consumption demands $l(a, i, k), \bar{c}(a, i, k), \bar{c}_K(a, i, k)$

Demand for specific goods $j \in G_c$ are derived from

$$c(j, a, i, k) = \left(\frac{\kappa(j, a)}{p(j, i)}\right)^{\omega} \bar{p}(a, i)^{\omega} \bar{c}(a, i, k)$$

Household Sector

Given an asset endowment $a(l,t,k)$ and inheritances received in year t, $I(l,t,k)$, the budget constraint is defined as

$$a(l+1,t+1,k) = [a(l,t,l) + I(l,t,k)](1+r(t))$$

$$+w(t,k)E(l,t)[h(l,t) - l(l,t,k)] - T(l,t,k)$$

$$-\bar{p}(l,t)[\bar{c}(l,t,k) + KID(l,t,l)\bar{c}_K(l,t,k)]$$

.

$h(a,i)$ is the time endowment of an agent age a at time i with $h(a,i) = (1+\lambda)h(a,i-1)$ and $E(a,i)$ is the year specific productivity per time unit. Net taxes, $T(l,t,k)$, include consumption, capital income, and progressive wage taxes as well as social security contributions, pension, disability and transfer health benefits.

Household Sector

Given individual consumption and leisure, we can aggregate values of assets, bequests, private consumption goods and labor supply:

$$A(t+1) = \sum_{k=1}^{3} \sum_{a=21}^{90} \mathbf{a}(a+1, t+1, k) N(a, t, k)$$

$$\bar{A}(t+1, k) = \sum_{a=21}^{90} d(a+1, t+1) \mathbf{a}(a+1, t+1, k) N(a, t, k)$$

$$C(j, t) = \sum_{k=1}^{3} \sum_{a=21}^{90} [c(j, a, t, k) + KID(a, t, k) c_K(j, a, t, k)] N(a, t, k)$$

$$L^s(t, k) = \sum_{a=21}^{90} E(a, t)[h(a, t) - l(a, t, k)] N(a, t, k)$$

Production Sector

Aggregate output $Y(j,t)$ of each good j is produced according to Cobb- Douglas Production:

$$Y(j,t) = \phi K(j,t)^{\alpha(j)}[\prod_{k=1}^{3} L(j,t,k)^{\beta(j,k)}]^{1-\alpha(j)}$$

where $\sum_{k=1}^{3} \beta(j,k) = 1$ and ϕ refers to total factor prductivity and $\alpha(j), \beta(j,k)$ denote capital's share and share of skill specific labor inputs in production.

Production Sector

Profit maximization requires

$$[r(t) + \delta_K]K(j, t) = \alpha(j)q(j, t)Y(j, t)$$

$$w(t, k)L(j, t, k) = [1 - \alpha(j)]\beta(j, k)q(j, t)Y(j, t)$$

where δ_K is the depreciation rate and $q(j, t)$ is the producer price of good j in t.

Government Sector

Each government issues debt $\Delta B(t)$ and collects taxes to finance government expenditures $q(g,t)C(g,t)$ (producer price * producer quantity), general revenue financed social benefits $SB(t)$ (pension, healthcare, disability) and interest on existing debt:

$$\Delta B(t) + \sum_{k=1}^{3} \sum_{a=21}^{90} T(a,t,k)N(a,t,k)$$

$$= q(g,t)C(g,t) + \varrho SB(t) + r(t) + B(t)$$

ϱ denotes the share of transfer payments financed by general revenue.

Government Sector

Each government maintains its debt-to-output ratio over time. The progressivity of wage taxes is modelled after Auerbach and Kotlikoff(1987) with marginal wage tax rising linearly with wage tax base. $PY(t)$ is the aggregate payroll tax base that has a fixed ceiling at a percentage of average income in a particular country (ie US's ceiling is 290).

Average employer and employee payroll tax rates $\hat{\tau}^p(t)$ for pension, healthcare and disability programs are region specific:

$$\hat{\tau}^p(t)PY(t) = (1 - \varrho)SB(t)$$

Government Sector

Pension benefits $Pen(a, t, k)$ depend linearly on average earnings during working life $\bar{W}(i, k)$:

$$Pen(a, t, k) = \nu_0 + \nu_1 \times \bar{W}(i, k)$$

where region specific parameters ν_0, ν_1 are chosen to match replacement rates reported in OECD(2009).

Computation Methodology

of what?

The computation method follows the Gauss-Seidel procedure of Auerbach and Kotlikoff (1987). Starting with an initial guess for quantities and government policy, we compute prices, optimal household decisions, and value functions. This involves discretizing the continuous elements of our state space Z using an algorithm descrived in Tauchen and Hussey (1991) to obtain an approximation of the distribution of ν with a set ϵ and a suitable probability funtion $\hat{\pi}$.

For discrete values of z_j we solve the household's optimization problem with numerical maximization and interpolation algorithms, Habermann and Kindermann (2007). With household measures, new macro quantities, and tax rates for social security and consumption to balance government budgets, we can update initial guesses. This repeats until values for quantities, prices and public policy sufficiently converge.

Computation Methdology

More specific

1 Normalize producer price of investment good and start with initial guesses of factor prices and product prices of consumption goods. This determines consumption, labor, and asset demands per region.

2 Sum up demand of traded goods and difference future and current assets (net public debt) across regions. This determines required world output for traded and investment goods.

3 Update factor and producer prices to compute region specific shares of production of traded goods using world supplies = world demands.

The economy is given 300 years to reach the steady state, which it (usually) converges to decades prior. We assume domestic firms outsource labor until any negative output shares disappear.

Data and Parameterization

The main data source for our population data is the medium variant of the United Nations population projections (UNPD 2008). Other callibrated parameters are gathered from UNESCO and country specific resources.

Labor estimates (dividing cohorts into the three different skill classes k) are obtained from Barro and Lee (2001) and OECD (2008) region specific earnings-dispersion data.

The aggregation of goods into four consumption goods (services, housing, low and high tech), an investment good and a public good is based on the March 2007 release of the EU-KLEMS database.

US Capital and Labor Shares

	Symbol	Services	Housing	Low Tech	High Tech	Investment Good	Public Good
Capital share in production	$\alpha(j)$	0.26	0.57	0.44	0.41	0.35	0.26
Share of specific labor inputs	$\beta(k, j)$						
Low-skill($k = 1$)		0.08	0.11	0.15	0.03	0.06	0.02
Medium-skill($k = 2$)		0.57	0.62	0.58	0.38	0.57	0.39
High-skill($k = 1$)		0.35	0.27	0.27	0.59	0.37	0.59
Technology coefficient	ϕ			4.25*			
Depreciation rate	δ_K			0.075			

Preference, Productivity and Policy Parameters

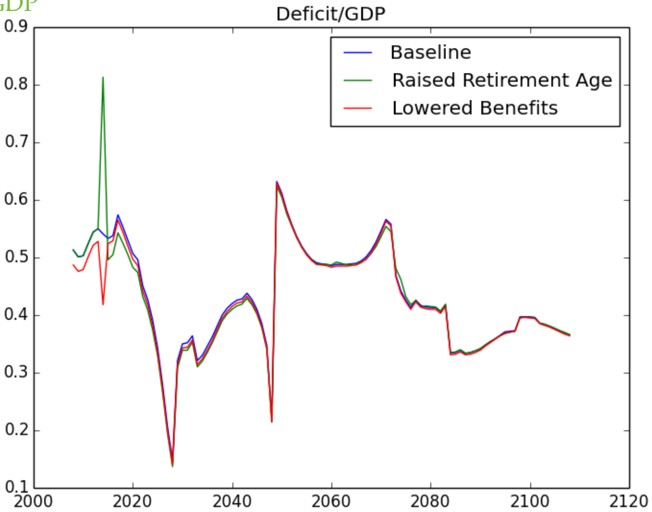
	Symbol	US	EU	JP	CH	IN	RU	KO
Capital Tax	τ^r	0.11	0.14	0.08	0.03	0.03	0.24	0.15
Debt (% of national income)	B/Y	0.7	0.76	1.46	0.21	0.72	0.1055	0.33
Retirement age	$\cap a$	63	60	60	60	60	58	65
Depreciation rate	δ_K				0.075			
Time preference rate	δ				0.01			
Intertemploral elasticity of substitution	γ				0.25			
Intratemploral elasticity of substitution								
-consumtion and leisure	ρ				0.4			
-consumtion goods	ω				1.1			
Leisure preference	ϵ				1.5			
Technological progress	λ				0.01			

Reforms Considered

1. Raising the retirement age (Kim 2012) from 65 to 67
2. Decrease in Social Security benefits (Kim 2012) from a 40% to 35% replacement rate

Defecit/GDP

Percent of GDP



Year

Next Steps

3 Increase in Social Security contributions (Kim 2012) from a 9% to 10% payroll tax rate